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and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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The Disposal of Creamery Refuse.

Wastes from dairy industries are among the most troublesome of trade waste waters. These wastes are difficult of disposal owing to their rapid decomposition. All the dairy wastes, whether from milk clarifying and pasteurizing works, cream separating and churning works, cheese factories or works for the production of casein or milk sugar, are very susceptible to bacterial action. The wastes are highly acid and, due to the production of butyric acid, produce very bad odors. When these wastes are discharged into small streams the oxygen in the stream is soon consumed and a nuisance is created.

Engineers experienced in sewage disposal are rapidly becoming actively interested in the problem presented in the disposal of trades wastes. A short time ago a Chicago engineer was looking up the subject of creamery refuse disposal and could find but few data on this subject in readily available engineering literature. Calls on other engineers and engineering editors failed to yield much additional enlightenment. In this issue we publish an admirable summary of previously published data and conclusions bearing on the subject of creamery refuse disposal.

The authors do not advance anything new but have made a systematic collection of the papers on creamery refuse disposal, heretofore widely scattered, and group the salient features of such papers for easy reference. This summary of what has already been done will form a much appreciated basis for future studies of this subject.

"Overhead Costs."

There appears in this issue the third article by H. P. Gillette on the valuation of water works. In this article the author discusses the appraisal of "overhead costs"—a term which, he points out, has no precise meaning save by more or less arbitrary definition.

In rate cases there are many instances of wide disagreement among witnesses as to percentages to be allowed fairly for "overhead costs," ranging from as low as 12 per cent to as high as 50 per cent. Mr. Gillette points out many reasons why the percentages may differ. One of the most important of the causes of difference is found in the method of doing the construction work. If the work is done by contract, the contract prices include certain overhead costs which would appear separately and be classed as "overheads" were the work done by the utility company's forces.

Although it is commonly assumed that nearly all the cost of production is a "direct cost," that is directly assignable without prorating, this is rarely the case. On the contrary a large part of many costs must be distributed or prorated to the units, on some theory. Thus there is opened a wide door for the entrance of divergent views.

In this connection we may instance the practice of two large manufacturing companies, one of which so prorated its "overhead costs" as to "load" its large machinery very heavily with charges, while the other company, on a different theory, "loaded" its small machinery with an excessive amount of "overheads." Naturally, the cream of the business in small machinery went to one company, while the other company took most of the orders for large machines. Thus differences in cost-keeping theories resulted in gradually driving each company out of a field that it should have occupied. This continued for several years, until one of the companies adopted an entirely different theory of prorating "overhead costs." Eventually, through changes in cost accounting, both companies became successful competitors for large as well as for small machines.

We cite this example to show that, even where competition makes the wits of men most keen, there may be serious divergence of opinion as to proper methods of allocating those items of indirect costs commonly called "overheads."

Although "overhead costs" have frequently been a bone of contention in appraisal cases, comparatively little has been published on the subject. Mr. Gillette's article should assist in eliminating some of the confusion that has arisen from lack of definition of "overhead costs" as used in appraisals.

An Editor as City Manager.

The great majority of city managers have been recruited from the ranks of men trained and experienced in municipal engineering. Some managers, however, have been called to this service from various vocations having nothing whatever to do with the administration of municipal business. Thus we find that one city manager was a lumber buyer and shipper, another a clerk of a judicial district, another a school teacher, another a fire insurance agent, and so on including a lawyer, a real estate speculator and one man whose record compels his classification as a politician. A few managers have seen service in positions somewhat allied to the managership of a city. In this group are former utility managers, a superintendent of water works, a superintendent of streets, and a superintendent of sewers. Now comes the announcement that the new city manager of Bakersfield, Cal., is an editor. For many years, we understand, he has been editor of one of the local papers.

This journal from preference and duty has always advocated the selection of a municipal engineer to fill the important post of city manager. When one of our progressive secondary cities called to its managership an experienced city engineer we wished him a full measure of success, believing that on his success our reliability as prophets as well as the future of the city manager plan in the larger cities would, for the near future at least, largely depend. That was a year and a half ago and this engineer has succeeded so well that we are no longer apprehensive that engineers will not make good as city managers. The news from Bakersfield, however, renders us once again as anxious as Andromachæ watching Achilles chase Hector around the walls of Troy.

We have no doubt that this Bakersfield editor has, in past years, given much advice through the columns of his paper to the city officials. Very probably he has told them just how to run the town. Apparently his advice was not taken, for the old form of government has been overthrown and he now undertakes a demonstration of how the city's business should be handled. May the gods uphold his hands! He goes to his post as the champion of all editors. It rests with him to vindicate the right of editors to tell other people how to run their affairs. Failure on his part will tend to render innocuous all editorial advice with respect to municipal management. We trust that the gentleman realizes that it is strictly up to him.

Of course we are only a distant cousin of his but the very remoteness of our relationship renders it incumbent upon us to wish him well and to quicken his appreciation of his broad responsibilities in the premises. This for the reason that we fear he will experience much difficulty as city manager in pleasing the editors of the other Bakersfield papers.

Construction Plant and Some Features of the Plant Used for the Detroit-Superior High Level Bridge in Cleveland.

It is difficult for those not engaged in construction work to appreciate the foresight and careful planning necessary to insure profit to the contractor, especially under conditions which now must be faced. A careful study of efficient construction methods on the part of the engineer is necessary if he is to design structures capable of being built economically. Contractors also must be prepared at all times to adopt efficient construction devices, even though this may mean a considerable change in the equipment possessed by them. It is, of course, evident that each construction job presents new problems, which must be given studied attention if they are to be solved economically, but a careful study of the equipment used on important jobs will usually disclose some device or method which can be adopted by others with only slight modification. The mistake should not be made, however, of believing that the most efficient methods are always used on large construction jobs, as necessity often compels the small contractor to use ingenuity and the highest skill to complete the job in hand with the equipment available to him.

In this issue we are publishing an article on the methods and equipment used in building the superstructure of the Detroit-Superior high level bridge in Cleveland, Ohio. A study of the data presented will disclose a number of simple yet effective devices used by the contractors on this work to secure economical construction. This bridge, which has a total length of 2,880 ft., offers an interesting study of the development which is taking place as highway bridge construction. It consists essentially of a series of long-span concrete arches flanking a 591-ft. steel arch over the channel of the river. The structure provides for a very heavy traffic by means of a double deck, the upper deck being designed for highway traffic only, while the lower deck is to carry six street railway tracks.

A double cableway of 1,200-ft. span serves that portion of the bridge which lies east of the river, the spacing of cables being such that each cable serves two of the four arch ribs of the concrete spans. The use of six sets of three-hinged steel centers enables work to be carried on simultaneously on two arch ribs in each of three different spans. The steel centers are supported on a track, which enables them to be shifted to the other side of the center line as soon as the first two arch ribs of each span are completed. The cableway has a capacity sufficient to set an entire segment of the three-hinged arch centers, weighing 12½ tons, at one operation. The two upper panels of each segment of these centers are provided with a toggle device which enables them to be easily lowered as soon as the concrete has set sufficiently.

The arrangement of the various units of the concrete plant is especially effective. This plant is located on the river bank, which enables the sand and broken stone to be unloaded from barges, by locomotive cranes equipped with clam-shell buckets, into storage piles, one on each side of the concrete plant. The sand is handled direct to a bucket elevator which lifts it about 50 ft. into the storage hoppers, while the broken stone is transported to its bucket elevator by a belt conveyor operating in a tunnel under the stone pile. The cement is delivered by rail to a storage shed having a capacity of 6,000 bbls., this shed being located about 100 ft. from the mixer. A 36-in. gage automatic dump car conveys the cement up an incline to the mixing platform of the concrete plant. A steam engine located on top of the plant operates both elevators and the belt conveyor. The radial gates, with which the storage hoppers are equipped, are particularly effective in that they are easy to operate and are positive in action. The original devices used to insure the use of proper quantities of cement and water are simple, yet they are practically fool-proof in operation. The cement is first dumped into a small hopper located at the sand side of the measuring hopper. This cement hopper, which has a capacity of six sacks, is hinged at a point just above its center of gravity, thus enabling it to be dumped easily and quickly. The water for mixing each batch is fed through a 2-in. pipe into a barrel placed at the broken stone side of the hopper. This barrel is also hinged at a point just above its center of gravity and is provided with a latch to hold it in an upright position. The small cement hopper and the water barrel can be filled while the preceding batch is being dumped, and both can be dumped almost instantly. The mixer discharges into a hopper which is directly over a 36-in. gage track; this enables the concrete to be delivered in bottom-buckets to points directly under the cableways. These buckets have gates which can be operated while the bucket is suspended from the cableway. One man on the measuring hopper floor operates the measuring hopper and also dumps the concrete mixer located on the floor below, by means of a chain and sprocket arrangement attached to the crank of the mixer.

The forms are built in units at a central saw shed and are placed in position with the aid of the cableway; they are also dismantled and again erected, by this cableway, without being lowered to the ground. A central boiler plant of 200 hp., located near the concrete plant, furnishes power for all equipment. The construction plant used on this work is an interesting example of studied planning, and the forces of the contractors have shown originality and ingenuity in its construction and use.

ROADS AND STREETS

Brick Pavement Design.

Contributed by W. D. P. Warren, Consulting Engineer, Decatur, Ill.

We are living in an age in which we speak of miles of pavements as naturally as we spoke of blocks of pavements a few years ago. Experience has shown the durability of brick pavement construction and yet many miles of other types, of inferior durability, are now being built. Many officials are demanding a pavement cheaper than brick, even though they realize that in so doing they get one less durable. In view of the enormous sums being spent for pavements, the problem now presents itself to design the cheapest and most durable brick pavement possible; to design a pavement with all the virtues that have made brick pavements favorably known; to design a pavement at a cost that will immediately attract the attention of engineers; and, above all, to design a pavement according to scientific engineering principles.

In order to obtain in a brick pavement the of a brick pavement, we must first know the requirements or the qualities that are essential in a first-class pavement of any character. Following is a list by Arthur H. Blanchard, of Columbia University, giving the recognized characteristics of a first-class pavement:

> It shall be durable, noiseless, sanitary, efficacious, for road users, easily cleaned and made dustless, provide good foothold for horses, be non-slippery for all classes of vehicles under varying climatic conditions, yield neither dust nor mud, have a low tractive resistance, low first cost, low annual cost, low maintenance charge, and an esthetic and impervious surface.

It is to be noted here that nothing is said regarding design; whether the pavement shall be one, two or three course; whether it shall have a 1 in. or a 4 in. wearing surface; whether or not it shall have a sand cushion, or whether it shall have a foundation of earth, gravel, or concrete, or whether it shall be 5 or 12 ins. in thickness.

WEARING PLATE.

In order to arrive at the scientific design greatest number of characteristics of a first-class pavement, we adopt without question a wearing plate of wire-cut-lug-brick, so united with a cement filler that the wear on them will be no more than that of friction and grinding. We thus secure in our wearing plate a combination of many virtues, virtues which are essential in any first-class pavement, and virtues which have made brick pavements famous the world over. The question now presents itself—is it economical to construct a brick pavement solely with such durable material as is necessary in the wearing plate? If not, what thickness of wearing plate is most economical and efficient?

With a one-course brick pavement, having a cement filler, the weight of traffic would be supported directly by the earth foundation and in case of failure of the cement filler through any cause, the weight of traffic might easily cause the pavement to settle where the subbase was soft, thereby producing a permanent injury to the pavement. Moreover, brick are usually expensive, being more durable than other paving materials, and experience shows that with a brick wearing plate it is more practical to support this wearing plate on a foundation constructed of cheaper materials than to build the pavement one course and depend solely on the cement filler to distribute the weight of traffic. This being true, what is the proper thickness of wearing plate? The requirements of a wearing plate are that it shall be durable, have little tractive resistance, the greatest amount of wear resistance, afford a sanitary condition, and that it shall have sufficient thickness and strength to resist crushing.

Experience has demonstrated the fact that in a well constructed brick pavement the actual wear may not exceed ¼ in. in 25 years; also that sufficient strength to resist crushing may be obtained in a brick having a thickness of 2 ins. or more. Regarding the qualities of a brick wearing plate, the Office of Public Roads, Department of Agriculture, Washington, in Bulletin No. 23, makes the following comment:

> The life of a well-constructed brick pavement can not be estimated with any great degree of exactness, first, because no brick pavement which has been constructed in accordance with the best modern practice has yet worn out. The amounts of wear sustained by given pavements during comparatively long periods of years have been determined in several instances, but have usually been so small as to make the problem of term of service appear almost indefinite.

To obtain a sanitary condition, it is necessary that a cement filler be used and that a bond be maintained between the brick, making the wearing plate monolithic. In addition to obtaining a sanitary condition, it is also the purpose and object of the cement filler to so unite the brick that the wear on them will be no more than that of friction and grinding.

It has long been the theory that a wearing plate should be supported by a sand cushion, affording a uniform support—an equilibrium to the vibration of the impact, yet a relief so slight that the cement bond would not be shattered. It is readily seen that if it is necessary to unite the brick and prevent shattering of the cement bond, it will require a greater area of brick, or, in other words, a greater depth of wearing plate. On the other hand, with a firm and unyielding foundation supporting the wearing plate, the purpose of the cement bond is simply, as before stated, to unite the brick so that the wear on them will be no more than that of friction and grinding, and afford a sanitary condition. With an unyielding foundation, the weight of traffic on the wearing plate will be immediately transmitted to the foundation and only a very slight stress will be produced in the cement filler.

An example of a brick wearing plate on an unyielding foundation is to be found in one of the modern Pennsylvania Railroad stations of New York, where it was built to care for a traffic of thousands of vehicles per day. A study of the design of this pavement is not only interesting but instructive. We have here a demonstration of the durability of a 2¼-in. wearing plate, and of the permanence of a cement filler 2¼ ins. in depth, when such a wearing plate is supported by an unyielding foundation, constructed so by adding cement to the sand cushion.

Halbert P. Gillette has long recommended for certain streets that brick should be laid flatwise for true economy's sake.

It is the belief of many engineers that for economy's sake it is necessary that a brick wearing plate should have a thickness not to exceed 3 ins.; this amount being sufficient to allow for a variation in the quality of the brick and to guarantee a proper factor of safety; and it is the further belief of many engineers that for the sake of efficiency it is necessary that this thickness be adopted; as by no process of investigation can it be ascertained that a greater thickness is required.

The design of brick pavements has gradually changed during the past thirty years; a 4 in. brick with sand filler having been used first on a rather unstable foundation, constructed of gravel, or building brick laid flatwise; later on, a 4 in. brick with sand or bituminous filler, on a substantial concrete base, and still more recently, a 4 in. brick with a cement filler on a substantial concrete base. The sand cushion has been used continuously on these various styles.

Looking backward now we can understand why a 4 in. wearing plate was necessary 30 years ago, having only a crude support below on which to distribute the weight of traffic; we can easily understand the necessity of the sand cushion in order to secure a uniform bearing for the wearing plate; and having looked backward it is more apparent than ever that we now have different conditions affecting the design of brick pavements.

As previously stated, it is of importance that when a 3 in. wearing plate is adopted, it shall rest directly on a firm and unyielding foundation. In the case of the driveway in the Pennsylvania Station, such a foundation was secured by adopting a practically dry mixture of cement and sand for the cushion, permitting it to receive sufficient moisture after the brick was rolled and at the time of the application of the cement filler to cause it to harden.

FOUNDATION.

Just as the wearing plate of a brick pavement is designed to fulfill certain requirements, so, too, is the foundation. The purpose and object of the foundation is to uniformly sustain the wearing plate: to form a monolithic support to which may be transmitted the weight of the traffic. To accomplish these purposes economically, it is necessary that a material be used which will be readily shaped to conform to the cross-section of the wearing plate, and which will support the weight of traffic. Experience has proved the value of concrete for foundation purposes, no other material being considered its equal, and this fact is shown by its use not only in brick pavement construction but in other pavement construction.

However, it is not only necessary to design the foundation to sustain the wearing plate, but it is equally as important to design it to withstand the vertical movements of the subbase. These vertical movements may be caused by the earth absorbing moisture, by the earth drying out, by the settlement of old trenches, by the action of frost, or by the settlement of fills. With a sub-base of equal density, a sub-base so thoroughly and uniformly compacted that there would be no vertical movement from any cause, the design of a foundation would be simple. However, experience has taught the necessity of design for average conditions and not ideal conditions, and it is therefore imperative that a foundation be secured having not only compressive strength, but tensile strength—strength to bridge over trenches, to bridge over soft spots in the sub-base and strength to distribute the weight of traffic. Such a foundation can be secured economically in but one way—by the use of reinforced concrete.

Reinforced concrete is concrete in which iron, steel or other metal is imbedded in such a manner as greatly to increase its strength, especially with respect to tensile stresses. A combination of steel and concrete constitutes a form of construction possessing in a large degree the advantages of both materials without their disadvantages. Concrete is characterized by low tensile strength, and yet, in disregard of this well known characteristic, how often have we seen the thickness of a concrete foundation increased 2, 3 or 4 ins., to gain additional tensile strength?

The use of reinforcement in *concrete* pavements has demonstrated a great possibility—the possibility of securing a permanent foundation for *brick* pavements at a reduced cost. Consider a reinforcement having an elastic limit of from 50,000 to 60,000 lbs. per square inch sectional area, with 85,000 lbs. ultimate strength. Take for example, Style No. 28, as placed on the market by the Trussed Concrete Steel Co., having a transverse area per foot of width of .074 sq. in. and a longitudinal area per foot of width of .037 sq. in., with a weight of approximately 30 lbs. per 100 square feet. Reinforcement of this type meets all requirements; is simply handled, being shipped in rigid sheets and can be very accurately placed.

In considering the thickness of concrete foundation necessary when used in combination with reinforcement similar to that above described, it should be remembered that the steel is mainly for the purpose of resisting tensile stresses, and the concrete mainly for the purpose of resisting compressive stresses. As an example of the strength to be obtained in a *plain* concrete slab 4 ins. thick, it will be of interest to review an experiment made at Fresno, Cal., on a section of State Highway.

According to Mr. Geo. D. Steele, the slab tested was of plain concrete, 4 ins. thick, constructed with a mixture specified as 1:2½:5. In order to learn the strength, a trench 2 ft. wide and 4 ft. long was dug under the slab from its outer edge toward the center. The rear wheel of a 10-ton Kelly-Springfield Road Roller was run back and forth over this unsupported span without any signs of fracture and the last position taken by the roller was on the extreme outer edge of the concrete pavement. This failing to break down the slab, a wooden block 2x4x8 ins. was placed with the long dimensions transversely across the pavement, and over the center of the excavation, and the roller run upon this block. The first position was about 8 ins. from the outer edge, and no failure of the concrete resulted. The block was then moved to within 6 ins. of the outer edge, and the wheel of the roller actually overhung the edge of the concrete slab, in which position the concrete crushed under the concentrated load. At the time of the test this concrete was 35 days old.

In the light of this test, and others where reinforcement was used, it is apparent that a proper strength in the foundation may be obtained by a much less thickness of concrete than has often been recommended and especially is this true with clean and well graded material.

By taking advantage of the strength to be obtained in a 3-in. wearing plate with a cement filler—a strength which has been practically ignored heretofore—it is obvious from all tests that a reinforced concrete foundation of 2 ins. thickness, using a mixture of one part cement with four parts aggregate properly graded from fine to coarse, will give ample strength to resist the weight of traffic.

It is interesting to note that the reinforcement proposed in the foundation has a weight much greater per square yard than that used in the reinforced concrete pavements at Sheboygan, Wis., Connersville, Ind., or Fond du Lac, Wis., also that the 2 ins. of 1:4 concrete proposed is far richer than that used in millions of square yards of foundation.

Compare this proposed reinforced concrete foundation with the average 4, 5 or 6 ins. of plain concrete foundation, and with the No. 2 paving brick foundation. Compare it in cost, in ease of construction, and in durability.

The results are highly instructive; it meets every requirement of a foundation; it possesses every virtue to be found in the older types, and, moreover, it possesses the new virtue of tensile strength (due to reinforcement) which is necessary to the permanence of any foundation.

SAND CUSHION.

It was shown above that the sand cushion is a source of weakness rather than of strength, in a pavement; that it is not necessary to afford an equilibrium to the vibration of the impact; that in undertaking to afford such relief there is danger of shattering the bond which unites the brick in the wearing plate; and, furthermore, it has been shown that a wearing plate resting on an unyielding foundation is highly successful.

Mr. Arthur H. Blanchard, Professor of Highway Engineering in Columbia University, records the successful use of a cement-sand cushion spread upon the foundation in the construction of wood block pavements and even more practical is the use of a plastic cushion in connection with wire-cut-lug brick, with the cement filler uniting not only the brick wearing plate but reaching down to grip the concrete cushion and holding thus the entire wearing plate and its adjoining foundation in a manner best suited to receive and distribute the weight of traffic.

MONOLITHIC SLAB.

Having determined the proper thickness of wearing plate and foundation and realizing the advantages to be gained in joining them, the proposition remains to accomplish this result in the best and cheapest manner.

The method proposed is to use a reinforced concrete foundation with a 1:4 mix, 2 ins. thick; to construct the same with a fairly soft, plastic mixture of cement and aggregate, graded from fine to ¼ in. or even to ¾ in.; to lay the brick directly on this foundation, it serving in its plastic state as a uniform support to the wearing plate, and finally serving, in its hardened state, as a foundation to the wearing plate.

The above method possesses a number of advantages over others and is thought will add substantially to the value of the pavement as a whole. It is more fully explained as follows:

Thoroughly prepare the sub-base as usual, sprinkling the same, if dry, immediately before laying the foundation.

For the foundation, use a fairly soft, plastic mixture of one part cement and four parts aggregate, so graded from coarse to fine as to reduce the voids to a minimum.

In practice it will be found that a coarse sand or clean gravel will often give most economical results.

Spread this foundation by the aid of a template having a steel faced edge.

With reinforcement in flat sheets, it will be found practical to lay it directly on the 2 in. concrete foundation, pinning it down at certain points, if necessary.

By this method, the reinforcement is better protected from moisture below and at the same time is better placed with respect to the depth of the slab as a whole, the pavement being considered a monolith.

It is not considered of any special advantage, with this method, to have the foundation course rolled, as is customary with the ordinary sand cushion.

Another advantage in placing the reinforcement immediately below the brick is that the rich cement filler grips it and tends thereby better to bond the whole into a monolithic slab.

While this method of placing the reinforcement seems the most simple and practical at the present time, it may be that further experiments will determine otherwise.

The reinforcement having been spread on the plastic concrete foundation, there shall immediately be placed the brick, the same being laid, inspected and rolled without delay. A good heavy type of hand roller will be found to give the best results in rolling the brick.

The surface having been thus prepared for the cement filler, the sides and edges of the brick shall be thoroughly wet by sprinkling before the filler is applied.

It is of prime importance in the application of a cement filler that the brick shall be clean, free from dust and dirt, and that they shall be thoroughly wet, and in obtaining this result it is necessary to use water freely.

Thus, in the operation of preparing the brick to receive the cement filler, there is assured abundance of moisture to obtain a successful reinforced concrete base, and so too in the operation of applying the cement filler there is secured sufficient bond between the brick wearing plate, the reinforcement and the freshly moistened concrete foundation, to obtain a successful monolithic pavement slab.

ADVANTAGES OF PROPOSED DESIGN.

The advantages gained by the proposed method of constructing brick pavements are as follows:

The concrete has a greater density and hence greater strength due to having been thoroughly compacted by the rolling of the brick.

The use of only cement and fine aggregate instead of cement, sand and stone, tends to cause less confusion in loading the mixer. The term "fine aggregate" as here used is intended to apply to a well graded mixture ranging in size from fine to ¼ in. or even to ¾ in.

The use of a fine aggregate instead of sand and stone tends to decrease the expense of spreading the foundation on the sub-base.

The use of a fine aggregate instead of sand and stone tends to decrease the cost of the materials as frequently a coarse sand or a well graded gravel mix can be obtained more cheaply than stone.

The covering of the foundation at once, by the wearing plate, gives protection and greater strength.

The expense of labor and materials for the sand cushion is eliminated.

The old difficulty with the sand cushion being forced up between the brick will be obviated, for the foundation mixture of 1:4 will be sufficiently rich when in touch with the cement filler to give the required bond strength between the brick.

The increased ease of inspection is obtained for the engineer and his assistants.

The decreased amount of water required for the concrete means a saving often of several cents per square yard and especially is this true of highway work where it is necessary to conduct water long distances.

The decreased thickness of pavement slab frequently means a saving of 4 to 6 cents in the cost of excavation for the pavement.

The bonding of the wearing plate to the

foundation is accomplished, thereby greatly increasing the efficiency of the pavement slab for purposes of receiving and distributing the weight of traffic.

The concentration of labor is secured, and with a less number of foremen, more direct supervision, and with each gang doing a certain part of the work in preparation for the gang which is to immediately follow, with each section of the work carried to completion, instead of being permitted to stand for days, at the risk of damage, with a less number of extra men, and less time lost hunting tools and materials, it is not only that better results are obtained in the finished pavement but also that they are obtained at a reduced cost. To illustrate more clearly the thought:

Last season the writer was supervising the construction of a reinforced concrete pavement covering possibly a mile and a half of streets, and at the same time was also supervising the construction of a brick pavement covering practically the same length of streets in a different city.

The entire force engaged in the construction of the reinforced concrete pavement were gathered under one foreman and it was noted that the material for the pavement was scarcely permitted to stop from the time it was lifted for use until it had been molded into its final form and covered for protection from the elements.

And in what contrast was the method used on the brick pavement construction! Not that it was different from the general method of constructing brick pavements, but that it lacked the directness and efficiency that should enter into the accomplishment of any desired result. But why relate the methods of handling a brick pavement job, with its several gangs scattered over a number of streets? Engineers who have had opportunity to see the organizations at work as they were for these jobs will readily comprehend the value of concentration.

RELATIVE COST.

A comparison of the cost of a pavement built as above outlined, and one built as generally recommended, will be of interest here. With materials at the following prices, delivered: cement, $1.20 per barrel; sand, $1.20 per cubic yard; stone, $1.25 per cubic yard, and common labor at 25 cts. per hour, consider the present style pavement of 4 in. brick, cement filler, 1½ in. sand cushion, 5 in. 1:3:6 concrete foundation; also consider the proposed pavement with a 3 in. brick, cement filler, and 2 in. 1:4 concrete foundation; reinforced with approximately 3 lbs. of mesh reinforcement per square yard. The cost of each, per square yard, is given in Table I.

TABLE I.

Brick surface, complete in place with filler	Brick	$0.70		Brick	$0.59	
	Hauling	.06		Hauling	.05	
	Laying	.05		Laying	.05	
	Grout	.09		Grout	.07	
		$0.90	4" brick		$0.76	3" brick
Sand cushion (labor and material)		.05	1½" cushion		.00	None
Foundation material		.42	5":1:3:6		.20	2":1:4
Labor mixing and placing foundation		.09			.06	
Reinforcement in place		.00	None		.10	3 lbs. at 3⅓c
Contingencies and profit (25%)		.37			.28	
Total cost per sq. yard		$1.83			$1.40	

Earth excavation is not considered in the above estimate, although it is a fact that the proposed design will frequently make a saving of several cents per square yard in this particular item. The proposed design reduces the cost of construction practically 25 per cent.

IDEAL DESIGN.

It is interesting to note the value of this proposed pavement as compared with different pavements. The Forest Service of the U. S. Dept. of Agriculture in Circular No. 141 gives Table II in which, for the purpose of easy comparison, a new column has been added showing the values of this proposed pavement.

In assigning values in the new column, the fact was taken into consideration that a large percentage of the pavements today are country highways and the travel and conditions affecting them as such are quite different from the travel and other conditions affecting city pavements.

Take for example the values of durability assigned brick and wood block. On a city street with heavy traffic a wood block would doubtless be more durable than brick, and yet on a country highway with average traffic, we have every reason to believe that wood block would fail much sooner than brick. This failure would be the result, not of wear, but of the action of the elements, such as sun, rain, frost, etc.

TABLE II.

Pavement qualities.	Ideal.	Granite.	Sandstone.	Sheet asphalt.	Block asphalt.	Brick.	Brick proposed.	Macadam.	Creosoted wood.
	Percentages								
Cheapness (first cost)	14	4.0	4.0	6.5	6.5	7.0	8.5	14.0	4.5
Durability	20	20.0	17.5	10.0	14.0	12.5	17.0	6.0	14.0
Ease of maintenance	10	9.5	10.0	7.5	8.0	8.5	9.5	4.5	9.5
Ease of cleaning	14	10.0	11.0	14.0	14.0	12.5	13.5	6.0	14.0
Low traction resistance	14	8.5	9.5	14.0	13.5	12.5	13.5	8.0	14.0
Freedom from slipperiness	7	5.5	7.0	3.5	4.5	5.5	5.5	6.5	4.0
Favorableness to travel	4	2.5	3.5	4.0	3.5	3.0	3.5	3.0	3.5
Acceptability	4	2.0	2.5	3.5	3.5	2.5	3.5	2.5	4.0
Sanitary quality	13	9.0	8.5	13.0	12.0	10.5	12.5	4.5	12.5
Total number of points	100	71.0	73.5	76.0	79.5	74.5	87.0	55.0	80.0

Taking each characteristic of the ideal pavement and assigning values to this proposed pavement in the light of present experience and conditions of travel, it is readily apparent that it ranks far above all others in efficiency.

What is efficiency? The definition given by Harrington Emerson, "High Priest of Efficiency," is:

"The elimination of all needless wastes, in material, in labor and in equipment, so as to reduce costs, increase profits and raise wages."

How does this Harrington Emerson obtain such results in efficiency? He probs here, there and everywhere to dig up basic facts. He takes nothing for granted. He is incessantly asking "Why?" "What for?" "How much?"

And by such methods of investigation it is proper that the design of brick pavements shall be probed. Why use a 4 in. wearing plate? Why not use a 3 in. wearing plate? Consider the thin wearing plate referred to in the Pennsylvania Station at New York. Consider the recommendations of Halbert P. Gillette, who has long recommended a thin wearing plate; and consider, too, the report in Bulletin No. 23, heretofore given, which comments on a brick wearing plate as follows:

"The life of a well constructed brick pavement cannot be estimated—"

Why use a sand cushion? The proposed mixture of cement and fine aggregate for the foundation furnishes a uniform support to the monolithic wearing surface.

The original sand cushion came into use, not to relieve vibrations of the impact; not to prevent shattering of the bond, but to afford a uniform support to the wearing surface because the foundation was of an uneven nature. A sand cushion for such purposes is no longer needed. Furthermore, the examples cited of brick and wood block laid on an unyielding foundation are proof that a cushion effect is neither essential nor necessary to the permanence of a wearing plate.

Why use a 5 in. foundation, without reinforcement? Why use a 1:3:6 mixture, 5 ins. thick, to obtain a strength to distribute the weight of traffic, when a 1:4 mixture, 2 ins. thick, with strong reinforcement accomplishes the purpose in a cheaper and equally durable manner?

The value of reinforced concrete over plain concrete is well known and so, too, is the value of an unyielding foundation.

The design herein presented is simply an application of knowledge gained by the practical experience of numerous engineers.

PRESENT PROBLEM.

The present and future requirement is for a pavement at a reasonable cost—a durable pavement—and a pavement which will encourage rather than discourage the sentiment in favor of permanent improvements.

The problem for many years was to build a durable pavement for city streets where the abutting property was more or less valuable; the present problem is to build a durable pavement not only for city streets but for country highways, where the requirement of low first cost is imperative.

Minnesota Road Work Statistics for 1914.

(Staff Abstract.)

Minnesota has 91,890 miles of public roads, of which 9,934 miles or 10.8 per cent are improved more or less, and of which 11,401 miles or 12.4 per cent have been designated as State Roads. The State Road system is made up of a radial system of main roads in each county and includes all main lines of intercounty travel. In comparing the total road mileage with statistics of the State, it is found that there is for each mile of road .88 of a square mile area; $15,265.00 valuation; and 22½ persons. The road work done in 1914 under supervision of the Highway Commission was as follows:

Clearing and grubbing, 3,694.90 acres	$ 197,312.01
Ditching, 409.98 miles	194,696.14
Grading, 2,150.87 miles	1,478,826.56
Gravelling, 537.43 miles	366,892.73
Macadam, 29.5 miles	83,988.60
Other surfacing, 78.58 miles	123,155.22
Concrete culverts, 36-in. and less, 1,328	79,602.38
Concrete culverts, over 36-in. in diam., 316	109,434.13
Corrugated metal culverts, 24-in. and less, 4,678	105,405.32
Corrugated metal culverts, over 24-in. diam., 346	21,237.59
Miscellaneous work	41,945.22

The total cost of all road and culvert construction was $2,802,995.96. A total of 7,250 miles of State Road were maintained at a cost of $323,111.27 under direction of the road engineers, the average cost being $44.67 per mile and ranging from $7.77 to $280.65 per mile for the year.

The State of Minnesota has given special attention to the matter of maintenance and in the present road laws have made adequate provision for the care of all roads. Township and county roads constitute approximately 90 per cent of the road mileage of the State, and of these roads, about 90 per cent are earth roads. To care for the town and county roads, a one mill tax is levied on all property in the town the proceeds of which constitutes the town dragging fund. This fund is expended under the direction of an overseer, appointed by the town board, for the purchase of drags, and in dragging all roads of the town, excepting State roads. This appears to be the most satisfactory method of caring for the earth roads under control of the local authorities, but there should be a provision in such cases, for general supervision of the work by the county highway engineer.

For the care of State roads in Minnesota, 20 per cent of the State road funds, with a due proportion of county funds, are set aside and may not be used for any other purpose than maintenance of State roads. As the State roads include all types of construction, different systems of maintenance have been required in the different localities. In general, three systems have been established: The patrol system on macadam and well built gravel roads, and the maintenance section system, and road drag system on other roads, all being under the direct supervision of the district highway engineer.

Under the patrol system, one man is assigned a section of from 5 to 7 miles of road and works with hand tools. It has been found necessary to supplement this work with the occasional use of a team and in that manner it has proven satisfactory on macadam and gravel roads.

Under the maintenance section system, one man is given charge of a section of from 20 to 30 miles of road and is employed continuously with his team on the care of his section. He is given authority to employ additional help, both teams and men, and usually has two teams and four or five men at work. Contracts are also entered into by the section foreman with residents along the road, for the dragging of same after each rain, or when ordered to do so by him. The section crew takes care of all minor items of construction, such as placing culverts, etc., and we have found that the work when properly done, is really of a constructive nature. This system is without doubt the most effective, and is being adopted generally throughout the State.

The dragging system requires the employment of a superintendent of maintenance, who for convenience should be one of the engineer's assistants, whose duty is to contract or make arrangements for the dragging of all roads under his charge, and to see that the work is done at proper times. This system is suitable for slightly undulating prairie country, where most of the roads are of earth, and to get best results, the superintendent should have at his disposal light graders to reshape the road bed at least at the beginning of each season.

On earth or gravel roads, no maintenance system is complete which does not contemplate the use of planers or similar devices, and a combination of work as outlined under the section system is recommended.

Comparative Cost of Asphalt and Brick Pavement.

To the Editors:—I trust that you will pardon brief and friendly comment upon statements made in Engineering and Contracting, issues of May 12 and June 16, to the effect that the annual maintenance costs of brick, asphalt and asphaltic concrete pavements in Chicago are respectively 19 cts., 18 cts. and 17 cts. per square yard. I do not challenge the fact, but I do except to the inference that may be drawn.

The statement, standing alone, seems likely to be misconstrued, for the reason that the brick pavements with which the Chicago asphaltic concrete pavements are compared are not, as a rule, representative of modern brick pavements as a type.

Very many of the brick pavements in the district embraced by the statement are of an early type of construction, with soft fillers. Such pavements inevitably cobble as the filler comes out under traffic, and require frequent repairs or resurfacing with some other material; moreover, they become rough, noisy, and impossible to keep clean without constant labor.

Necessarily, the cost of annual maintenance of a softfilled pavement is considerable. The district covered by the statement has many such pavements.

Well-constructed, grouted brick pavements, in which the most suitable materials are used, involve no maintenance charges for many years. They can be cleaned easily by flushing or sweeping. They are smooth, sanitary and durable.

I could cite you to grouted brick pavements which have been in continuous service for fifteen years and which have never required the expenditure of a dollar for repairs or maintenance, and yet which are smooth, even, and in first-class condition.

If the Chicago district has brick pavements under twenty years of age which incur an annual maintenance charge of 19 cts. per square yard, the fact proves nothing except that the pavements were not constructed properly with the best kind of filler.

My objection to the statement of comparative maintenance costs is that old and poor types of brick pavements are used for purposes of cost comparisons.

It is true that Mr. Fixmer, the engineer in charge of the district, in his communication in the issue of June 16, is careful to explain that the experience of a single section cannot be taken as a basis for generalizing, yet I feel that a little light thrown upon the type of brick pavements with which the comparison was made may prevent some misconception on the part of persons unacquainted with the facts—persons to whom the term "brick pavement" conveys no idea of distinctions among types or of differences in constructional methods.

Yours very truly,
F. A. CHURCHILL.
Conneaut, O., June 22, 1915.

SEWERAGE AND SANITATION

Design and Construction of the Arroyo de la Brea Storm Sewer System, Los Angeles, Cal.

(Staff Article.)

The city of Los Angeles is now engaged in designing and constructing a comprehensive system of storm water sewers. The construction work on one of the largest collectors, the Arroyo de la Brea sewer, was completed early in the present year, fully eight months before the time specified for its completion. The contractor, James Kennedy of Fargo, N. D., put forth every effort to complete this work in short time and accomplished this result by means of good organization and adequate construction plant.

The Arroyo de la Brea sewer is named for the natural water course which it partially supersedes and into which it discharges. It drains an area of 2,678 acres. The materials of construction and limiting dimensions are as follows: A reinforced concrete section, with arched top, 4,621 ft. long and 10 ft. 10 ins. to 13 ft. 4 ins. in greatest inside dimension; a reinforced concrete section 8 ft. square and 660 ft. long; a plain concrete circular section 6,054 ft. long ranging in diameter from 5 ft. 6 ins. to 8 ft. 6 ins.; 26,751 ft. of reinforced concrete from 2 ft. to 5 ft. in diameter; 11,932 ft. of 1 ring brick sewer from 23 ins. to 3 ft. in diameter; 9,526 ft. of vitrified clay pipe sewer from 12 to 22 ins. in diameter, and 9,520 ft. of vitrified clay pipe catch basin connections from 8 to 22 ins. in diameter. The contract also included the construction of 324 catch basins, 137 manholes, and the reconstruction of 2,200 ft. of sanitary sewer with 17 manholes. About 17,450 sq. ft. of asphalt paving was torn up and replaced over trenches. The contract price was $662,063.04.

The construction necessitated the excavation of about 180,000 cu. yds. of material. The contract was given to the James Kennedy Construction Co. on March 26, 1914, and it was finished about the first of January of this year. Actual construction work was begun on April 25, 1914. This was Mr. Kennedy's first big job in California and he made every effort to establish a local reputation for reliability and promptness. In this he was successful for he finished the work within half the allotted time.

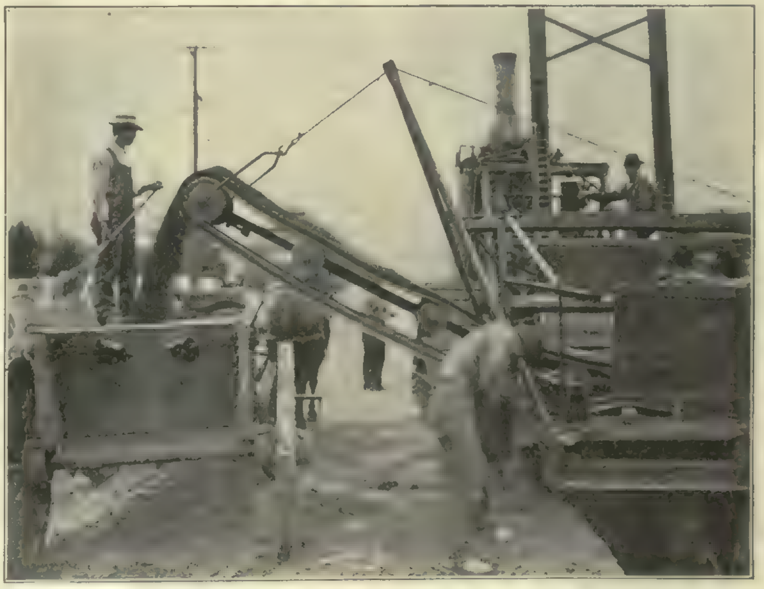


Fig. 1. View of Parsons Excavator on Trench 6½ Ft. Wide and 20 Ft. Deep in Hard Material, Los Angeles, Cal.

CONSTRUCTION CAMP.

The construction camp was used as a supply base as well as the location of blacksmith and tool repair shops. Here was located, also, the wood shop where the concrete forms were built, knocked down and rebuilt to different dimensions. The sewer section varied slightly with corresponding changes in grade and this necessitated a considerable number of slight changes in the dimensions of forms and centering. At this camp also were located the stables for the 40 head of Dakota horses Mr. Kennedy always takes to his construction jobs wherever located.

CONSTRUCTION PLANT AND METHODS.

At the outset of the work three construction crews were put on the job. A month later three more crews were started and other crews were added from time to time. The maximum number of men employed was 400.

The excavation for the lower end of the sewer, the large reinforced concrete arch section, was done with a model 36 Marion revolving steam shovel with a long handled dipper. The shovel traveled on heavy trussed timbers laid across the trench. These timbers were swung by means of chains and the shovel dipper, from the rear of the machine to the front of it as the excavation progressed. The excavated material was hauled in two-horse dump wagons to the point where backfilling was in progress. Figure 1 shows one of the Parsons trench excavators depositing excavated material into a dump wagon from a trench 6½ ft. wide and 20 ft. deep. The excess material was readily disposed of to nearby property owners for filling in low lots. In general trenches were backfilled within a maximum distance of 500 to 600 ft. from the excavating machines.

Nearly all the balance of the excavation was carried on with four Parsons trench excavators. These were followed, in the deeper and wider trenches, with two Potter trenching and backfilling machines. The Parsons machines gave good service in all the soil encountered although this was at times so hard it could scarcely be loosened with a pick. The greatest trench width was 30 ft. and the greatest depth 16 ft. The trimming and finishing was done by hand tools. Generally the trench walls stood without any bracing.

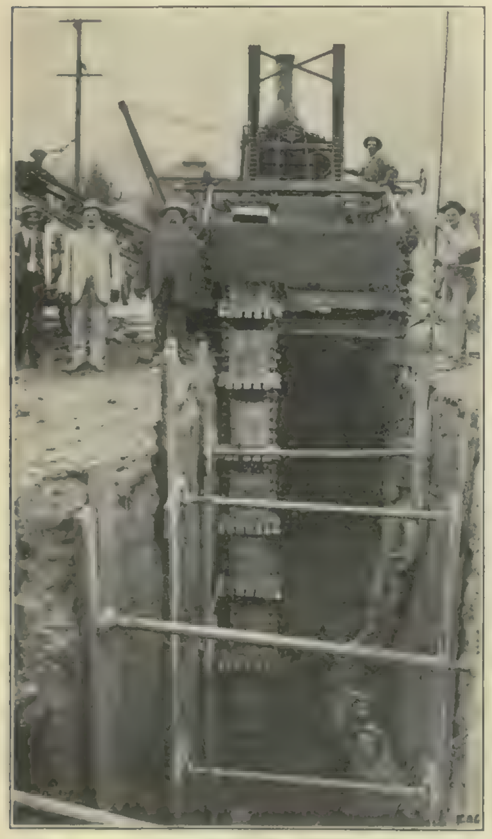


Fig. 2. View of Parsons Excavator on 6½x 15 Ft. Trench at Los Angeles, Cal.

Figure 2 shows a Parsons excavator making a trench 6½ ft. wide and 15 ft. deep in very hard material. The braces shown were used only to protect a water main parallel to the trench. Figure 3 is a view of the operator's side of a Parsons trench excavator equipped with Parco traction and oil burner. This machine is excavating a trench 6½ ft. wide and 20 ft. deep.

All the concrete for the monolithic sewers was mixed in three Smith mixers placed alongside the trench at the middle of the block. The concrete was taken to the trench in one-batch side-gate cars pushed along a narrow-gage industrial track by two men to a car. Concrete was chuted from cars to its place in the forms through jointed steel spouts. The reinforced concrete pipe was made on vacant property and on the parkway along the sewer by the Western Reinforced Concrete Pipe Co.

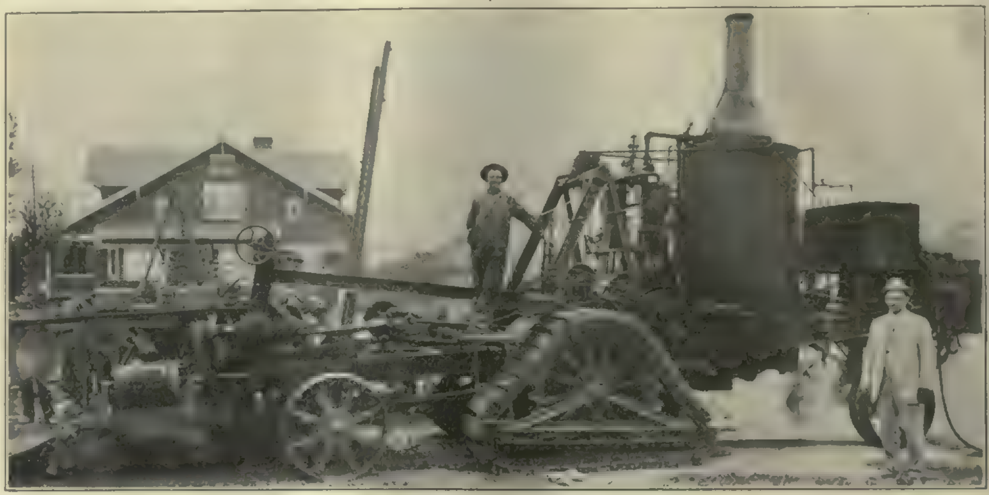


Fig. 3. View of Parsons Trench Excavator Equipped With Parco Traction and Oil Burner on 6½x20 Ft. Sewer Trench at Los Angeles, Cal.

PERSONNEL.

The sewer was designed under the direction of Mr. E. A. Tuttle. Mr. Homer Hamlin was at that time city engineer. The construction was in charge of Mr. John P. Kennedy although James Kennedy was on the work the greater part of the time.

The Typical Iowa Sewage Treatment Plant and Its Proper Operation.

(Staff Abstract.)

About 60 towns and cities in Iowa have installed more or less complete and effective sewage treatment plants. In Iowa the typical plant consists of a tank and sand filters. Means for raising funds are so limited in many cities that a choice has had to be made between no sewage treatment plant, or one deficient in size, and the greater evil of no sewer system at all.

The engineers who have designed the plants have been forced to adapt themselves to these conditions, and in many cases, have found it impossible to install really adequate filter beds. Inadequte filter beds may answer for a short time after the construction of the sewer system, while the sewage flow is still small, and while those city officials who built the plant are still in authority and consequently retain an active interest therein. Soon, however, the flow of sewage increases, such maintenance as was at first given is neglected, and the filter beds practically go out of operation. The sewage continues to flow through the septic tank, but with the gradual accumulation of sludge therein even the limited degree of purification effected by a sewage tank decreases.

The proper maintenance of a sewage treatment plant is comparatively simple and inexpensive, especially for those of the comparatively small size commonly required in Iowa. As stated, the typical sewage treatment plant in use in Iowa consists, first of a sewage tank, second, of sand filter beds. The sewage tank is most often of single story or "septic tank" design, but sometimes the "Imhoff" two-story tank may be required, especially where the water supply is from a deep well source, and contains a considerable amount of sulfur compounds. Combined with the sewage tank a dosing chamber is usually provided, equipped with automatic alternating siphons for supplying the sewage in intermittent doses to the sand filters in rotation. The sand filters are generally at least two in number, and their total area ought to be, according to the best conservative authority, at least equal in area to one acre for each 1,000 to 1,200 tributary population. They should be thoroughly under-drained, and so designed that the intermittent doses of sewage will be evenly distributed over the entire upper surface. The sand ought to be good, clean, coarse mortar sand.

The care of such a plant is simple and comparatively inexpensive, providing that some reliable person is put in charge by the city to visit the plant every day, and to daily perform whatever work is needed to keep it in good condition all the time. The work necessary consists in keeping the surface of the beds constantly clean, and loose enough to cause each dose of sewage to disappear in a short time after application. In addition, the alternating siphons, or other device, used for distributing the doses of sewage upon the different beds, should be examined each day and constantly maintained in good working condition. The sewage tank itself should always be designed in such a manner as to permit ready emptying of the sludge upon a sludge bed. In the case of the single story tank, the sludge should probably be emptied about twice a year. An Imhoff or two-story tank need not be completely emptied at any one time, but relatively small amounts of sludge should be discharged at comparatively frequent intervals.

The sludge problem is not a difficult one in the case of the small plants common in Iowa. All that is necessary is to allow the sludge to dry out thoroughly upon the sludge bed and then to remove it with a team and wagon for use as fertilizer upon some cultivated field.

PROPER OPERATION.

Proper care in the maintenance of sewage treatment plants in Iowa could readily be secured by the following measures:

1. A law should be passed giving the cities and towns authority to raise the money necessary for the construction of adequate sewage treatment plants, or extensions thereto, as directed by the State Board of Health. It should not be necessary to design plants to fit a certain sum of money. They should be designed and constructed to meet the real needs for sewage treatment.

2. Each city should be required by law to place a competent man in charge of the maintenance of the plant. It would be a good idea to require this man to file a bond, and to give any person who suffers a damage from neglect of the plant the right to recover on this bond, providing he can prove the damage by legal evidence.

3. The State Board of Health should be authorized and required by law to inspect

every sewage plant in the state at regular intervals, and to issue proper orders from time to time for its operation, obedience to which orders should be required of the city officials under adequate penalties.

ACKNOWLEDGMENT.

The comment here made on sewage disposal conditions is taken from the latest report of the Sanitary Committee of the Iowa Engineering Society, of which Dean A. Marston of Iowa State College, Ames, is chairman.

Fine Screening Adopted in Preference to Sedimentation and Separate Sludge Digestion, on Cost Basis, at Brooklyn.

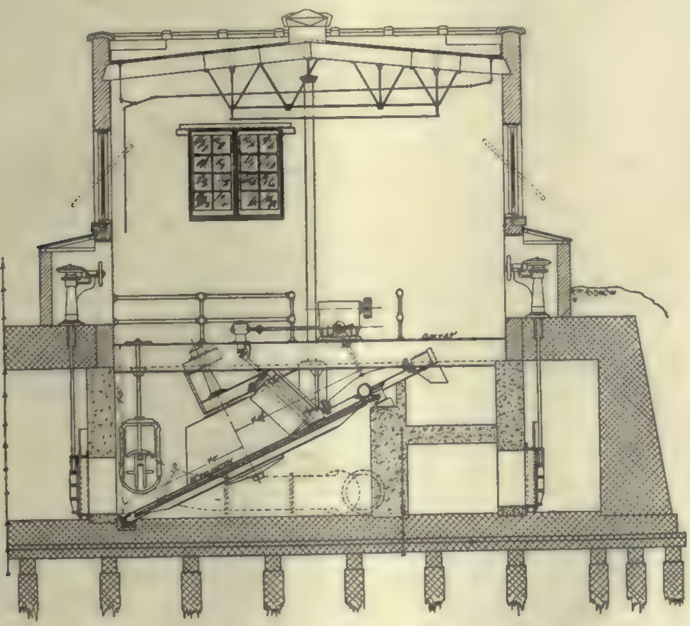
(Staff Article.)

Fine screening was adopted recently at the 26th ward sewage treatment plant, in the Borough of Brooklyn, in competition with sedimentation and sludge digestion. The capacity of the plant is 12,000,000 gals. per day. Alternative projects were considered in taking bids for the construction of a treatment plant at this site. Thus designs were prepared for and bids were received on the construction of Imhoff sedimentation tanks and sludge drying beds, plain sedimentation with provision for separate sludge digestion and sludge drying beds, and fine screens of the Reinsch-Wurl type. The wording of the specifications, admitting these three processes to direct competition, was as follows:

> The contractor shall install, complete and ready for operation a plant for the purpose of removing suspended solids from the ordinary dry weather flow of sewage at the 26th Ward disposal plant at Hendrix Street, near Vandalia Avenue, Borough of Brooklyn, in accordance with one of three methods and designs for removing suspended solids shown on the plans of the work. The contract gives him the option of installing one of the following three methods and the plant for operating same:
>
> Optional project A—Riensch-Wurl screens, with direct removal of screenings.
>
> Optional project B—Imhoff tanks with drying beds for sludge.
>
> Optional project C—Sedimentation tanks with separate sludge digestion tanks and sludge drying beds.
>
> Either of the plants mentioned will be equally satisfactory to the city if it secures the results in removing suspended solids from sewage hereinafter set forth as the general requirements to which the plant installed must conform. Each of the optional plants mentioned are shown on the plans and designated thereon and in these specifications as set forth above.
>
> When operating under average ordinary dry weather conditions the plant shall be of sufficient capacity to treat 12,000,000 gals. of sewage per day.

Several bids were received and the contract was awarded to the lowest bidder, the North Eastern Construction Co. This company proposed using the screens.

The essential elements of the screening plant are shown in the accompanying sectional elevation. The plant is under construction at this time and it is expected that it will be placed in operation before fall. The rapidity with which the screening plant could be installed contributed to the decision to adopt the screening process.



Sectional Elevation of Fine Screening Plant of Riensch-Wurl Type, Now Being Constructed in Brooklyn.

A Summary of the Results of Experiments on the Purification of Creamery Refuse and Their Application.

Contributed by H. R. Crohurst, Sanitary Engineer, U. S. Public Health Service, and A. D. Weston, Sanitary Engineer, Massachusetts Department of Health.

At the present time when the tendency of local, state and federal health authorities is toward the study of stream pollution by industrial refuse discharges, and as at this time further studies are in progress to find suit-, nothing new, but have gathered together such wastes, it seems pertinent to give a review of the data already at hand on the methods of purification suggested by experiments which have been made up to the present time.

It has been the aim of the writers to gather such data as are at hand on the purification of the various trade wastes and to ascertain what methods of purification are recommended from the experiments thus far made and what methods are actually in use and what results have been obtained. The writers offer nothing new, but have gathered together such information as is available, giving all credit to the persons who have made the investigations.

Probably one of the most difficult wastes to handle on account of rapid decomposition is that produced in the dairy industry. Results of experiments on the proposed methods of purifying this class of wastes have from time to time been published by the individual experimenters, but so far as is known these isolated results have never been assembled and published collectively.

THE DAIRY INDUSTRY.

The processes carried out in the dairy industry may consist of only clarifying and pasteurizing the milk to be bottled and shipped, on the separation of the cream from the milk to be used as such or to be churned into butter, the production of cheese from fresh or skimmed milk, and the production of casein or of milk sugar.

Where the milk is only clarified and pasteurized the wastes consist of cooling water, the wash water from floors and from the cleaning utensils.

At the separating stations the milk is usually brought to the depot where it is weighed, run through the separators to obtain the cream, and the whey, either returned for feed or evaporated to obtain the milk sugar. The wastes produced are similar to those above and consist of cooling water and wash waters from floors and utensils.

When butter is made, the cream is churned to cause the fat globules to separate from the milk and aggregate together. The buttermilk produced is now bottled and sold and does not constitute a waste. Wastes result from the washing of the butter, during which small particles of the butter are washed away with the water, and the wash water from the floors and utensils.

In the making of cheese either fresh or skimmed milk is precipitated by rennet which throws out the casein, and in settling carries down with it most of the fat. The curd thus produced is washed, compressed and ripened into cheese. The wastes are similar to those of butter making and contain small amounts of casein and the water used in washing floors and utensils.

Milk sugar is prepared by evaporating the whey, clarifying the residue, evaporating again until the sugar crystallizes out. The liquor remaining is small in amount, but contains considerable organic matter, which is liable to cause nuisances when discharged without some treatment.

TABLE I.—REPRESENTATIVE ANALYSES OF CREAMERY WASTES FROM VARIOUS SOURCES.—PARTS PER MILLION.

Number.	Oxygen consumed.	Organic Nitrogen.	Free amm.	Acidity.*	Suspended matter.
1	966	249	40.0	518	.....
2	2,845	250	17.0	...	.....
3	751	115	14.0	230	.....
4	494	68	1.6	142	.....
5	107	52	46.0	303	.....
6	480	80	2.5	544	2,475
7	512	924	2.1	...	.....
8	7,500	1,980	60.0	...	.....
9	425	230	16.5	...	.....
10	1,470	480	2.4	240	.....

*To phenolphthalein.

1-5. Composite samples, skimming station, Blanchester, Ohio, Ohio State Board of Health.

6. Butter factory, Zanesville, Ohio, Ohio State Board of Health.

7. Chance sample, Uxbridge, Mass., Massachusetts State Board of Health.

8. Equal parts skim milk and water, Massachusetts State Board of Health.

9. One part milk and 35 parts water, Massachusetts State Board of Health.

10. Weighted composite sample butter factory, Sunbury, Ohio, Ohio State Board of Health.

In all the above processes the wastes produced are very similar and consist of a dilute solution of milk which may contain some small particles of butter, fat and casein. This liquor ferments very rapidly, becomes acid, containing approximately 1,000 parts per million acidity, and gives off very offensive odors due to the production of butyric acid, and is very likely to cause a nuisance when discharged into small volumes of water. The high oxygen consumed figures in the following analyses show how rapidly the available supply of oxygen is used up in the streams into which these wastes are discharged and nuisances result unless the volume of the diluting water is very large.

The composition of these wastes from various sources are given in Table I, taken from the paper on the purification of dairy wastes by A. Elliott Kimberly in the Quarterly Bulletin of the Ohio State Board of Health for July-Sept., 1909.

The quantity of waste produced in this industry has been estimated by the several investigators as follows:

Dr. F. Guth (gesundheitsingeniem), March 4, 1911: 100 to 300 or more gallons for every 100 gals. of milk treated.

Journal of the Department of Agriculture and Technical Instruction for Ireland, March, 1904, Vol. 4, No. 3: 100 gals. of waste for each 125 gals. of milk treated, or 100 gals. for every 200 gals. of cream treated.

Kimberly, in the Ohio State Board of Health Bulletin, July-September, 1909: 100 gals. of refuse for every 100 lbs. of butter produced.

MASSACHUSETTS EXPERIMENTS.

Probably the first experiments with a view to purifying this class of waste sufficiently so that it could be discharged into streams without causing a nuisance were undertaken in 1898 and 1899 by the Massachusetts State Board of Health at the Lawrence Experiment Station. The results obtained from these studies were published in the 1898 and 1899 and later in the 1909 annual reports of the Board. A brief summary of this work from the above reports is given below.

Owing to the difficulty of obtaining representative samples, mixtures of milk and water were used in the experiments. A mixture of skimmed milk and water in equal parts was first applied to a filter 4 ft. deep, the sand having an effective size of 0.23 mm. This waste was applied at a rate of 200,000 gals. per acre per day, but the filter clogged immediately. The mixture was reduced to one-third milk and two-thirds water and the rate of application on the filter reduced to 100,000 gals. per acre per day, but the filter again clogged rapidly, and in a few days 2 ins. of curd were removed from the surface. The mixture was again changed so that it contained only one thirty-fifth as much milk as water. An analysis of this mixture in parts per million was as follows:

Free ammonia	16.5
Albuminoid ammonia	76.7
Oxygen consumed	425.0

The skimmed milk used in these mixtures was sour when applied to the filter and the applied liquor and effluent were acid in reaction. No nitrification took place in these experiments. The analyses of the effluent in parts per million for two months were as follows:

	April.	May.
Free ammonia	52.0	152.3
Albuminoid ammonia	185.0	27.2
Nitrates	0.0	0.0
Nitrites	0.08	0.04
Oxygen consumed	2170.0	53.3

The mixture used was then made up with sweet milk or when sour milk was used, milk of lime in quantities from 1 to 13 grains per gallon were added to make it alkaline. The filter was then washed by flooding with water for two weeks until in good condition and the liquor again applied. The effluent improved slightly, but from time to time the results were still poor. Again the mixture was changed until it contained only 1 per cent of milk and then good nitrification began in the filter. At first the effluent had an odor of sour milk which persisted for some time, but as nitrification was established the odor disappeared and during the year 1899 the effluent was clear, almost colorless and odorless. At the end of 1898, however, the rate was reduced to 50,000 gals. per acre per day. The applied liquor and the effluent in parts per million during the latter part of 1898 were as follows:

	Applied liquor.	Effluent.
Free ammonia	1.0	8.0
Albuminoid ammonia	22.5	.75
Nitrates	....	27.0
Nitrites	....	.50
Oxygen consumed	91.5	3.8

About the first of January, 1899, the strength of the applied liquor was doubled and the rate of filtration cut to 25,000 gals. per acre per day. This liquor gave an analysis very similar to the analysis of the waste liquor from a creamery in actual operation. In June the water used in the mixture was heated to 100° F. and when applied to the filter was nearly at this temperature. As the water used to wash cans and utensils at the creamery was at the boiling point it was desired to know what the effect of this high temperature would be upon the bacteria in the filter. Salt was also added, increasing the chlorine present to over 5,000 p.p.m. as the waste from the manufacture of ice cream containing salt was mixed with the creamery waste during the summer. Nitrification was not seriously disturbed by these changes, but the free and albuminoid ammonia in the effluent increased slightly. The filter continued to operate successfully as shown by the average analyses in parts per million of the liquor and effluent.

Quantity applied 26,400 gals. per acre daily:

	Applied liquor.	Effluent.
Temperature	54°	61°
Free ammonia	2.764	5.665
Albuminoid ammonia	49.8	.969
Chlorine	2,080.0	2,148.5
Nitrates	.....	66.1
Nitrites	.....	1.594
Oxygen consumed	358.2	6.8

At the time the chemical studies were being made, many bacterial examinations were also made to obtain information relative to the number and species of bacteria present and their effect on nitrification. During the periods when the strongest liquors were being applied counts of 50,000,000 to 80,000,000 bacteria per c.c. were obtained. With the dilute solutions the counts were less. There was a reduction in the number of bacteria when lime was added to make the mixture alkaline. The mixtures made with sour milk were found to contain more bacteria than the mixtures made with sweet milk. Bacteria in the effluents were slightly less than in the applied liquor at the beginning of the experiment, but later the effluent contained slightly greater numbers than the applied liquor.

Two species of bacteria were particularly noticeable, one of which liquefied gelatine while the other did not, and both thriving best at 30° C., and both producing lactic acid fermentation. The presence of these bacteria in such large numbers and their rapid growth explained to some extent the poor nitrification obtained in the filters. During periods of cool weather these organisms did not develop as rapidly and the nitrifying organisms had a chance to develop, producing a better effluent. Boric acid added to check the growth of the lactic acid bacteria did not work satisfactorily.

As a result of the above experiments it was concluded that creamery waste could be purified by methods similar to those employed in the purification of sewage, but that the rate should not exceed 25,000 gals. per acre daily.

EXPERIMENTS IN IRELAND.

Experiments similar to those made in Massachusetts were conducted in Ireland, and the results published in the Journal of the Department of Agriculture and Technical Instruction of Ireland for March 1904.

As a result of these studies plants have been constructed and operated on a large scale, and have succeeded in purifying this class of waste so that it can be disposed of without nuisance.

These investigators have estimated the quantity of waste from milk stations as follows:

A creamery receiving 2,500 gals. of milk per day may expect 2,000 gals. of refuse. A creamery receiving 2,000 gals. of milk and the cream from 3,000 gals. of milk separated at cream separating stations may expect to have from the milk 1,600 gals. of refuse and from the cream 1,500 gals., or a total of 3,000 gals.

The most putrescible portion of the refuse is the first washings of the granular butter in the churn, and next the rinsings and water used in cleaning the separated milk and butter milk tanks.

METHODS OF PURIFICATION.

Only two methods of purification have so far met with success. Irrigation and septic tank treatment, followed by treatment in contact beds or on sprinkling filters.

Irrigation.—Ground of a suitable nature, that is, a medium soil with a sandy or gravelly subsoil, will purify the refuse at a rate of 20,000 gals. per acre daily. Stiffer soils will purify less, in some cases only 2,000 gals. per acre daily. Where good land can be obtained at a sufficient distance from public highways broad irrigation offers the simplest and cheapest method of disposal.

Septic Tank Treatment.—The plant necessary will depend on the degree of purification required. In some cases the tank alone is sufficient. When further treatment is required a bacterial bed should be added, and if further purification is still required a second or even third bed will be necessary. The tank may be open or closed, but if open should be at such a distance from the creamery or highway that decomposition products from the tank will not be carried in that direction. The tank should be capable of holding five days' maximum flow in the case of a cream separating station and at least ten days' flow in the case of a large creamery with separating stations. The tank should be long and narrow, the most satisfactory dimension so far being 6 ft. wide and 6 or 7 ft. deep and of sufficient length to give the required capacity. Rectangular tanks with division walls giving the required width have proved successful. If tank treatment only is required the last 10 ft. of the tank should be filled with broken stone, preferably limestone, which will tend to neutralize the acid. The scum and sludge formed in these tanks will require emptying once a year into a sludge pit or bed.

A tank covered with a wooden covering over which there was placed 6 ins. of earth has never given off any odor under any circumstances. The effluent from the septic tank is slightly opalescent and has a strong odor. Compared with the original sewage a purification of 80 to 90 per cent will have been effected. The odor can be reduced or eliminated by adding a 1 per cent solution of chloride of lime at a rate of ⅛ ounce per gallon.

For further purification a contact bed is recommended. The capacity of the bed should be equal to one day's maximum flow. The contact bed can be constructed of stone, gravel, clinkers or any hard material. The size recommended is ¼ to ¾-in. material. Suitable underdrains are provided to carry off the sewage rapidly and to aerate the bed. The tank effluent is delivered to the bed at the bottom to obviate odors. This bed will last for years without disturbance.

If a secondary bed is provided this is similar to the primary bed, but the material used is finer, ⅛ to ½ in. in size.

Percolating beds can be used in place of the secondary contact beds. They are not recommended in the treatment of the tank effluent, as the spraying of the bed distributes any odor in the effluent very widely. The material of the percolating bed is similar to the material used in the primary bed.

OHIO EXPERIMENTS.

In 1907 small scale experiments were made at Columbus, O., by the State Board of Health using mixtures of milk and water in the proportion of 1 part skimmed milk and 50 parts water. This mixture was treated in settling tanks and on sand filters. Sedimentation experiments along were tried on the entire wastes from a skimming station at Blanchester, O.

These experiments indicated that this kind of waste could be treated along lines similar to the methods used in the purification of sewage providing certain changes were made as to the preliminary treatment and the area of filters provided.

In 1908 the Ohio State Board of Health made arrangements with the Sunbury Co-operative Creamery Co., of Sunbury, O., to conduct experiments at their plant on a large scale. Following is an outline of the experiments made at this creamery taken from the Quarterly Bulletin of the Ohio State Board of Health for July-September, 1909. There already existed at the creamery a settling tank about 14 by 40 ft. in plan and 8 ft. deep, into which the combined wastes were discharged before entering the brook in the vicinity. This method of purification was not sufficient and considerable nuisance was created.

In the experiments conducted by the Ohio State Board of Health this existing tank was reconstructed to form a new tank 13 by 25 ft. in plan and 8 ft. 2 ins. deep, having a depth of water 7 ft. 2 ins. and a capacity of 17,400 gals. The tank was provided with an inlet and an outlet baffle. In the third compartment of the old tank there was constructed a dosing chamber 12 ft. 4 ins. by 12 ft. 5 ins. in plan and 3 ft. 3 ins. deep, having a capacity at the discharge line of a 5-in. syphon of 2,570 gals. Both the settling and the dosing compartments were provided with a wooden cover.

Four sand filters were constructed, each 41 ft. square, containing 30 ins. of lake sand of an effective size of 0.23 mm., underlaid with graded gravel 2 to 7 ins. in thickness. The average area of each filter was 1,384 sq. ft. Each bed was under-drained by two lines of 4-in. tile drains with open joints which discharged into a 6-in. collector between the beds. The beds were laid out in the form of a square with a distributing manhole in the center to discharge the wastes onto any or all beds.

The final cost of construction, which was done by day labor, was $1,155.71. This figure included labor, grading, seeding and the work in stopping leaks in the original tank.

This plant was put in operation April 24, 1909. Data of results up to Aug. 18, 1909, published in the Quarterly Bulletin of the Ohio State Board of Health for July-September, 1909, show that the total volume of waste treated from April 24 to June 12 was 205,400 gals., or an average of about 4,000 gals. per day. This flow contained the washing water, cooling waters from the pasteurizes as well as the melted ice. From June 13 to Aug. 18 the flow was 186,300 gals., or about 2,800 gals. per day. This latter figure did not contain the clear waters used for cooling. From the product produced, the flow gives a waste of 1,400 gals. per 1,000 lbs. of butter for the total wastes and 933 gals. per 1,000 lbs. of butter for the latter. Corresponding with the above flows the periods of sedimentation were 4.9 days and 7.7 days. The waste entering the settling tank contained considerable casein in suspension due to the high acidity. It was found that this matter first settled, but later due to gas formation, rose to the surface, where it formed a layer nearly 18 ins. thick. Odors were at first noticeable, but as the scum hardened these disappeared.

TABLE II.—EXPERIMENTS AT SUNBURY, OHIO, ON THE PURIFICATION OF CREAMERY WASTES BY THE OHIO STATE BOARD OF HEALTH.

Analyses of Applied Wastes—April 24 to June 12, 1909. Parts per million.

1909.		Oxygen consumed.	Organic matter.	Free ammonia.	Nitrites.	Nitrates.	Chlorine.	Acidity lactic acid.
			Nitrogen as					
Apr.	26	73	32	16.0	0.00	0.0	600	...
May	1	[illegible]	10	30.0	0.00	0.0	790	...
May	4	88	23	1.0	0.00	0.0	860	...
May	7	94	19	1.4	0.00	0.0	1,000	800
May	10	87	14	10.0	0.00	0.0	890	560
May	14	51	28	36.0	0.00	0.0	870	850
May	18	82	10	30.0	0.00	0.0	1,030	800
May	21	79	24	16.0	0.00	0.0	960	900
May	24	93	34	14.0	0.00	0.0	1,020	900
June	1	120	76	4.0	0.00	0.0	990	890
June	8	166	90	150.0	0.10	0.0	1,100	400
June	11	124	24	40.0	0.00	0.0	100	840

Remarks: All samples putrescent. Acidity, phenolphthalein indicator, sodium carbonate alkali.

Analyses of Applied Wastes—June 13 to Aug. 5, 1909.

1909.		Oxygen consumed.	Organic matter.	Free ammonia.	Nitrites.	Nitrates.	Chlorine.	Acidity lactic acid.
			Nitrogen as					
June	14	132	100	60.0	0.00	0.0	1,500	860
June	17	150	160	80.0	0.00	0.0	1,800	800
June	21	190	30	90.0	0.00	0.0	2,300	1,050
June	24	172	90	50.0	0.00	0.0	2,250	*700
July	1	174	180	60.0	0.00	0.0	1,950	680
July	13	240	[illegible]	100.0	0.00	0.0	2,750	790
July	16	249	68	140.0	0.00	0.0	2,500	920
Aug.	5	268	12	100.0	0.00	0.0	2,300	...

*Soda ash applied (June 24-July 16) (July 26 to ——).

At first two filters were used, on alternate days, at a net rate of 64,600 gals., or an actual rate of 129,200 gals. After June 13 the rates were net 48,700 gals. and actual 97,400 gals. per acre per day. This decrease was due to separating the cooling waters from the remainder of the waste. On August 11 both filters were placed in daily operation and the rate became 31,500 gals. per acre per day on a basis of 2,000 gals. of settled waste daily. There was a little tendency toward clogging and a slight scum from ⅛ to ¼ in. in thickness formed on the surface of the beds, but this was easily broken up by raking. The applied waste disappeared in from 10 to 30 minutes and there was no odor noticeable at a distance of 25 ft.

Tables II and III show the character of the liquor applied and the effluent of the filters.

Analyses of the effluent show that the degree of purification was not as high as was expected from the small scale experiments at Columbus. The acidity of the wastes was so high that it inhibited the action of the bacteria in purifying the wastes in the filters. The addition of soda ash to neutralize this acid showed an improvement in the effluent. The effluent from the filters was at first clear with but little odor, but on standing 8 to 10 hours at room temperature it darkened, and became foul, showing that purification was not high.

From these experiments the writer of the paper, Mr. A. Elliott Kimberly draws the following conclusions and recommends the following treatment. The quantity of waste will be approximately 1½ gals. per pound of butter produced where the total waste is to be purified, or 1 gal. where the clear water is separated from the other objectionable wastes. The wastes will be milky in appearance and sometimes yellow, due to small quantities of butter in the washings. The wastes normally carry about 1,000 p.p.m. of acidity. The method of purification should be sedimentation and oxidization. Two days sedimentation should be provided. The tank should have inlet and outlet baffles and two or more baffles in the body of the tank. The depth of the tank should be from 4 to 6 ft. With a settling tank of this type cleaning should not be necessary more than once a year. The sludge should be dried before trenching. Filters should have a depth of 30 ins., preferably 36 to 48 ins., well underdrained, of an effective size of about 0.30 mm. The rate should not exceed 25,000 gals. per acre per day. An automatic dosing device to flood the beds to a depth of 1 to 3 ins. should be provided.

On account of the acidity of the wastes which lessens the bacterial action in the bed, an alkali should be added to reduce the acidity. Lime or caustic soda are suggested.

Wastes treated as above will create no nuisance if the effluent is discharged into a dry ditch.

Wastes might under good conditions be disposed of by sedimentation and dilution alone. This method would require a two-day sedimentation period and would require a stream 30 times the volume of the waste into which the effluent could be discharged.

Mr. Kimberly, the author of the paper, suggests the following design for a creamery with a 1,000-lb. churning daily. The quantity of wastes with clear water excluded will amount to 1,000 gals. daily. The works should consist of a settling tank 5x9x6½ ft. deep, with a dosing tank 5x9x4 ft. deep with a depth of draw of 36 ins., provided with a 5-in. siphon. A filter of two units each—35 ft. 6 ins. square 4 ft. deep—of a sand of 30 mm. effective size over graded gravel. Each bed to be underdrained by two lines of 4-in. tile pipe laid on a grade of 1 in 40 spaced 6 ft. from each side of the center line of the bed. The cost of such works would be about $1,000.

SUMMARY.

The wastes produced in the dairy industry consist chiefly of dilute solutions of milk in which are particles of butter, fat and casein which come from the washing of the products, utensils and floors. The waste is very susceptible to bacterial action, quickly becomes acid, containing approximately 1,000 p.p.m. acidity, and gives rise to very disagreeable odors due to the production of butyric acid.

TABLE III.—ANALYSES OF EFFLUENT FROM CREAMERY WASTES TREATMENT PLANT AT SUNBURY, OHIO, APRIL 24 TO AUG. 5, 1909.

Parts per Million.

1909.		Oxygen consumed.	Organic matter.	Free ammonia.	Nitrites.	Nitrates.	Chlorine.	Acidity lactic acid.	Putrescibility.
			Nitrogen as						
Apr.	26	14	31.0	1.0	0.00	14.0	350	...	0
May	1	19	10.0	6.0	0.00	3.0	650	...	0
May	4	23	1.4	1.0	0.00	0.0	650	...	0
May	7	45	1.4	1.0	0.00	4.0	770	120	+
May	10	50	1.4	1.0	0.00	0.0	790	80	+
May	14	19	8.0	8.0	0.00	0.0	800	14	+
May	18	33	2.0	14.0	0.00	0.0	980	10	+
May	21	27	6.0	10.0	0.00	0.0	620	16	+
May	24	24	4.0	4.0	0.00	12.0	890	16	+
June	1	55	16.0	8.0	0.00	0.0	980	20	+
June	8	54	75.0	25.0	0.10	0.0	950	80	+
June	11	36	14.0	6.0	0.00	0.0	1,200	290	+
June	14	40	20.0	12.0	0.00	0.0	1,100	150	+
June	17	33	42.0	6.0	0.00	0.0	1,600	250	+
June	21	36	36.0	24.0	0.00	0.0	1,700	200	+
June	24	46	20.0	10.0	0.00	0.0	2,100	90	+
June	28	51	50.0	10.0	0.00	0.0	2,000	120	+
July	1	47	26.0	14.0	0.00	0.0	1,650	140	+
July	13	33	38.0	20.0	0.00	6.0	850	110	+
July	16	46	30.0	14.0	0.00	10.0	1.950	110	+
Aug.	5	70	12.0	12.0	0.00	4.0	2,450	...	+

Operation notes:

June 13—Clear water removed from waste sewer.

June 24—Surface of filters slightly raked.

June 24—Began application of soda ash to tank.

July 16—Stopped application of soda ash to tank.

July 26—Resumed application of soda ash to tank.

Aug. 11—Began operation of both units for each dose.

Because of the high oxygen demand it creates a nuisance when discharged into small streams by quickly using up the available oxygen, after which putrifaction begins.

From such data as are available the following methods of purification are suggested as the result of experimentation.

Where the volume of the waste is comparatively small and suitable land is available it may be disposed of by irrigation at rates varying from 20,000 to 2,000 gals. per acre per day.

If suitable land is not available one of the following biological methods is suggested.

Sedimentation in septic tanks for from 2 to 10 days and if diluting water in sufficient volume is at hand disposal by dilution.

Sedimentation in a septic tank for from 2 to 10 days, followed by filtration through sand at rates not to exceed 25,000 gals. per acre per day. Where sand treatment is employed it is recommended that the acidity be reduced by the addition of lime so that bacterial action will not be retarded.

Sedimentation in septic tanks for from 2 to 10 days, followed by treatment in primary contact beds, and if necessary by secondary contact beds or trickling filters. Trickling filter treatment following sedimentation is not recommended because of the dispersion of odors in applying the liquid after sedimentation to the surface of the filter.

Nuisances from the septic tank have not been created when the tank was closed and covered with a few inches of earth.

It is felt that any of the above methods of treatment will produce an effluent which will not give rise to a nuisance when discharged into a small stream or brook.

BRIDGES

Methods and Equipment Used in Constructing the Superstructure of the Detroit-Superior High Level Bridge in Cleveland, O.

(Staff Article.)

The Detroit-Superior high level bridge, which is being built by Cuyahoga County to form a new and continuous means of communication between the east and west sections of Cleveland, O., is a combination reinforced concrete and steel structure having a total length of 2,880 ft. The new bridge connects Superior Ave. to Detroit Ave., and spans the Cuyahoga River and the wide, flat valley adjacent to it, the elevation of this valley being about 100 ft. lower than that of the city grade on each side. The existing bridge is an iron structure, with a swing span over the river, and was built in 1876. The location of the new bridge is such that its construction does not interfere with traffic over the old structure. The new structure provides two decks, the upper deck being used for highway traffic and the lower one for street railway traffic. The upper deck comprises a 44-ft. 9-in. roadway and two 12-ft. sidewalks, while the lower deck carries six street railway tracks, the vertical clearance for these tracks being 15 ft. The steel span permits a clearance for river traffic of about 93 ft. The bridge is being built for Cuyahoga County at a total cost of about $2,500,000.

GENERAL FEATURES OF NEW BRIDGE.

The bridge consists of a 591-ft. steel arch span over the river and a series of reinforced concrete arch spans, with trestle and retaining wall approaches, on each side of the steel span (see Fig. 1). There are twelve concrete arches, three on the west side of the steel arch and nine on the east side of it. The largest concrete arch has a clear span of 174 ft., and the shortest one a span of 58 ft. Each concrete arch has four ribs which support, by means of heavy spandrel columns, the beam-and-slab street railway deck. These spandrel columns are continued above the railway deck to support the highway floor, which is also of beam-and-slab construction. For architectural effect, and to increase the rigidity of the structure, longitudinal jack arches are added at each deck. Expansion joints are provided in the superstructure at each pier. The 591-ft. span is a riveted three-hinged steel arch, with a rise of 144 ft., a depth at the crown of 20 ft., and a depth at the end hinges of 91 ft. The two arch ribs of this span are spaced 49 ft. 3 ins. on centers, a part of each deck being cantilevered beyond the arches. Each arch rib is divided into twenty-four 24-ft. 7½-in panels. At the fifth panel point in the lower chord from the end the top of the upper, or roadway, floor is at the same elevation as the lower chord joint; from this point to the corresponding point on the opposite side of the center line the upper deck is suspended from the lower chord panel points by hangers. The lower deck crosses the lower chord just above the third panel point.

CONCRETING WEST APPROACH.

The concrete for the west approach is being handled by means of towers and "Lakewood" chutes. The material is delivered in trucks, and is dumped into bins which feed by gravity into a "Lakewood" mixer of 1 cu. yd. capacity. The plant has a capacity of from 30 to 40 cu. yds. per hour. Figure 2 is a view of the west approach showing the system of towers and chutes used in its con-

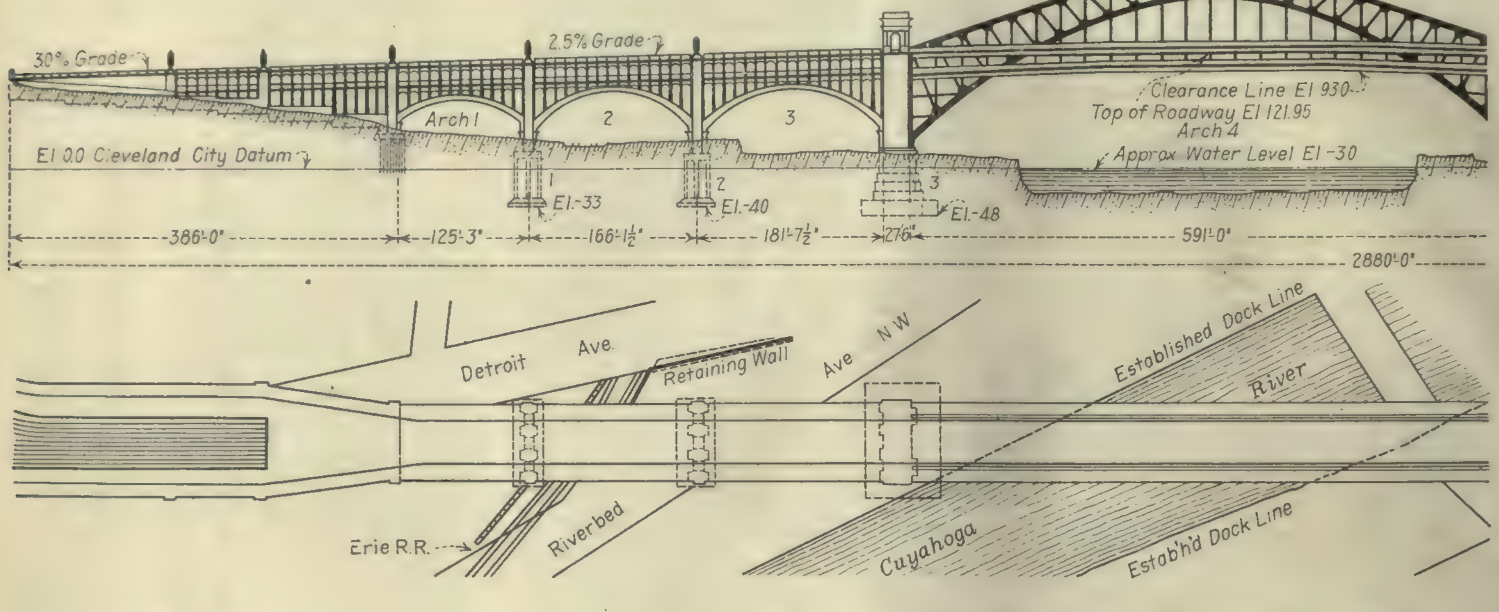


Fig. 1. General Elevation of Detroit-Superior High Level Bridge,

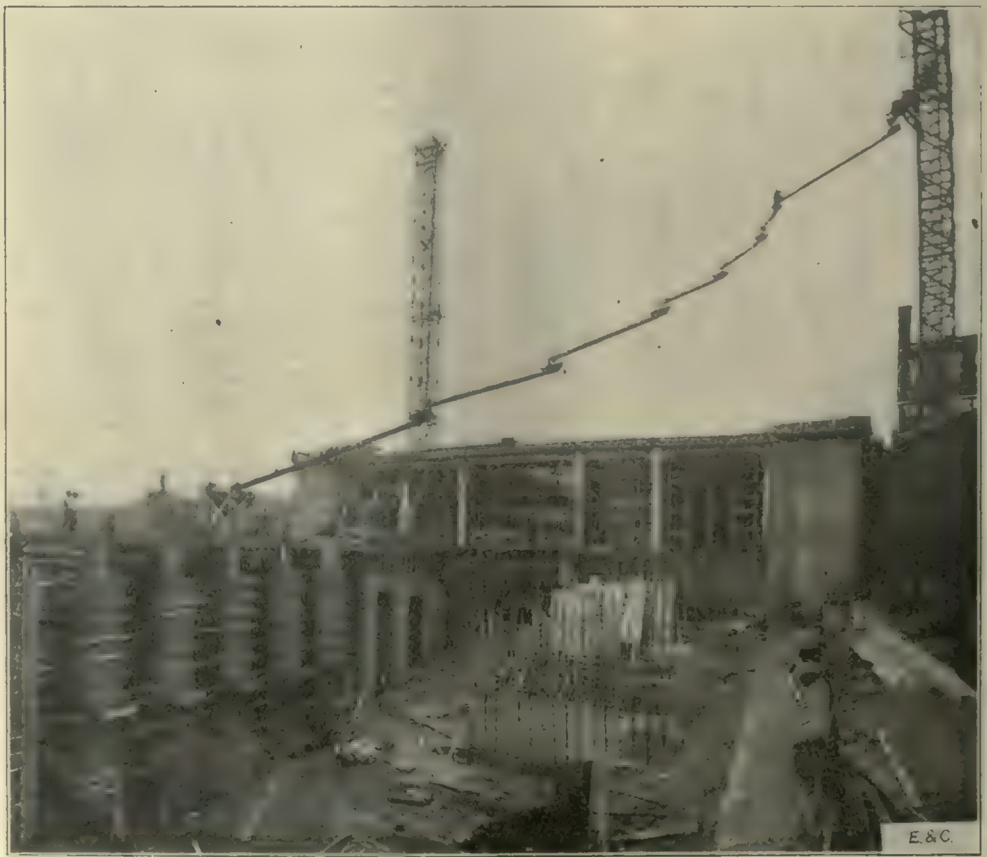
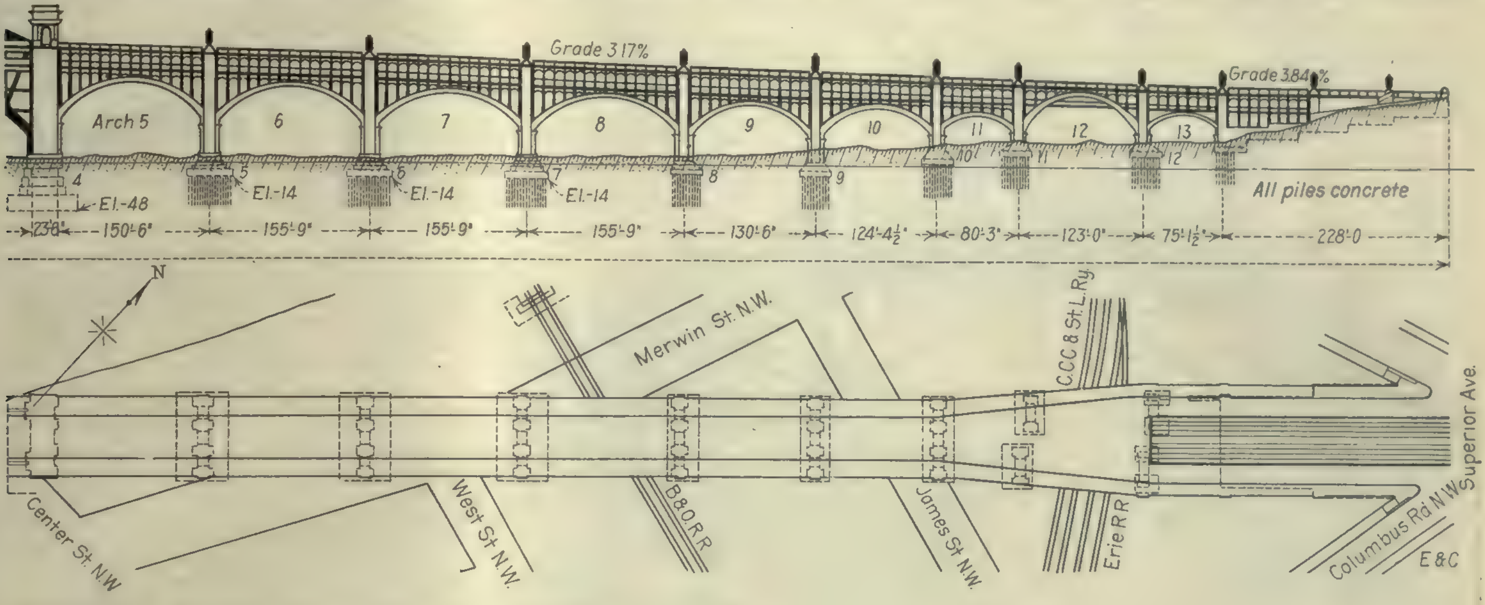


Fig. 2. View of West Approach of Detroit-Superior High Level Bridge, Illustrating Concreting Plant and Procedure.

struction. It will be noted by referring to this view that the concrete is spouted from the mixing plant into a hopper, from which it is transported to place in buggies. The view was taken May 21, 1915, and the approach is now nearing completion.

CABLEWAY USED FOR CONSTRUCTING SUPERSTRUCTURE EAST OF RIVER.

The superstructure of the portion of bridge east of the river is being built with the aid of a double "Lidgerwood" cableway of the latest type. The span of the cableway is 1,200 ft., the steel head tower has a height of 180 ft., and the steel tail tower a height of 130 ft. The main cables are 2¼ ins. in diameter and are of the "Leschen" locked coil type. The hoisting cables are of ⅞-in. plow steel. Under ordinary working conditions the cableway has a capacity of 8 tons, but segments of the three-hinged steel arch centers weighing 12½ tons each are occasionally handled. The design of the head tower is such that the arch ribs located where it stands can be constructed before the tower is removed (see Fig. 6). Provision is also made to allow the anchor arms, which will be used during the erection of the steel arch by the cantilever method, to pass through the tower. The cables are suspended above, and midway between, the inner and outer arch ribs on each side, thus enabling the concrete and other material to be hoisted after the ribs are concreted. The cableways are of the high speed type, with a hoisting speed of 700 ft. per minute and a traveling speed of 1,800 ft. per minute.



Cleveland, O., Showing Types of Structure and General Dimensions.

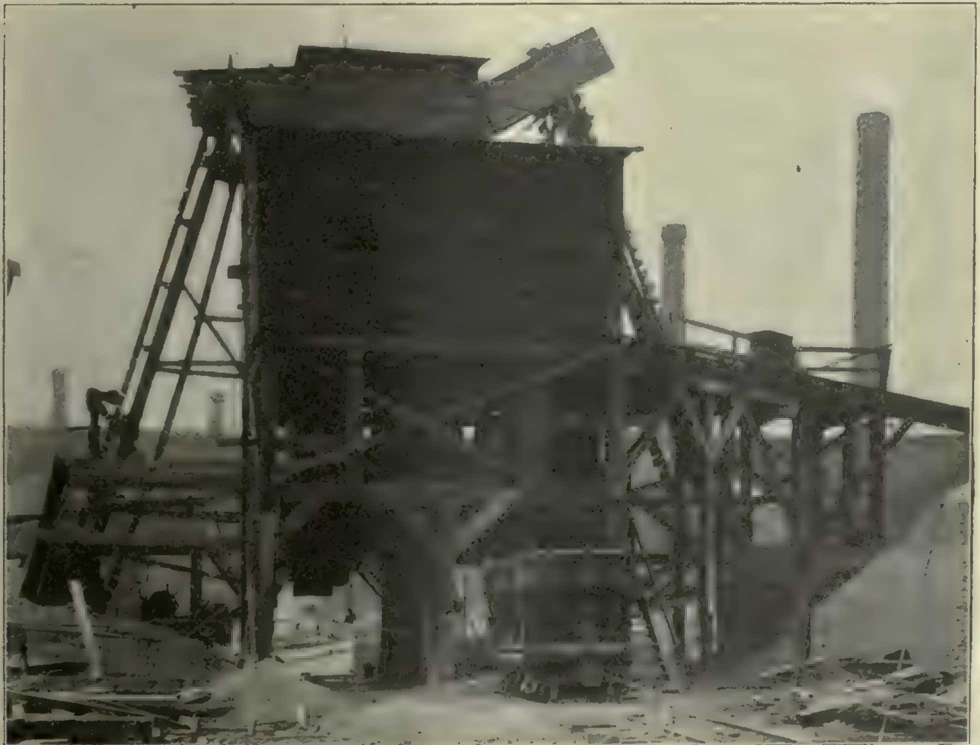


Fig. 3. View of Concrete Plant for Detroit-Superior High Level Bridge, Cleveland, O.

CONCRETE PLANT.

The concrete plant is located on the east bank of the river opposite arch No. 6 (for location see Fig. 1). The concrete aggregates —"Peelie Island" sand and "Kelley Island" crushed limestone are delivered by barges of from 500 to 1,200 cu. yds. capacity, the materials being unloaded to storage piles by two locomotive cranes equipped with "Owen" clam-shell buckets. The sand is rehandled direct to a bucket elevator by one of the cranes, while the stone is transported to its elevator by a belt conveyor which operates in a tunnel under the storage pile. The bucket elevators raise the materials 50 ft. into bins located above the mixer, one single-cylinder 12x20-in. steam engine, located on top of the plant, operating both the elevators and the belt conveyor for the stone. Figure 3 is a view of the concrete plant. The plant is also shown in the background of Fig. 5.

Sand and broken stone are fed into a standard "Smith" measuring hopper through special radial gates, which allow easy opening and positive closing. Instead of operating vertically these gates move in the arch of a circle, and they have been found especially effective.

Water for mixing is handled in an extremely simple and practically fool-proof manner. For this purpose a barrel, hinged on lugs placed a short distance above the center of gravity, is used. A latch holds the barrel in an upright position and prevents it from tipping while it is being filled to the proper mark from a 2-in. pipe having its opening directly above the barrel. A lever gate is used to control the water. When water is wanted in the mixer the latch is lifted and the barrel emptied into the stone side of the measuring hopper, thus sluicing the broken stone into the mixer. By the use of this device the mixing is never delayed, as it is possible to pour in the entire volume of water almost instantly. Figure 4 is a sketch illustrating the devices used in handling water and cement.

The cement is delivered by rail to a cement shed having a capacity of 6,000 bbls., this shed being located about 100 ft. from the mixing plant. A 36-in. gage automatic dump car conveys the cement up an incline to the mixing platform (see Figs. 3 and 5). A small hopper having a capacity of six sacks of cement is located at the sand side of the measuring hopper, this cement hopper being hinged just above its center of gravity. By the use of this hopper it is possible to note at a glance whether or not the correct amount of cement is placed

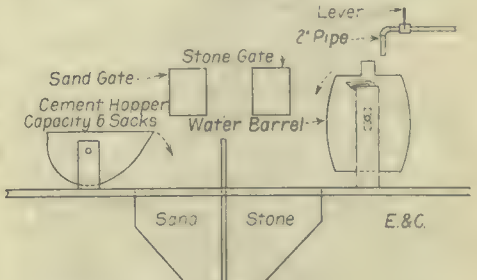


Fig. 4. Sketch Showing Manner of Gaging Cement and Water in Concrete Plant for Detroit-Superior High Level Bridge.

in each batch; it also enables the cement dumpers to empty the sacks while the previous batch is being discharged.

The proper amounts of sand and stone are obtained by filling the respective hoppers to a certain level, but the mixer men become expert in gaging the quantities, and the hoppers are only occasionally leveled off.

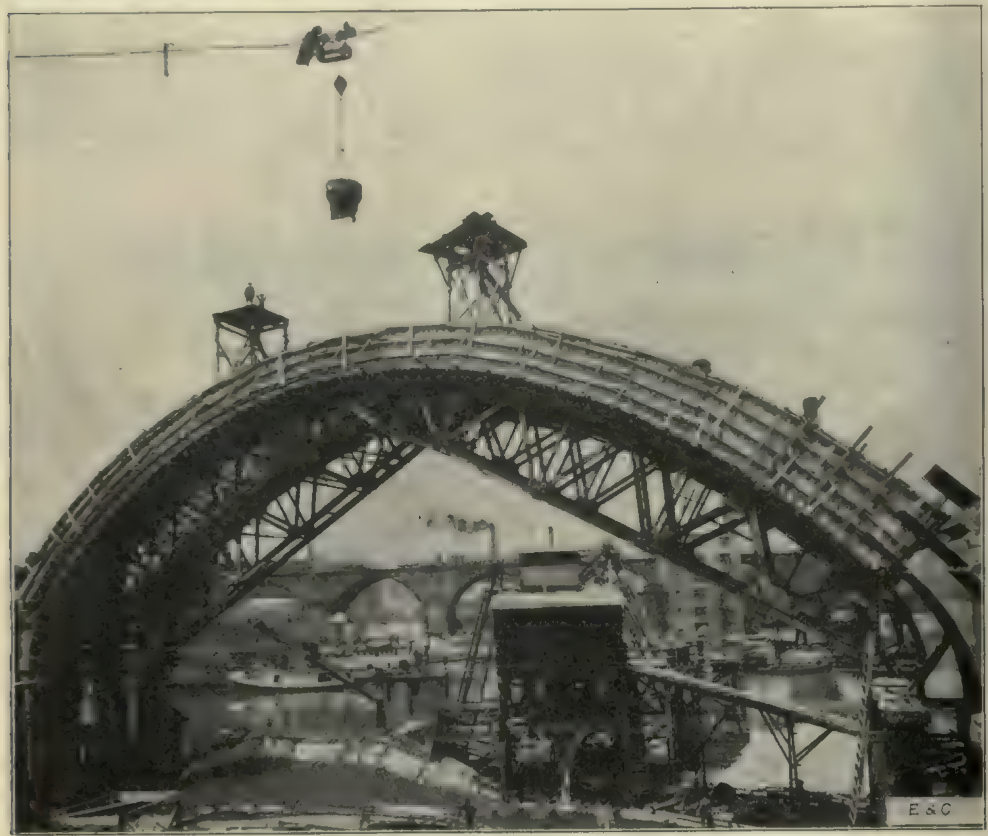


Fig. 5. Concreting Ribs of Arch No. 6—Concrete Plant Shown in Background—Note Three-Hinged Steel Arch Centers and Equipment for Handling Concrete.

A 1-cu. yd. steam driven "Smith" mixer is used for all of the concrete, this mixer being located on the floor below the mixing platform (see Fig. 3). In order to dispense with the services of a man on the mixer floor the crank worm-driven dumping device is connected by a chain and sprockets to a crank located on the floor above; this arrangement enables the man who charges the mixer to dump it.

The mixer dumps into a hopper directly above the 36-in. gage track which serves the cableways. One large flat car accommodates two 3-cu. yd. "Haynes" buckets, this car being hauled on a level track in turn to points under the cableways, at respective distances of 40 ft. and 75 ft. (see Fig. 3). One drum of a reversing hoisting engine is used for hauling the car. This drum is used as a spool, with an endless cable passing over a sheave at the end of the track. A second drum of this engine elevates the cement cars from the shed to the mixer. The buckets are of the bottom-dump type with controllable gates, and they have proved very satisfactory, as they are easy to open and are positive in action. The capacity of the plant depends on the ability of the cableway to deposit the concrete. Ordinarily, by concreting with one cableway, from 30 to 48 cu. yds. of concrete per hour are placed. Using both cableways the number of cubic yards placed per hour has run as high as 55.

A central boiler plant of 200 hp. is located near the concrete plant, and it supplies the cableway engines, the mixer, the car hoist, the bucket elevator hoist, and one of the locomotive cranes.

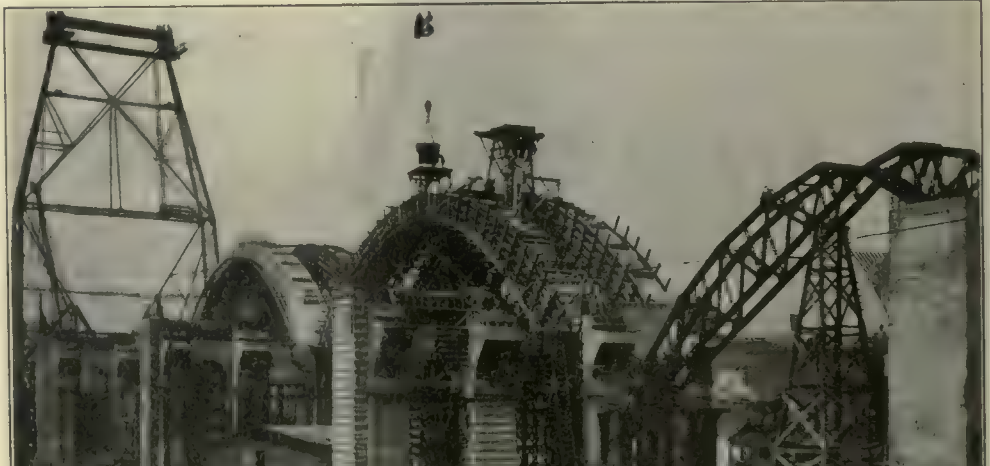


Fig. 6. View of Arch Spans Nos. 6, 7 and 8 of Detroit-Superior High Level Bridge—Note Head Tower for Cableway in Background—View Illustrates Construction Procedure.

FORMS.

In so far as it is possible the forms are made in sections at a central saw shed. This shed is 25 ft. wide by 40 ft. long and is equipped with a swing cut-off saw, a rip saw, a band saw, and a "Handy" woodworker, the latter being used for boring and cut-off work. The roof of the saw shed is supported on four posts, and there are no sides to the shed as free access to the saws is desired. All of the saws are electrically driven.

Only three sets of arch rib forms are used. They are made in 12-ft. sections of matched 2x6-in. sheeting, laid perpendicular to the arch rib and nailed to 3x6-in. studs spaced 2 ft. on centers (see Figs. 5 and 6). Waling timbers, 6x6-in., placed perpendicular to the arch ribs on 5-ft. centers, are bolted with ¾-in. bolts above and below the concrete arch rib. Where necessary, extra bolts are run through the concrete, tin tubes being used to enable the bolts to be withdrawn after the concrete has set. These bolts are pulled the day after the rib is poured, the cableway being used for this work in the following manner: A ⅝-in. wire rope is fastened to the end of the rod, with a hook over the nut. The cable is passed through a snatch block fastened to the arch rib opposite the bolt which is to be pulled, the end of the cable being attached to the fall block of the cableway. The bolt is then easily and quickly removed by hoisting on the cableway.

The side forms of the arch ribs are removed with the cableway, and are transferred to their new positions without lowering them to the ground. A 150-ft. rib has been stripped and the forms again set up in five hours.

All bolt holes are drilled with portable electric drills, 220-volt, alternating current being distributed over the job by an underground conduit system, equipped with outlet boxes at each pier, where the lines for drills, grinders for surfacing, steel bending machine, and lights can be connected by inserting plugs. This method is so simple that any man can make the connections required by him without the aid of an electrician.

CENTERING.

Each of the larger arches is composed of four arch ribs, which are centered with three-hinged steel arches resting on a steel covered runway, the latter consisting of three 12x12-in. oak timbers supported from the concrete pier footings by steel columns (see Figs. 5 and 6). Six sets of steel centers are used, permitting work on three different arches at the same time, the steel centers being placed for two arch ribs in each of three spans. After these ribs have been concreted and have set for about 14 days the centers are lowered by means of the toggle at the upper end of each segment, and are rolled over into position for the other two ribs of the span. The steel centers rest on 4-in. rollers, on which they are rolled to their new positions. To enable the centers to be moved the end pins of each three-hinged arch are tied together with cables. When in position for concreting, the ends of the steel centers are blocked against the piers by means of cast steel shoes, which are connected to the centers by large screws. The centers are set with the cableway, one segment at a time. To support the upper end of one segment while the other segment is being placed and the pin driven, a tower, constructed of 8x8-in. posts, well braced, is used (see Fig. 6). It has been found that a settlement of about 2 ins. occurs at the crown of the arch ribs when they are concreted, this settlement being taken into account in setting the centering.

CONCRETING OF ARCH RIBS.

The concreting of an arch rib is a continuous operation, work being started at the haunches and the half ribs brought up practically together over the crown. As shown in Figs. 5 and 6 the concrete is conveyed by the cableway in the "Haynes" buckets to the arch, where it is dumped into hoppers supported on short towers placed near the crown of the arch. From these hoppers it is spouted into the arch ribs. No rise of the crown during the concreting of the haunches has been detected. The view of arches Nos. 6, 7 and 8, shown in Fig. 6, indicates the procedure used in constructing the arch superstructures; this view shows construction progress on June 10, 1915. From the present outlook it is expected that the bridge will be opened to traffic in the fall of 1916.

PERSONNEL.

The bridge was designed under the direction of F. R. Lander and A. M. Felgate, formerly county engineer and bridge engineer, respectively, of Cuyahoga County, Ohio; it is being built under the direction of W. A. Stinchcomb and A. W. Zesiger, the present holders of these offices.

The foundations of the structure are all completed, most of them having been built during the past year; the two main river piers were constructed by the O'Rourke Construction Co., all others, except pier No. 12, were built by the Great Lakes Dredge & Dock Co. The King Bridge Co. has the contract to furnish and erect the 591-ft. steel arch over the river, work on the erection anchor arms now being under way. The Hunkin-Conkey Construction Co. has the contract for pier No. 12 and for the entire concrete superstructure and approaches, for whom Harold E. Ketchum is superintendent in charge of construction. K. D. Cowen is resident engineer for Cuyahoga County. We are indebted to Mr. Ketchum for the construction data upon which this article is based.

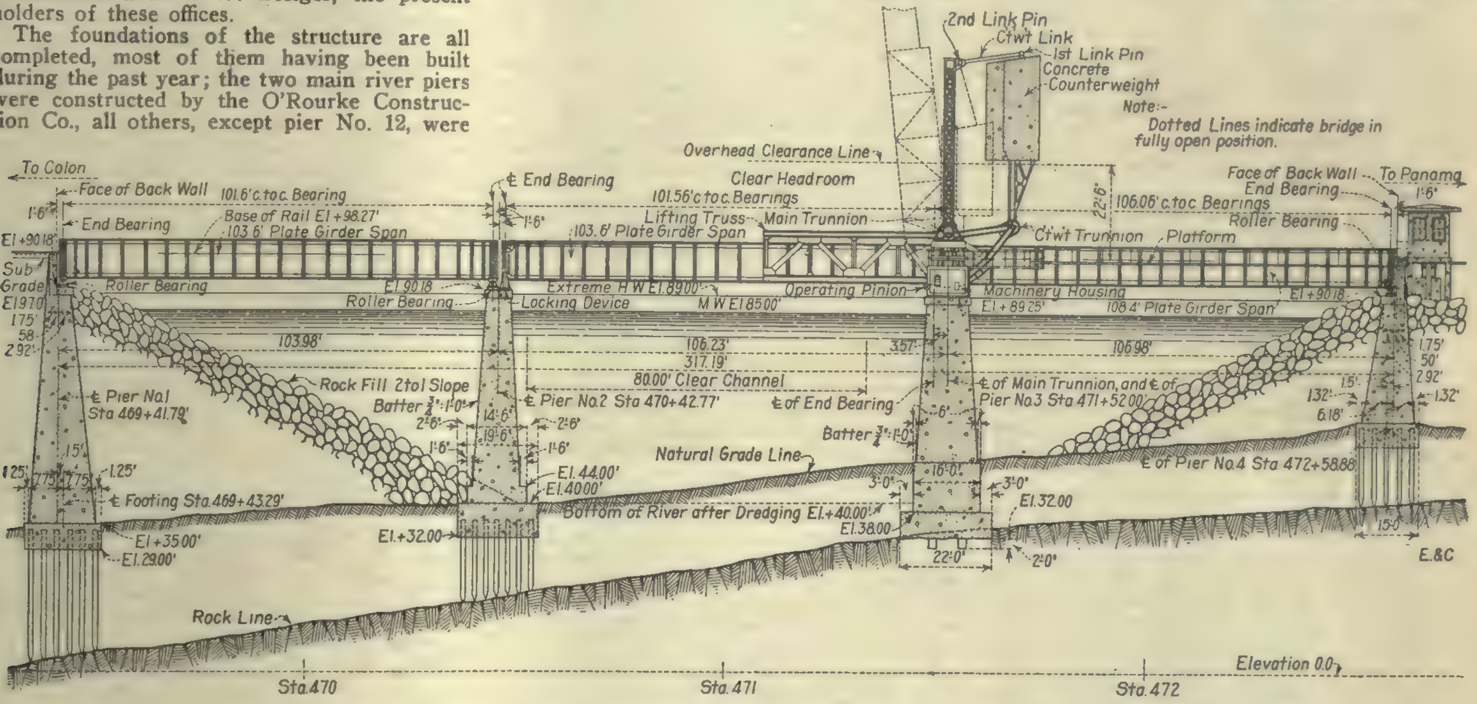


Fig. 1. General Elevation of Gatun River Bascule Bridge, Showing Type of Structure and Subsoil Conditions.

Design Features of the Gatun River Bascule Bridge, Panama Canal Zone.

(Staff Abstract.)

The Gatun River bascule bridge is a part of the improvement included in the relocated line of the Panama R. R. The new 40-mile line extends from Mindi, near the Atlantic terminal, to Corozal, near the Pacific terminal, and represents an expenditure of $8,870,000, or about $221,500 per mile. Since the waters of Gatun Lake were raised considerably, due to the construction of Gatun Dam, that portion formerly known as Gatun River became the upper arm of the lake. Anticipating this change in conditions a site was selected for the bridge (or more correctly, for the river), which would provide the most satisfactory and economical foundations for the bridge piers. The bridge is located near the south end of Gatun Valley, near Monte Lirio station. The elevation of the old river bed was 17.0 ft., which would have required piers about 85 ft. high, whereas the site selected required a height of piers of only 58 ft. This, however, necessitated the excavation of a new river channel from the west side to provide a depth of water of 45 ft. In other words, the problem consisted of constructing a bridge, and then building the river to conform to the requirements of the bridge, instead of the usual reverse procedure.

Figure 1 is a general elevation of the bridge and a profile of the bridge site. The drawing also shows the various water stages, and indicates subsoil conditions. The bridge consists of three plate girder spans, the central span being a bascule, to permit access by vessels to the upper arm of Gatun Lake and Gatun River (which since the completion of the canal has become navigable), and to assist in developing the territory contiguous to the upper arm of the lake and river. The three plate girder spans were already on hand, it being the original intention of the Isthmian Canal Commission not to provide for navigation above the bridge. When it was decided later to permit navigation above this structure, it was necessary to convert the central span into a movable span with the least possible alterations to the fabricated girders. The overhead counterweight type of bascule ("Strauss" design) was adopted as being suitable for these conditions.

The method adopted to make the central girder span operative is as follows: Two short longitudinal lifting trusses are connected by means of vertical diaphragms, at the end panel points, to the main girders. These trusses are mounted, by means of trunnions secured by fixed collar bearings to their top chords, in symmetrical trunnion bearings, whose centers are coincident with the center line of the pier. The outside trunnion bearing is secured to a structural steel frame anchored to the pier, which also carries the column for the counterweight link above. The inside trunnion bearing is secured to the top flange of the approach girder, the latter being reinforced with stiffener angles between the top and bottom flanges under this bearing. This approach girder, as well as the bascule girder, is supported on a short structural steel shoe anchored to the masonry. At the rear extremity of the lifting trusses counterweight trunnions are secured to the top chords, as indicated in Fig. 1.

These counterweight trunnions support the concrete counterweight above by means of structural steel columns, or legs, which are provided with bearings secured to them at their bases in which the counterweight trunnions are free to turn. The counterweight is guided and maintained in a vertical position by means of the well-known parallel system.

The center of the main trunnion, about which the trusses rotate, is the center of gravity of the entire moving structure. This point, the counterweight trunnion and the combined center of gravity of the main girders and lifting trusses lie in a straight line; the weights of counterweight and moving leaf are inversely proportionate to their leverages about the main trunnion; these conditions and the parallel movement of the counterweight maintain the structure in equilibrium in all positions.

While the structure is balanced, mechanical power is required to overcome the inertia, wind and friction, in opening and closing the bridge. Both electric and emergency hand operation are provided for this purpose.

The operating machinery is located on top of the trunnion pier and in two symmetrical units outside of each lifting truss, and is suitably housed. The main operating pinions are keyed to a shaft, which extends across the bridge below the trusses. These operating pinions engage circular racks secured to the bottom chords of the trusses, whose centers of rotation are the main trunnions. Each operating pinion is actuated by a 22-hp., alternating current motor (710 r. p. m. 25 cycle, 220 volt, three-phase circuit) connected to the operating pinion through four gear reductions. No equalizing device is required, since the operating pinions are keyed to one shaft. This shaft turns in bearings secured to the base of the outside trunnion posts and to the structural steel shoe under the ends of the main girders, which serve as very rigid supports; this method of support increases the efficiency of the machinery to a marked degree.

The motor is controlled from an operator's house of reinforced concrete, located at the end of the bridge (see Fig. 1). The electrical control is interlocked with the automatic signal system of the railroad to guard against trains proceeding toward the bridge at the times of operation.

The hand operating devices are two in number and are located on top of the machinery enclosures on each side; each consists primarily of a windlass with double hand-cranks, which are connected to the operating machinery by two sets of chains and sprocket wheels.

The sprocket wheel on the motor shaft is not keyed thereto, but is provided with a clutch, which is operated by means of a lever from the operator's platform, and when thrown in it becomes keyed to the motor shaft through the agency of the clutch. When the clutch is withdrawn the motor shaft turns free in the hub of the sprocket wheel and the hand operating device remains stationary.

For hand operation a foot brake is also provided, which is operated from one side only, but the brake mechanisms on either side are connected by means of a cross rocking shaft. One 100-lb. weight operates each brake, the leverage of which can be adjusted. The motors are provided with dead-weight solenoid brakes, springs not being desirable on account of the corrosive influence of the climate.

Since the plate girders are assumed to carry the live load, as in an ordinary fixed structure, a positive lock is required to force them down tightly on the shoes. The locking mechanism is located on the front end of the moving leaf, and it has proved to be positive and definite in action. It is driven by a 3-hp. alternating current motor (220-volt, 3-phase, 25-cycle), and is electrically interlocked with the track signal and leaf motors to insure their operation in correct sequence.

EXTRACTS FROM SPECIFICATIONS.

The following extracts from the specifications drawn up by the Isthmian Canal Commission give some of the general requirements as to design:

All bids must be on a type of lift bridge which is adaptable without alteration of the substructure as built and which will make use of the three existing plate girder spans with the minimum possible alterations. . . .

Special attention must be given to any change of stress in the existing girders from those for which they were originally designed, and the ultimate stresses must be in strict accordance with the provisions of these specifications. In case the dead load of the movable span comes upon the adjacent approach span, either when the bridge is closed or during operation, this span must be figured for the weight of the span itself and the weight of the movable span and counterweight, proper reduction being made in the unit stresses as specified below to take care of impact, vibration, machinery effect, etc.

Design shall be of such character that all parts, including operating devices, are rigid and positive and free from material deformation and indeterminate stresses. No design will be considered having the counterweight immersed or dipping below extreme high water.

It is desired that the center of gravity of the lifting span, open or closed, be kept close to the base of rail, and that the center of pressure of the wind force on the opened span should be as low as possible. Preference will be given to designs in which the operating machinery is located on the stationary part of the structure.

In effecting the connection of the present plate girder to the lifting parts, both the top and bottom flanges of the plate girders must be thoroughly connected to the lifting mechanism, and full provision must be made for the transfer of the stresses under all conditions.

For structural steel, pins, and cast steel for structural purposes:

Case 1.—Bridge closed and subject to dead and live loads; loads and unit stresses as for stationary structures with Cooper's E-50 loading, and general specifications for steel railroad bridges of the American Railway Engineering Association.

Case 2.—Bridge Moving.—Find the actual maximum stress in each member that will occur at any angle of opening in the movement of the bridge, and apply unit stresses equal to five-sixths of the dead load unit stresses for stationary purposes. Neglect reversal of stress, as this takes place slowly.

Wind Load.—Fifteen pounds per square foot of entire surface of moving leaf.

Operating Machinery.—Figure the strength of the operating machinery for a wind load of 15 lbs. per square foot, as above, using the unit stresses given in specifications for movable bridges by C. C. Schneider.

Motors.—Figure motors strong enough to operate the bridge against a wind pressure of 10 lbs. per square foot of moving load in 1½ minutes.

Clearance.—Lifting apparatus to be designed to provide 22 ft. overhead clearance, above top of rail, and 7½ ft. clearance on each side of center of track.

Speed of Operation.—Sufficient power shall be installed which will permit the span to be raised from the fully closed position in 1½ minutes, and in like manner closed from the fully open position in the same time.

Climatic Conditions.—The wiring and entire apparatus will be subjected to more severe climatic conditions than are usually encountered in the United States. The temperature will fluctuate between approximately 75° and 125° F. There are heavy, warm, tropical rains, severe electrical disturbances, and the air is saturated with moisture. These conditions must be taken into account in designing all equipment.

GENERAL DATA.

The structure was completed in August, 1913. The total weight of the structural steel in the bascule, including main girders, lifting trusses, trunnion posts, counterweight frame towers, etc., is approximately 313,000 lbs. The trunnions and bearings, and sheaves for same weigh approximately 15,000 lbs., while the operating machinery, including the front end locks, weighs about 48,000 lbs. The concrete in the counterweight weighs approximately 925,000 lbs.

PERSONNEL AND ACKNOWLEDGMENT.

The entire work was under the direct charge of Lieut. Frederick Mears, formerly chief engineer of the Panama R. R. The bascule was designed by the Strauss Bascule Bridge Co., Chicago. The steelwork was fabricated by the Penn Bridge Co., Beaver Falls, Pa., and was erected by the forces of the Panama R. R.

The foregoing data were taken from a paper by P. L. Kaufman, of the Strauss Bascule Bridge Co., in Professional Memoirs, Corps of Engineers, U. S. Army.

Cost of Excavating Abutments and Wing-walls for a Street Bridge.

Contributed by H. R. Ferriss, Victoria, B. C.

The accompanying data give the costs of excavating for the concrete abutments and wing-walls of a street bridge, which was built to carry one street over another, the difference in elevation of the two streets being about 30 ft. The excavation (in the form of the letter L) covered by these data include one area 59x12 ft. excavated to an average depth of 30 ft., and another area 30.5x11 ft. excavated to an average depth of 25 ft. About 1,100 cu. yds. of clay and gravel were excavated, the work being done with pick and shovel. About 600 cu. yds. of the material were thrown on top and after re-filled, the cost of re-filling not being included; the remainder was hauled a distance of about 1,500 ft. A double-track street car line and a temporary bridge were kept constantly open to traffic over the 30.5x11 ft. area. It required 22 days to complete the work, as only a small force could be worked to advantage; this force averaged 26 men and 6 teams. Considerable bracing was required, due to the constant jarring caused by traffic. All bracing was placed by the foreman with such assistance as he required from the diggers. Good Italian labor was employed, and a competent foreman was in charge at all times. About 12,000 ft. B. M. of rough lumber was used for shoring and bracing. The itemized costs were as follows:

Kind of labor.	No. of 8-hour days worked.	Rate per day.	Total cost.	Cost per cu. yd.
Foreman	22	$4.00	$ 90.00	$0.081
C'mon laborers.	510	2.25	1,147.50	1.043
Teams	99	6.50	643.50	0.585
Blacksmith	5	2.50	12.50	0.012

WATER WORKS

The Valuation of Water Works Properties.

III. The Appraisal of "Overhead Costs."

BY HALBERT P. GILLETTE.

Several recent decisions of public utility commissions serve to call attention to a rather general lack of knowledge about overhead costs. One decision even goes so far as to impute dishonest motives to certain engineers who had estimated overhead costs at what appeared to be a very high percentage. Dishonesty is rarely to be found in appraisals of "overheads," but ignorance is certainly more in evidence. At times this ignorance results in excessive allowances for overhead costs, but quite as often it leads to under-estimates. Why, it may be asked, are engineers ever ignorant in such matters? An answer will be given to this question first, and then to several other related questions that often bother commissioners as well as company managers.

To begin with, the term overhead costs, or its equivalent, has no generally accepted meaning. In its broadest sense any cost is an overhead cost if it cannot be directly assigned to a given class of construction units, and in this sense overhead cost is identical with "indirect cost." Perhaps a better conception of the difficulty of defining overhead cost, except in a general manner, will be evident upon defining "cost" and "unit cost."

The impression prevails that all the actual costs of a plant are to be found in the plant account of a well kept set of ledgers. The fact is that some cost items rarely appear in the plant account at all, notably interest during construction. And again, operating expenses are often charged with plant or capital costs, notably managerial costs.

The following definitions will serve to introduce a discussion of the subject of overhead cost.

Cost of production includes money outlays, debits incurred, proprietary losses of normal income and compensation for risks involved in production.

Cost may be divided into two classes of business debits:

1. Debits of the business to others than the proprietor.
2. Debits of the business to the proprietor.

In well-kept ledgers all of the first-named class of costs will be found, either as property costs or as operating expenses, but it frequently happens that not all—and sometimes not any—of the second class of costs, are entered in the ledgers. Thus, interest during construction, compensation for the proprietor's time and his office expenses, etc., may not appear on the ledgers at all.

Costs of production may be divided into two parts:

1. Direct costs.
2. Indirect costs.

Direct Costs are those costs directly assignable to a group of units of product without prorating.

Indirect Costs are costs that cannot be directly assigned to a group of similar units, but must be prorated among different groups of units.

Unit Cost is the cost per unit of product, and is determined by dividing the total cost assigned to a group of units of product by the total number of units.

A unit cost includes all the direct costs and it may include all or none of the indirect costs, depending upon the method of accounting or cost analysis.

In appraisal work, as well as in estimating the cost of projected work, it is customary for engineers to use unit costs that include only part of the indirect costs, and the remainder of the indirect costs is called "overhead costs."

Overhead Cost is that part of the indirect cost not included in the unit costs.

No hard and fast line can be drawn between unit cost and overhead cost. It is entirely a matter of more or less arbitrary definition. If a company does its construction work by contract, the contractor's *unit prices* are the company's *unit costs;* but the contractor's unit prices include all of *his* overhead costs. Hence, if a company does its construction with its own forces, its overhead costs will ordinarily be greater than if it does its work by contract. To this I shall revert again.

Appraisal engineers usually, although by no means universally, limit the items of construction "overhead costs" to the following:

1. Engineering and Inspection.
2. Supervision (other than gang foremen and the profits of contractors).
3. Organization (preliminary to construction).
4. Administration, Accounting and Clerical.
5. Legal.
6. Insurance (casualty, fire and title) and Damages.
7. Taxes.
8. Interest.
9. Contingencies, Omissions, Waste and Incidentals.
10. Broker's Fees.
11. Promoter's Profit.

Broker's Fee and Promoter's Profit are not infrequently omitted by appraisal engineers, but the remaining nine items usually appear, either separately listed or grouped together. They are commonly expressed as percentages, either of all the direct charges taken as a whole or of some of the direct charges, or of the direct charges plus some of the overhead charges. This variation in practice is itself confusing, but when we add to it variations caused by the "burying" of some of these eleven "overheads" in the unit prices, the confusion often is so great as to lead to complete misapprehension on the part of those not accustomed to cost analysis. Indeed even skilled estimators are frequently found to be using "overhead percentages" erroneously.

It will be observed that I have omitted "Going Value" or "Development Cost" from the list of "overheads," and in doing so I follow present practice, although "Development Cost" is itself largely interest during construction and its sequel—deficit in interest during the development period.

I am informed by Mr. C. M. Larson, Chief Engineer of the Wisconsin Railroad Commission, that his estimated "overhead costs" *exclude* items 6, 10 and 11 of the above list. Item 6, Insurance, is included in the unit prices that he uses. Item 10, Broker's Fee, is taken into consideration by the Wisconsin Commission (as I interpret their decisions) in arriving at the proper rate of "fair return" on the investment, since brokerage fees commonly constitute part of the discount on bonds. Item 11, Promoter's Profit, appears not to receive recognition by the Wisconsin Commission. Mr. Larson informs me that he usually adds to the direct costs 15 per cent for overhead costs on "the larger properties which show a high type of construction," and he intimates that of this 15 per cent very little constitutes Item 10, or Contingencies, because his "inventories are usually made quite complete by means of co-operation of the officers and agents of the companies." For small plants Mr. Larson commonly allows 12 per cent for overheads. These percentages—12 and 15—seem very low, and I believe they are low where a utility company does most of the construction with its own forces. Mr. Larson, however, uses unit prices that are assumed to be fair *contract prices* for the plant "in place," which puts a somewhat different light on these low overhead percentages. As to unit prices he says: "These prices cover contractors' profits, liability insurance, and, in a word, every item which is ordinarily in the same to a general contractor." Since a general contractor is a business manager, and since his subcontractors are really superintendents, it follows that, when their services are paid for in the form of profits included in their unit prices, Items 2 and 4, Supervision and Administration, are smaller than where a company does the construction with its own forces. This alone explains a considerable part of the difference between percentages estimated by different appraisers for overheads. Even the same appraiser may use different overhead percentages at different times, if for no other reason than to enable him to have an appraisal that can be readily compared with the accounting records. Thus, in my appraisal of the steam railways of Washington State, I included the general contractor's 5 per cent profit in the unit price, by adding 5 per cent to the subcontractor's price. Thus a large part of Item 2, Supervision, was automatically "buried" in the unit price, which was in accord with steam railway accounting prices. But in my appraisals of electric railways, electric power and light properties, and telephone plants, knowing that many companies do most of their construction with their own forces, I have used unit prices that often included relatively little or no Supervision (other than gang foremanship). Even in these cases it occasionally happens that a manufacturing company undertakes to do much of the engineering and supervision involved in laying out and installing apparatus, and then a large part of such "overheads" as engineering and supervision are automatically buried in the prices charged for apparatus installed "in place."

In the appraisal of land and right of way it often happens that the appraisal engineer has no voice as to "overheads." Then all "overheads" may be lumped in with the price fixed upon the land by real estate experts This was what was done in the original appraisal of the steam railways of Washington, and it has led not a few writers to misapprehension as to the overhead percentages used in that appraisal.

Parenthetically, I have never understood the reason that led Justice Hughes to exclude overhead costs on land and right of way in the Minnesota rate cases, unless he believed that the land prices included all overheads. On this theory, and on no other, is his decision sound, for land and right of way are accounts that ordinarily must carry very heavy "overheads" in the form of interest and taxes during construction, to say nothing of title insurance, legal and other expenses.

Returning to Item 2, Supervision, I find that some utility companies include "dead time," traveling expense, unapportioned freight and cartage, and the like, under this head. To put the "dead time" (due to bad weather and holidays) of laborers in this account is a mistake, it seems to me. Similarly traveling expense of laborers and unapportioned freight should not be called Supervision. Nevertheless they are sometimes charged to such an account. Even tool expense may be occasionally found there also.

Perhaps I have gone far enough in this discussion of details to indicate the danger that lurks in ordinary comparisons of "overhead percentages," particularly when the accounting practice of different companies is not thoroughly understood. But one more instance—a very striking instance—should be given to emphasize this point. Most large companies build additions to plant at the same time that they make repairs and renewals. Often the same gangs make both renewals and additions simultaneously. The same engineering, managerial, and executive forces are usually engaged in maintenance as well as on new construction. Therefore it becomes necessary to prorate engineering, supervision, etc., to two or more distinct classes of work. Such prorating may be done according to different theories, the two most common being: (1) In proportion to the cost of direct labor, and (2) in proportion to the combined cost of labor and materials. These two methods rarely give the same results; often the results are widely different. Maintenance work generally involves a relatively high proportion of labor to material costs, whereas the converse is often true of new construction. Hence a company whose practice is to allocate engineering and supervision between maintenance and new construction in proportion to the direct labor involved will have a plant account containing lower overhead costs than a company whose practice is to allocate these overheads in proportion to combined costs of material and labor.

It is not my purpose in this article to discuss correct methods of prorating overhead costs, for that is a big subject in itself. Evidently the theory of such prorating has an important bearing upon final results. As an illustration I may cite one company whose new construction annually amounts to many millions of dollars and whose maintenance costs are equally large. Upon analysis of that company's costs, I found that its overhead charges on new construction would have been 3 per cent greater than they appeared in the plant account had they been apportioned according to total costs instead of according to direct labor costs.

Some companies charge all general management, auditing, legal expense, etc., to operating expense, and thus reduce the overhead plant charges.

It may be said that overhead percentages should be determined solely by analysis of construction costs of companies during construction periods and prior to beginning operation. But to confine analysis to such companies would eliminate most of the new construction of public utility companies throughout America.

Often it is said that it matters not in the end whether overhead charges are improperly prorated or not, for by as much as the capital account is undercharged, by that much will operating expenses be overcharged. The users of this argument lose sight of the fact that an appraisal usually marks the passing from the old regime of *laissé faire* to the new regime of state regulation. One of the objects of an appraisal then is to start the new plant account as nearly right as practicable. Even more important is the consideration that the source of a company's plant is of minor consequence, whereas its "present value" is of great importance. True plant cost is independent of accounting methods, of whether property has been paid for or out of earnings or by the sale of securities. But accounting records can be used as evidence, from which true plant cost may be inferred, and to that end it is desirable that both the property accounts and the maintenance accounts be carefully analyzed at least for a number of years back. Upon such analysis adjustments can be made. Then correct unit costs and correct overhead costs can be derived. To this use of accounting records many engineers do not resort; their failure thus to use accounting records explains most of the ignorance respecting overhead costs, and makes clear why engineers have so frequently underestimated "overheads."

In this connection it may be remarked that while most engineers are fairly familiar with contract prices, and while some engineers are equally familiar with actual unit costs, relatively few engineers know from personal study of accounts what overhead costs average under given conditions. Until quite recently the accounting records of few utility companies were open to the study of engineers. And even when the records were available not many engineers analyzed them thoroughly, both as to operating and construction charges. The consequence has been that engineers employed by public service commissions have commonly underestimated overhead costs. Engineers employed by companies have ordinarily been closer to the mark, but occasionally have grossly overestimated overhead costs because they were guessing.

In a recent commission decision, the overhead costs estimated by commission's engineers were rejected as being too high, although, in fact, they were much too low in my judgment. The commission reasoned that because the plant account of the company showed nominal charges for engineering and supervision, and no charges for interest during construction, it could not be possible that the company had spent much for these items. This is an instance of a sort of blind faith in "book values," a faith, by the way, that would quickly have ebbed had the company been found to have "book values" that greatly *exceeded* the commission's engineer's estimate of reproduction cost.

Very few operating companies charge any "interest during construction" when new construction proceeds *pari passu* with renewals. In other words, after the original nucleus of a plant is built, the "interest during construction" account, if ever there was one, is closed. In the case of railways, the interest account contains only interest on bonds and notes. Hence it usually does not adequately represent full interest on all the plant even during the original construction period. In my early appraisals I did not recognize this fact and accordingly underestimated "interest during construction."

On the other hand there is often a slight duplication of interest charges arising from the practice of making a per diem charge for "train service" which is itself high enough to cover interest on the rolling stock. Analogous to this is the practice of charging for transporting their own freight over their own lines at rates that are high enough to cover part, if not all the interest on the track and equipment.

Interest during construction, as I now view it, should be charged at the full "fair return rate" rather than at the bond interest rate. Otherwise the investor fails to get a "fair return" on his money during the construction period.

It has often been claimed that bond discount is a proper "overhead charge," but usually this claim has been rejected by commissions. Commissions have reasoned that bond discount merely reflects the rate paid for the use of money, and is, therefore, to be considered only as a factor in determining the "rate of fair return" on the investment. This reasoning, however, is not wholly correct. Bond discount is a composite of two entirely distinct things: (1) Brokerage fee and (2) advance payment to the bond purchaser. The broker requires part of the discount to compensate him for investigating the property, giving it the endorsement of his approval, circularizing his clientele, advertising and selling the bonds. First, in the case of a large issue, there is the wholesale broker, and, second, there are many smaller firms, who retail the bonds that they have bought from the wholesaler. Securities are thus sold as if they were merchandise. It costs money to market them. The brokerage fee, therefore, is just as much a part of the cost of the property as is the engineering. Indeed, there is often not a little engineering involved in the study of a property by the representatives of investment brokers.

Occasionally a witness who has testified as to brokerage fees is asked such a question as this: "If Jones builds a $10,000 house with his own money, whereas his next door neighbor, Smith, builds a $10,000 house with borrowed money, is Smith's house worth more than Jones'?"

The answer is no, and upon receiving such a reply it is presumed that the entire argument in favor of brokerage as an overhead cost is overthrown. But let the cross-examiner himself be asked: "If Jones, who is an architect, builds a house, and his neighbor, Smith, who is not an architect, but hires one, builds a duplicate house, is Smith's house worth more than Jones'?"

Here the negative answer might with equal reason be used to support the contention that architect's fees are not a proper overhead charge. The fallacy in this line of reasoning arises from the confusion of *cost* with *value*. The "worth" of a thing is its value, which may be quite distinct from its cost. Appraisals of utility properties are *cost* of reproduction estimates whenever they consist of a summation of priced-out quantities. The commercial *value* of a utility property is the present worth of its prospective earnings, or its equated annual net earnings capitalized by dividing them by the rate of fair return. While neither interest during construction, nor taxes, nor brokerage fee, nor many another item adds to the commercial *value* of a property, it does add to its *cost*. Whatever normally increases cost is an element to be appraised by one who is seeking either true investment or true cost of reproduction.

Among court decisions on this point of brokerage fee, none is better expressed than the decision (Jan. 13, 1913) of the Royal Courts of Justice relating to the purchase of the National Telephone Co. by Great Britain. The Court said:

> Next, it is said that the cost of raising the capital necessary to construct the plant is not an item to be taken into account in finding the cost of its construction. . . . The company has given evidence, by way of example, that it cost them 4.41 per cent to raise £5,500,000. No one has given evidence that it would not cost anything, nor has that proposition been put forward even in argument. I know of no commodity and no service that can be procured as of a right for nothing. I am clear that, as a fact, money cannot be procured for nothing. . . . It is not true to say that this involves the proposition that the value of plant varies with the credit of the constructor. The cost to be considered is the cost to the hypothetical constructor who is a person in good credit.

Accordingly the Court allowed a commission or brokerage fee of about 2 per cent of the construction cost of a telephone plant having a total cost of about $65,000,000.

The brokerage fee on small properties is usually a higher percentage than on large properties, for reasons that are quite apparent.

CONTINGENCIES.

Contingencies, as the term is ordinarily used by appraisal engineers, denotes the probable aggregate cost (or value) of items not formally listed in the appraisal inventory.

Contingencies may be divided into three classes:

1. Omissions of quantities through carelessness, ignorance or oversight.

2. Omissions of minor quantities, purposely left out of the formal inventory, either because of the difficulty of enmuerating them or because of their relatively small value.

3. Underestimates of unit costs or values.

Some appraisers include an allowance for contingencies in their unit costs, in which case contingencies may not appear as a separate item, yet may in fact exist in the appraisal.

An allowance for contingencies is usually made by engineers in estimating the probable cost of *projected* work. Such an allowance is seldom less than 5 per cent of the total of the scheduled estimate, more commonly is 10 per cent, and not infrequently reaches a much higher per centage, depending on the carefulness with which the plans have been prepared, the degree of certainty as to the conditions that will be encountered, the experiences of the engineer, and, finally, the optimism of the engineer. Obviously a higher allowance for contingencies should ordinarily be used in estimating the probable cost of *future* works than in estimating the cost of replacing or reproducing *existing* works. It sometimes happens that the engineering records of quantities and the accounting records of costs are so complete and reliable that no allowance at all need be made for contingencies in an appraisal of existing works. This is particularly true when the works are comparatively new. However, as an engineer gains experience in estimating and particularly after he has had occasion to check over the appraisals of other engineers, whether in his own employment or as independents, he is more likely to recognize the necessity of some allowance for contingencies in nearly every instance. What this allowance shall be is a matter of judgment, but not necessarily a matter of mere guesswork.

Perhaps at the basis of the phenomenon of underestimating there is the psychological fact that most men are optimists. The hope that work can be done cheaply is father to the too low estimate. In addition to this well known cause there are many other reasons why estimates of cost tend to be too low. Some of these are not generally recognized even by expert appraisers. For example, in not a few articles, decisions and books on appraisals, there appear diagrams and tables of unit prices of materials—such as copper, steel, water pipe, etc.—accompanied by statements that the average of these prices over a period of years was used as the base price in the appraisal. This seems a philosophical method to use when *average* prices are sought, but closer investigation discloses the fact that it is not so philosophical as it seems, for sight is lost of the following basic fact in the business world where the law of supply and demand operates:

In general, average weighted prices are higher than average unweighted prices, because more materials are bought during periods of high prices than during periods of low prices—the higher prices being, in fact, the result of the greater demand.

This generalization is deducible from the law of supply and demand, but it may be arrived at inductively from the actual purchase records of large companies that have been in existence many years. As a corollary of this generalization, we can immediately infer that even the "average monthly" or "average yearly" prices of materials as published in the technical journals are deceptively low, for they, too, are unweighted averages. The sale price of 1,000,000 lbs. of copper in the first week of a month is given as much weight as the sale price of 5,000,000 lbs. in the last week of the month, in arriving at the "average monthly" price.

The correct method of arriving at a true average, or weighted average price, is this: Multiply the number of units in each sale by the sale price, total these products and divide by the total number of units to get the weighted average price.

In this excess of weighted average price over unweighted average price, we have a good example of the sort of underestimating that justifies a contingency item in many appraisals.

Another common cause of underestimates by engineers is traceable to their lack of familiarity with the detailed records of the accounting department. The engineer may keep quite careful cost records in the field, yet fail to know some of the very important elements of cost that disclose themselves only in the records of the accounting department. This, perhaps, has been one of the greatest sources of underestimates in the past, but is fast becoming less in importance now that engineers are more frequently familiar with accounting practice and records

In the following list of items will be found some of the things that not infrequently result in underestimates. Of course most of these items will ordinarily be provided for in the unit prices, but the fact remains that unit prices usually do not include sufficient provision for all items of cost. Hence the reason for an allowance for Contingencies and Omissions made up of such elements as the following:

Accidental Omissions of Quantities and Cost Items.

1. Quantities inventoried in the "field survey" but overlooked in the final summary.
2. Quantities seen but omitted because they were believed not to belong to the company.
3. Quantities not visible:
   - (a) Underground obstructions.
   - (b) Sewer connections.
   - (c) Foundations in quicksand, piling, etc.
   - (d) Rock excavation, hardpan, etc., beneath an earth surface.
   - (e) Clearing, grubbing and trimming.
   - (f) Pole butts treated.
   - (g) Ground braces, bog settings, concrete settings, etc., for poles.

  (h) Work abandoned due to changes of plans after work was begun.
4. General Cost Items Overlooked:
  (a) Casualty Insurance and contractor's indemnity.
  (b) Fire Insurance.
  (c) Title Insurance.
  (d) Brokerage Fee.
  (e) Demurrage.
  (f) Miscellaneous Items.
  (g) Value of Leases.
  (h) Taxes during Construction.
5. Damage Costs:
  (a) Changing location of a highway, incident to building the utility plant.
  (b) Ditto sewers, water pipes, etc.
  (c) Ditto buildings.
  (d) Ditto water courses.
  (e) Severance damages.

Items Properly Omitted in the Inventory.

1. Material wasted, stolen, etc.
2. Excess material needed for splicing, joining, trimming, etc.
3. Increased length of wire and cables, due to sags, dips, map shrinkage, inclines and slopes of ground.
4. Small items of hardware, miscellaneous small supplies, etc.
5. Disconnected installations and wiring, available for use.
6. Cost of reels and freight thereon.
7. Changes made after construction is begun, resulting in property lost, e. g., pole holes.

Underestimates of Unit Costs and Overhead Costs.

1. Use of average prices instead of weighted average prices.
2. Use of wholesale unit costs when, under no rational hypothesis, could work be done entirely wholesale.
3. Use of car-load freight rates throughout, when less than car-load rates would often be incurred.
4. Assumption of good weather conditions throughout, when bad weather, night work, etc., would normally occur for at least part of the work.
5. Assumption of continuous work, when delays due to non-shipment of materials and freight congestion on railways, would normally add to some unit costs. Other delays, such as those involved in securing right of way, also occur.
6. Assumption that surface conditions are sufficiently indicative of subsurface conditions, or that a few borings are ample to indicate subsurface conditions, resulting in underestimates of unit costs of excavation, hole digging, etc.
7. Assumption that existing plans and specifications were followed, resulting in underestimating the cost incurred because of change of plans and specifications, which changes were not recorded.
8. Assumption that all the general and overhead costs of construction appear in the construction ledgers. Some items may have been improperly charged to operating expense. Some may have never been charged at all.
9. Insufficient allowance made for higher unit costs occasioned by the existence of other plant units that obstruct work, as when overhead wires make it difficult to raise poles; or when proximity to underground pipes makes work on conduits difficult.
10. Assumption that unit costs based on work with relatively small and well trained gangs of picked men can be equaled where the work is extensive, and particularly where the work is both extensive and scattered.

Since overhead costs are indirect costs and since indirect costs are usually prorated or apportioned to different direct costs, it is inevitable that overhead costs should ordinarily be expressed as percentages. Yet the very fact that they are so expressed has often produced an impression that overhead costs are less real—more visionary—than unit costs. This unfortunate misapprehension has received apparent confirmation because of the different overhead percentages used by different appraisers for overhead items bearing the same name.

I have pointed out the fact that until one knows just what an appraiser has included in his unit prices it is impracticable to compare most of the overhead costs of two different appraisals. It seems desirable to add that even the same words used to designate overhead items are not always used in the same sense. The term "Engineering" may or may not include inspection, architects' fees, office expenses incident to engineering, etc.

In this connection it may be added that "office expenses" may or may not include interest and taxes on the office floor space. These fixed charges on office buildings, etc., are sometimes overlooked entirely. At other times they are cared for under Interest and Taxes. Again at other times they are distributed among other overhead items. Considering all such variations, it is scarcely to be wondered that percentages allowed for Engineering may vary considerably. But, if in addition to these variations we have cases where the engineers are also superintendents of construction, we have a satisfactory explanation of the fact that Engineering ranges from 3 to 10 per cent or more.

As indicative of the errors that are being made through rather blindly adopted overhead percentages used by other appraisers without also understanding what their unit costs contain, I will quote again from one of Mr. Larson's letters to me:

> Some commissions in the Southwest have been known to quote the Wisconsin Commission as putting on only 12 to 15 per cent [for overhead costs], which they declare cover not only the items enumerated, but also promotion, discount on bonds and going value. I wish to mention this only that it may call to your mind the fact that these overhead charges are not intended to cover such items.
>
> It should be noted that when a telephone company purchases a switchboard the cost of a large part of the engineering on that switchboard is included in the price paid the supply company. When a gas company purchases a gas tank the cost of a large part of the engineering is paid to the supply company. Since we [the engineers of the Wisconsin Railroad Commission] place the price of these items at the amount paid by the local companies to the supply companies, this fact must be taken into account in applying our overhead charges.

I have been so frequently asked by public service commissions to explain why my percentages for overhead charges exceed those used by the engineers of the Wisconsin Railroad Commission that I found it desirable to secure from Mr. Larson a statement as to what his overhead costs included and what they excluded. The correspondence between the author and Mr. Larson, on this subject, is quoted in full below.

Since relatively little exists in print on the subject of overhead costs, and since much that is to be found in books on appraisal is misleading, it has seemed wise to discuss overhead costs at some length. I would caution against the assumption that the foregoing is more than a bare outline of the theme of this article. Prorating indirect costs, which is so closely associated with overhead costs, is itself a large and complicated subject, which I have barely mentioned. But, depending on the method of prorating general expenses over capital account and operating expense, there will be marked differences in the overhead costs of construction wherever construction is carried on by the same organization that is operating the utility plant.

CORRESPONDENCE BETWEEN H. P. GILLETTE AND C. M. LARSON, CHIEF ENGINEER WISCONSIN RAILROAD COMMISSION, WITH REFERENCE TO ALLOWANCE FOR OVERHEAD CHARGES.

Letter of Mr. Gillette to Mr. Larson, Dec. 8, 1914.—In estimates made by your department I have frequently noticed the allowance of 12 per cent for engineering and other overhead charges. Will you be kind enough to let me know what overhead charges are included in this 12 per cent? I infer that it covers engineering, business management, clerical expense, plant expense, legal expense, interest during construction and contingencies.

In the course of our investigations of the actual costs of construction for a considerable number of utility companies, I find that the overhead charges, as I use them, are very much in excess of 12 per cent, without any allowance for contingencies. However, I realize that it is the practice of many appraisers to include certain overhead charges in their unit prices. Contingencies, for example, are often placed there; likewise much of the general superintendence is also included in unit prices by some appraisers and I have done this myself in many cases. For instance, in my appraisal of a railroad for the Washington Railroad Commission, I allowed 5 per cent for general contractor's charge, which was added to the unit prices. It had been the practice of nearly all the large railways in that State to award their contracts for large work to some general contractor on a percentage basis, the percentage being usually 5 per cent. This contractor, who was in fact the business manager of the construction, then sub-let nearly all the work at unit prices. Now it is evident that this 5 per cent could either be added to the unit prices or treated as an overhead charge, to be subsequently added to the grand total, and in the case of the Washington railways I chose the former method. It has always been my practice to include in the unit prices all costs of foremen and local superintendents engaged directly on the work, as well as time-keepers, etc.

In a recent investigation of a large utility company, I found the following actual percentages for the overhead charges named below:

	Per cent.
Engineering and inspection	5.0
General supervision	1.3
Clerical expense	2.0
Executive, legal and accounting dept.	1.8
Traveling	0.6
Rent and furniture expense	0.6
Stationery, postage, etc.	0.4
Miscellaneous	0.3
Total	12.0

This did not include liability insurance, as you will note. May I ask whether it is your practice to include liability insurance in the unit prices? The above 12 per cent did not include the local foremen and time-keepers, whose costs are regarded as direct costs and therefore included in unit prices.

Since the above 12 per cent is rather typical of a good many companies, you will see that I am at a loss to understand how you can use so low a percentage as 12 per cent to include not only the above items, but to provide for interest during construction, contingencies and the preliminary expenses of organization.

I would greatly appreciate as detailed a reply as you care to make to these questions, for, as you will realize, the precedent established by the Wisconsin Commission is largely followed by other commissions, and I am frequently confronted with the statement that the Wisconsin Commission never allows more than 12 per cent for overhead charges. Realizing that the practice of engineers differs as to where they place the overhead charges; that is, whether they are included in unit prices or not, I anticipate that you may have distributed your overheads to a large degree in the unit prices.

Letter of Mr. Larson to Mr. Gillette, Dec. 17, 1914.—I have your letter of the 8th instant concerning overhead charges allowed by us in making valuations of physical property.

It is our custom to allow from 12 to 15 per cent for these charges; in general, 15 per cent is allowed on the larger properties which show a high type of construction. This item is supposed to cover engineering and superintendence during construction, general organization and legal expenses during the same period; also interest during construction and omissions, such as items not included in the inventory or items of cost which are not discovered at the time of making the valuation. These latter are rather low, as our inventories are usually made quite complete by means of co-operation of the officers and agents of the companies.

This overhead per cent is applied to a figure which is supposed to include the total cost of labor and material, including contractors' profit, liability insurance, etc. Furthermore, it is not supposed to include any promotional profits, nor is it expected to cover the item of discount on bonds; in other words, the overhead charge, together with the figure to which it applies, will represent the actual value as nearly as may be determined of the physical property, assuming that money shall have been provided for the construction of the property.

I realize that there are plants which show higher costs for specific items than may be allowed, and it is entirely possible that in some cases where excessive difficulties are met with that engineering and allied charges may run as high as that cited by you. However, in the absence of specific information on these subjects, the valuation engineer is expected to report as the value of the property the most probable value, taking into account conditions as he finds them as compared with conditions under which he obtains his cost data.

I have had the accounts of many companies investigated under my direction, and the actual costs of specific items have been applied to the specific costs of construction, and I am led to conclude that with few exceptions 15 per cent is high enough to cover the items mentioned in the first part of my letter.

In a recent valuation of the Milwaukee Gas Light Company, a $10,000,000 property in Wisconsin, a very careful study of the probable cost of overhead charges was made by the manager of that company and by members of our staff. This was made by several methods, one of which was to make a very liberal estimate of the force necessary to construct the property. The very highest figure to be obtained under this method was 18 per cent, and that was based upon construction of the entire $10,000,000 worth of property before operation began; and this, as you know, is not the way plants are constructed. We finally placed an overhead allowance of 15 per cent in this case.

We have in this state a hydro-electric property designed and constructed by an engineer who charged for his services 10 per cent on all items handled by him. After the entire plant was constructed the books were examined and the specific costs of construction found to be something over $1,000,000. As applied to this cost the entire charges for engineering and superintendence was 4.51 per cent; legal expenses, 0.27 per cent; organization and office expenses, 2.30 per cent; insurance, taxes and damages, 1.71 per cent; interest during construction, 5.87 per cent; discount and commissions, 0.58 per cent; or a total of 15.24 per cent. The period of construction was two years. It should be said that these overhead expenses include also preliminary expenses incurred some two years before construction began.

During our studies we have received statements of extremely high overhead charges and have proceeded to investigate some of them. One case which was cited by a Wisconsin corporation was that of a large power company in the west. It was reported to us that the cost of specific construction was approximately $5,000,000, while the cost of overhead charges was 49.6 per cent of that—nearly $2,500,000. This was given with sufficient detail to appear to be good evidence. However, we inspected the details of the book-keeping accounts and found that in the overhead had been charged such items as camp equipment, repairs and renewals, $131,000; construction equipment investment, $232,000; repairs and renewals to same, $44,000; auxiliary and operation equipment, $209,000; small tools, $22,000; dismantling plant, $4,000; boarding house loss, $9,000; suspense credits, $88,000; warehouse operation, $29,000; undistributed hauling, $41,000; employment expenses and transportation, $45,000; liability insurance, etc., $54,000; watching, lighting and guarding, $38,000; hauling and erecting construction equipment, $4,000; and a number of other small items which we include in our cost of specific construction. If, now, all these items had been added to specific construction it would have raised the construction cost to a considerably higher figure and would have reduced the overhead charges a corresponding amount; the per cent of overhead would then have been reduced to a reasonable figure.

I have cited the above simply as instances which illustrate the point I have in mind, and not at all as representing the extent of our investigation.

I have had many calls for information on the above subject, and would be very glad to have as much detailed information as possible. Some commissions in the southwest have been known to quote the Wisconsin Commission as putting on only 12 or 15 per cent, which they declare cover not only the items enumerated, but also promotion, discount on bonds and going value. I wish to mention this only that it may call to your mind the fact that these overhead charges are not intended to cover such items.

It has not been our practice to distribute the overhead charges to the unit prices except as mentioned above; that these prices do cover contractors' profits, liability insurance and, in a word, every item which is ordinarily included in the same to a general contractor.

It should be noted that when a telephone company purchases a switchboard, the cost of a large part of the engineering on that switchboard is included in the price paid the supply company. When a gas company purchases a gas tank, the cost of a large part of the engineering is paid to the supply company. Since we place the price on these items at the amount paid by the local companies to the supply companies, this fact must be taken into account in applying our overhead charges.

I shall always be glad to discuss this or related matters with you or other engineers, and shall be glad to have from you any statement you can make in regard to your own practice.

Letter of Mr. Gillette to Mr. Larson, Dec. 22, 1914.—I have your letter of Dec. 17, relating to overhead charges.

I am interested to note that you are at present allowing about 15 per cent for overhead charges on the larger properties which show a high type of construction.

I think that the more we study the accounting records of the large companies the more we shall perceive that most of them make inadequate charges to the construction account for what we term overhead costs.

I have just completed the analyses of overhead costs of a large utility company in New England, and find that at least 4 per cent should be added to their book value for overhead costs (exclusive of interest). Too large an amount of overhead costs has been charged to operating expense.

What may be termed expenses of administration, including legal expense and general accounting, are very frequently charged entirely to operating expense, although upon no correct accounting theory can this be justified. This alone may amount to 2 per cent or more of the cost of construction if properly prorated thereto. I am speaking now of companies that do a very large amount of construction each year.

Another point to be considered is the manner of prorating these overhead charges. The company above referred to has pro-rated all its engineering, superintendence, etc., in proportion to the direct labor, and not in proportion to the total cost of work done. Their practice is unquestionably erroneous, at least for certain of the overhead charges, and the tendency of this practice is to reduce the per cent of overhead charges to the construction account, because the repairs and renewals involve a far larger percentage of labor than is the case with additions to the plant.

Regarding the item of "Interest During Construction," it is the practice of railway companies to charge only the interest on bonds. Therefore, if most of the property has been built from money secured by the sale of stock, the charges to "Interest During Construction" are too low. In a slight measure this may be offset, however, by making a charge for "train service" which itself is high enough to cover interest on the rolling stock.

The instance that I cited in my letter of the 8th was one in which no extraordinary difficulties existed. I cited it because it is fairly typical.

These examples that you cite, and those that I have mentioned, indicate how necessary it is for engineers to be specific and detailed in their statements as to what is included in overhead charges, and how the charges have been arrived at.

Let me thank you for your very interesting and instructive letter.

Bringing Order Out of Chaos in the McAlester, Okla., Water Department.

(Staff Abstract.)

Seven years ago, and for the greater part of those seven years, the affairs of the municipally owned water works, at McAlester, Okla., were truly chaotic. Water was pumped to the consumer but there was little management of the department in anything like the best sense of the word.

The water works plant was constructed out of a joint bond issue which defrayed the expense of constructing the sewer system as well. The officials under whom these systems were constructed retired from office and it was difficult for their successors to arrive at the exact original cost of the water plant. The original cost records were not sufficiently well kept so that the cost of the water and sewer systems could be accurately separated.

The water plant was considered something of a luxury at first and but little effort was given to conducting its affairs in a systematic manner. It was conducted as too many of the smaller municipal plants are conducted, that is, to use the phrase of the present head of the department, "just conducted." The plant just ran along until it had almost stopped running. The present superintendent served in the department as "handy man" under several different heads of department, until at last he became well posted as to the needs of the department. He also learned the location of the service pipes, valves and meters; in short he knew the plant from the pumping station to the consumer.

Many of the original maps and drawings of the plant were lost or misplaced. While the present superintendent knew the location of all the underground elements of the plant, he did not know the cost of putting them there, what it was costing to keep them there or what they were earning for the city by being there. He knew this lack of exact knowledge was all wrong, but, while he was serving as "handy man," he was kept busy putting in services, stopping leaks, reading meters, and keeping water going to the citizens, who sometimes paid for it, to make a study of past costs and current earnings. This condition lasted for years and through it all, save for a couple of dry years, the water system rendered satisfactory service. Of course, during this time, no one knew or seemed to care whether the plant was paying or not.

Finally a man who had made a success of his private business became the city's commissioner of public works. This commissioner with the present superintendent, the former "handy man," have worked together to put the affairs of the water works on a business basis.

The first step taken was to inventory the plant and to separate the original water and sewer costs as accurately as possible. Allowances were made for depreciation on all plant elements. The method of making the inventory was based on the article by Halbert P. Gillette entitled Inventorying a Water Works Plant, published in Engineering and Contracting of May 5, 1915.

The next step was to learn just what it was costing to put water into the consumers' fixtures. All elements of expense were taken into account in arriving at the cost of the service. This study showed clearly that it was costing too much to supply the water. Following this discovery all the pumping machinery was over-hauled as were all the water meters in service. A meter testing machine was purchased and soon paid for itself. Underground leaks were located and stopped. As a result of these measures the pumping hours were reduced from a maximum of 22 hours per day to a maximum of 11 hours per day. This lowered the cost of supplying water, reduced the amount of consumption and increased the amount of collections.

The water rates were revised so as to cover all operating and maintenance charges and overhead costs. Notice was served on all patrons that they would have to pay their water bills by the 20th of the month or water would be shut off. The people did not take this notification seriously and about half the services were shut off the first time the bills became due under the new order of things. The superintendent says: "We stood firm and got knocked but we got the money." Moreover a charge of $1 was made and collected for turning water on again. As soon as the consumers understood what the officials were trying to do they approved the action described and encouraged its continuance. This stand on the part of the officials not only rendered the books free from delinquent current accounts but enabled the officials to collect over $11,000 outstanding delinquent accounts carried over from the preceding administration. It is planned to put in about 500 more meters and with the addition of these it is expected the works will earn a net revenue or, at least, will be at all times self-supporting. This will be the case even though the present plan be continued of furnishing water free for fire protection, schools, municipal buildings and street sprinkling.

The present superintendent's water works "creed" is worthy of quotation:

> Briefly, these are our plans: First, eliminate politics. Next, employ the men who will and can deliver the goods; then systematize the work from office to ditch; meter all services, large or small; go over the entire plant as often as possible, watch for leaks in the mains, watch collections, supplies and labor, and, most of all, be on the job from start to finish.

ACKNOWLEDGMENT.

This article is abstracted from a paper by Mr. R. S. Naylor, Superintendent of Water Works at McAlester, Okla., before the recent annual convention of the Southwestern Water Works Association.

DRAINAGE AND IRRIGATION

Durability of Wood Pipe and Factors Affecting It.

(Staff Abstract.)

"How long will it last?" is a question asked perhaps oftener than any other in the discussion of wood pipe. It was the common question during the early years of its manufacture, and it is common today after the experience of more than 30 years of extensive use.

The failure of wood pipe is in general due either to decay of the wood or corrosion of the bands, though wearing out of the wood is also under certain conditions a matter upon which the life of a pipe may depend. The range of variability with reference to these points in the life of the pipes that have been built has been such as to demonstrate conclusively that how long any pipe will last can not be accurately predicted without a thorough knowledge of all the conditions involved.

Sufficient time has not yet elapsed to show the life of some of the earliest continuous stave pipes that were built, while others have endured but from 5 to 12 years. In support of the foregoing statement specific data bearing upon the durability of a number of pipe lines, several of which were inspected by the writer, are given in the following pages.

In writing of the first continuous stave pipe built in the West, at Denver, in 1884, S. Fortier states:

> The pipe was laid in a portion of its length about 15 inches above the hydraulic gradient. Native pine, whose durability under unfavorable conditions is from three to five years, composed the staves, and in the portion of the line referred to the pipe was never more than two-thirds full of water. The top staves decayed rapidly. In the fall of the year (1889) the Denver Water Company had bands loosened and the staves from the upper are removed without shutting off the water. It was then found that the lumber was perfectly sound up to the surface of the water in the pipe, and in the next stave above on either side, whereas the remaining staves which the water could not reach by capillary attraction or otherwise, were rotten.

A part of this line, lying close to the river, under conditions where both exterior and interior are kept wet, was said to be still in use in 1912.

In 1886-87 the next important pipe line of this kind was built from Cherry Creek crossing to Denver. Some of this lasted until 1907 when it was replaced by a 30-in. fir pipe. The original line consisted of about 7¾ miles in all, of 37, 30, and 24-in. pipe, the material being about two-thirds western yellow pine (Pinus ponderosa) and the remainder redwood.

In 1890 a 30-in. pipe was completed from the Platte Canyon to Ashland Ave., Denver, about 21 miles; 16.4 miles of this line is wood—Texas pine and California redwood. It is still in use. In the spring of 1890 a 24-in. redwood pipe 5½ miles in length was built at Ogden, Utah. In 1911, 4,674 ft. of this line was replaced, but is still used as an overflow pipe from a reservoir. On a few summits, where not always full, the pipe has decayed badly, but with these exceptions the original line is in general very well preserved. When inspected in October, 1912, repairs were being made at a river crossing, where settling of the bridge had caused the splitting of many staves, which were being replaced. These staves were not rotted materially, but about ⅛ in. of the interior was so softened that it could be easily scraped off with a knife. Many of the staves were also split back from the saw kerf several inches, thus permitting the outer portion to decay more rapidly than the rest of the stave. This portion of the pipe at another point, where supported on a trestle protected from the sun by rough boards, showed the staves to be in a perfect state of preservation. The pressure at the latter point was light, as indicated by the spacing of bands, which were 1 ft. apart.

A 48-in. redwood pipe, 2,000 ft. long, built by the Bear Valley Irrigation Co., at Redlands, Cal., in 1891, was in continuous use until the summer of 1912, when it was replaced by a ditch. About 500 ft. of this pipe at the upper end was completely buried, and of the remainder of the line which was originally supported 200 to 300 ft. became partially covered by slides from the slopes. Where in contact with the earth the staves of the pipe were considerably decayed, but in other parts the wood was well preserved at the time of its removal.

In 1892, 48,193 ft. of 24-in. redwood pipe was built for the Butte (Mont.) Water Co. Eugene Carrol, manager of the company, under date of January 15, 1913, states:

> During the past season we had occasion to open this pipe to make a new connection at the lower end and found it in excellent condition. As far as we know, the whole line is in excellent condition, and there has been no deterioration noticeable. Of course, the bands are rusted considerably, and when it is necessary to remove a band a new one has to be substituted. At one point where earth was hard to get we backfilled with broken rock, which allowed the air to get to the outside of the pipe. It is our experience that this caused the deterioration of the wood, and the broken rock was removed and replaced with sand and earth, carefully tamped around the pipe. This apparently stopped the decaying of the wood. The Basin Creek line has now been in service 20 years, and it is impossible to estimate how much longer it will last, as at present it has shown no signs of giving out.

An 18-in. redwood pipe 8,600 ft. long was built at Logan, Utah, also in 1892. This is still in service, but its condition is not known, though presumed to be good.

Roswell Snow, superintendent of water works, Provo, Utah, under date of Jan. 30, 1913, writes as follows concerning a redwood pipe:

> I have been in touch with this pipe for the past eight years, and have been taking note of it in the different ground in which it is laid. I find that in the clay ground it seems to be nearly as good as new, in gravelly ground it is in fairly good shape, but in loam and light soil it is nearly gone. It has been in use nearly 25 years and I would think that the pipe in the clay ground would last 20 years longer.

In the years from 1897 to 1901 and 1902, the Union Hollywood Water Co. at Los Angeles, Cal., installed continuous stave redwood pipe, which, according to F. C. Finkle, consulting engineer, who examined it in 1910, was rotted to a mere shell from 1/16 to 3/16 in. thick. This was in a gravity system under a head of not to exceed about 50 ft. and in places considerably less. He states that of another redwood pipe installed at Long Beach, Cal., in 1900, 4,000 ft. or so was replaced in January, 1912. This, under his observation from 1908 to 1912, was found to be badly decayed, and the bands were seriously corroded, though none failed. It was laid in a compact soil which contained some alkali. The pressure ranged from 20 to 40 lbs.

In the fall of 1895, 7½ miles of fir pipe was built at Astoria, Ore. In 1905 portions of this line were found to be badly decayed, and in 1911 it was all replaced by another pipe of redwood. G. W. Lounsberry, of the Astoria Water Commission, states:

> Where the line was buried to a depth of 2 feet or more in fine-grained sand or clay it lasted much better than where it was laid in black soil mixed with decayed vegetation or where it was laid in shale. This, regardless of the water pressure, and the staves in the bottom where there was a constant flow of water were equally affected with those on top that at times were dry on account of the pipe not running full.

The 72-in. fir pipe, 3 miles in length, built for the Pioneer Electric Power Co. at Ogden, Utah, in 1897 is still in service. Repairs in the nature of an occasional new stave have been necessary for several years, and in the month of October, 1912, when it was inspected, arrangements were being made to replace the upper end where the pressure is light. This pipe is in many places but little below the hydraulic gradient and in most parts but lightly or partially covered.

At one point some distance below the intake where uncovered for repairs, the staves of the lower half of the pipe were found to be decayed to a mere shell. The 4-in. spacing of bands indicated a fairly good internal pressure. The backfill was stony. Near the dam, where the pressure was not more than 10 or 15 ft., the staves were badly decayed, and it is probable that much of the pipe was in poor condition at this time. On a bridge where it had always been fully exposed there was no appreciable decay of the staves other than at leaky joints, and the same was true along the top of the pipe where exposed or covered with only an inch or two of coarse soil, which permitted it to remain dry.

R. M. Hosea, chief engineer of the Colorado Fuel & Iron Co., writes as follows about a pipe several miles long:

> The oldest line we have—28 ins. in diameter—was built in 1900. For five years past it has been repaired in places by inserting new staves where old ones were badly rotted on the exterior. This allows bands to sink into soft wood and staves to leak. The rot progresses until one-half to three-fourths of the wood is rotted. It occurs in patches, or on certain staves their full length, according to amount of pitch in the wood, or some variation in its quality. This pipe was of Texas pine staves. I should add also that the bands become rapidly corroded where leaks have formed and ground is moist, and I should doubt a life of 20 years for this line even if repairs are kept as above indicated, where we are constantly putting in new fir staves and some new bands.

This pipe is laid in fine adobe soil and covered to a depth of 2 ft. or more.

By the side of the pipe just mentioned, and under the same conditions, a 48-in. fir pipe was laid in November and December, 1906. Mr. Hosea says that in three years it was decayed sufficiently to cause leaks. When inspected in October, 1913, it showed serious decay, and was being incased with reinforced concrete. This pipe was covered with the adobe soil from 18 ins. to 2 ft. deep, and where examined was under a head of perhaps 30 ft. or more. In most instances the decay extended half way through the staves. Sometimes a sound stave occurred, while those on each side of it might be badly rotted. The bands were in good condition and only slightly corroded. Twenty-five other pipe lines built by this company about the same time as this one have also been incased with concrete, decay in the case of each having made more or less progress.

Under date of May 15, 1912, L. B. Youngs, water superintendent of Seattle, Wash., writes as follows:

> The first wood pipe that we installed in this city was put in 12 years ago, and was made out of our native timber here, known as Douglas fir. * * * In clay soils the pipe lasts fairly well, and I would place its life at from 12 to 20 years; in sandy and gravelly soils I would place its life at from 7 to 12 years. However, in the case of large pipe with individual bands the cost of reinstallation would be the cost of the wooden part of the pipe only, as we find the iron bands to be in good condition after 10 to 12 years' service, so that they could be used for the new wood.

In 1901 the National Sugar Manufacturing Co. at Sugar City, Colo., built about 4 miles of fir pipe, which was covered by earth to a depth of 2 to 4 ft. The ½-in. steel bands began to give way after six years, more of them each succeeding year, causing frequent breaks in the line and much annoyance, especially in winter. In 1910 this line was rebanded with ⅝-in. round, refined bar iron.

A 24-in. fir pipe 3 miles long was built for the Pueblo (Colo.) water works in 1904. This was banded with ½-in. soft steel bands, buried from 1 to 3½ ft. deep, a part in shale, and some in an adobe loam soil. About seven or eight years later the bands began to fail. Four thousand feet of this pipe was replaced in 1912, and the reamnider was taken up in 1913.

The foregoing examples are all continuous stave pipes, but an investigation of the life of machine-banded pipe shows a like variability, the length of service being dependent altogether upon conditions. Instances are frequently published illustrating the extremely long life of the old bored log pipes which were used in the early days, and there is probably a considerable amount of machine-banded pipe which under favorable conditions has now been in use for 30 years or more, while in a great many places the conditions of service have been such as to render the life very short.

A. F. Doremus, of Salt Lake City, Utah, states that flat-banded bored pipe laid for the city water system of Tooele, Utah, in 1890 is still generally in good condition, except in places where it was not kept wet. This system now consists of about 20 miles of wood pipe, much of which is of modern machine-banded stave type. Some of the modern pipe has had to be replaced in three years. A great many instances might be cited where the life of machine-banded pipe has been only from 4 to 10 years. Based upon the experience in Spokane, Wash., the life of machine-banded wood pipe is given as ranging from 4 to 12 years. Such short life in most instances is probably due to bad judgment in the matter of location or the use of pipe under conditions altogether unfavorable to its life.

Frequently in connection with municipal water systems pressures are imposed far in excess of those for which the pipe was designed, thus hastening it detruction. For irrigation systems the demand by some of the promoting companies for an extremely cheap pipe without particular consideration as to its durability has probably in some instances led the manufacturers to incorporate poor material in the pipe supplied.

The unfavorable conditions of whatever nature, singly or together, result most frequently in the decay of the pipe, thus shortening its life. The decay of wood pipe is probably due primarily to the growth of fungi, though possibly certain forms of bacteria may assist in the final destruction of the wood cells. The growth of fungi to an extent detrimental to the life of the wood requires a favorable combination of moisture, air, and heat. The exclusion of any one of these beyond certain limits inhibits their growth.

From this it follows that with pipes buried in the ground the wood will endure longest where the air is most nearly excluded either by a high internal pressure which completely saturates it or by a deep covering of very fine soil. In accordance with the foregoing statement, experience, which might be illustrated by many specific examples, shows that in contact with the soil wood pipe decays more rapidly under a light head than it does under heavy pressure, and other things being equal, it usually decays more rapidly in a porous open soil, such as sand or gravel, than it does in a fine soil of silt or clay, because the finer soil is more effective in excluding the air. Experience appears to indicate also that wood decays more rapidly in a loamy soil, rich in humus or partially decayed organic matter, than it does in one containing little or none. This is probably due to the fact that the presence of organic matter affords more favorable conditions for the development of fungus growths and bacteria.

Pipes fully exposed to the atmosphere and free from contact with the soil will, as a rule, be too dry on the exterior to favor the development of fungus spores, and so long as the outside of a pipe remains dry no appreciable decay will occur, even though the internal pressure is very light. Decay of exposed pipes almost invariably starts at the ends of staves, as a result of leaky joints. Where water leaks out and runs down over the outside of the pipe favorable conditions are afforded for the growth of algæ, which usually get a start, then mosses may begin to grow in the soil that collects on such spots, and decay spreads to adjoining staves. Bruising the staves in handling or injuring by too tight clinching of bands renders them more susceptible to infection by the spores of wood-destroying fungi, thus hastening decay. The life of exposed pipes may be prolonged by promptly stopping all leaks as they develop and by keeping the exterior dry. The decay of buried pipes has also in some instances been arrested by removing the covering and leaving them exposed.

The asphaltum or tar coating applied to machine-banded pipe, while intended primarily as a protection against corrosion of the bands, doubtless helps also to some extent in preserving the wood. Until recently the practice has been to leave the ends of wooden sleeve couplings untreated. These couplings almost invariably decay long before the main pipe. This may indicate that infection by wood-destroying organisms starts principally where the coating is absent, though less perfect saturation of the wood in the sleeves may be the more largely responsible for the early decay, as it may be noted also that decay occurs at summits of pipe lines where air accumulates much sooner than at depressions.

The practice of coating continuous stave pipe has not been common, but in a considerable number of cases some treatment has been applied for the purpose of preserving the wood. There is wide difference of opinion as to the value of such treatment, and the effectiveness for the purpose intended may depend also greatly on what is used and upon how and when it is applied.

On exposed portions of new pipes the United States Reclamation Service has used a paint consisting of 6 pounds of red oxid mixed with 1 gallon of boiled linseed oil. One gallon of the paint was sufficient for two coats on 125 sq. ft. of pipe. On top of the pipe where exposed to the sun and where water from leaky joints runs down over it this paint does not last long, much of it being gone in two years. Repainting while the pipe is in use is usually not practicable, because oil paint will not adhere readily to wet material. The use of paint on exposed pipes under ordinary conditions probably adds very little to their life.

The Denver Union Water Co., on new work in 1911, used a primary coat of linseed oil and lampblack, and a secondary coat consisting of an asphaltum mixture. In March, 1914, the "Mabton siphon," which had been uncovered the fall previous on account of decay, was given two coats of coal tar tempered with creosote. The mixture was applied by a machine which pumped the hot mixture through a hose and nozzle, shooting it on to the pipe with considerable pressure. The same machine was used in cleaning the soil and decayed material from the pipe before painting. Other instances might be cited showing the use of asphaltum or tar on old pipes after uncovering. The cost of the work is considerable and its value is questionable, particularly where pipes are to remain exposed.

The staves of a 50-in. pipe built at Burbank, Wash., December, 1912, were creosoted before construction. This pipe was buried in sandy soil and operates under little or no internal pressure. The cost of treating the staves was said to be $24 per thousand. Carbolineum was used as an exterior coating on part of a 48-in. pipe built at Wenatchee in 1907, and on a 12-ft. pipe built in Oswego County, N. Y.

Where pipes are to be placed in contact with the soil, and where the internal pressure is not sufficient to insure complete saturation of the staves, it is probable that their durability may be increased by treating with some preservative.

A difference in the effectiveness of materials for this purpose is indicated by the following example: In 1890 a 54-in. pipe of Texas pine was built for the Bessemer Ditch Co., at Pueblo, Colo. About 1,500 ft. of this was subjected to light pressure, and at times the pipe was only partially filled. This portion was badly decayed in five years, and 1,100 ft. of it was replaced by redwood in 1895. With the exception of a 100-ft. section near the middle of the new part, the redwood was painted with hot coal tar. The 100-ft. section was painted with asphaltum paint. According to Mr. C. K. McHarg, secretary of the company, the pipe coated with tar was found to be perfectly sound when examined in 1910, while the 100-ft. section was badly decayed and had to be replaced.

Contrary to the theories commonly held 30 years ago, it has been found that the durability of wood pipe is usually dependent on the life of the wood rather than on the life of the bands. Only in rare instances, some of which have been cited, have the bands failed first. Corrosion of the bands being a chemical action, requires the presence of moisture and oxygen. It usually occurs most rapidly where pipes are buried and the backfill is wet, under conditions which, as a rule, are most favorable for the life of the wood. Corrosion is greatly accelerated by the presence of alkali in the soil. The early failure of bands in the few instances cited was due chiefly to this cause. Under such conditions the bands almost invariably fail at the bottom of the pipe.

Wearing out of the wood as a factor in the durability of pipe is a matter of small consequence, though it must at times be recognized. A 48-in. spruce pipe on the Catlin Canal in Colorado, in 23 years' use, was worn nearly through the staves for a distance of nearly 100 ft. at the outlet end. The inlet end of a redwood siphon near North Yakima, Wash., had to be lined with sheet iron to preserve it from wearing action of grit, and one of the large pipes on the King's Hill project in Idaho was nearly cut in two at one place by the circular movement of chips and debris floating on the surface near the intake where the pipe was not full.

With so many influences affecting the life of wood pipe no attempt should be made to strike an average of durability except in cases where attending conditions are known to be the same. Where pipes are fully exposed and supported free from all contact with the soil the conditions are much less variable than otherwise, and a life of at least 20 years may be quite reasonably expected for either fir or redwood if properly maintained. If placed in the ground or in contact with the soil, the life of wood pipe may, under very vavorable conditions, be much greater than 20 years, otherwise it may be a great deal less. In contact with soil the durability is nearly always a matter of some uncertainty.

Extracted from Bulletin 155, U. S. Department of Agriculture, by S. O. Jayne, irrigation manager.

Cost of and Profits From Tile Underdrains.

(Staff Abstract.)

COSTS.

The cost of drainage will vary considerably with the location of the work, owing to differences in the cost of tile and of labor; it will vary more with the nature of the soil and the consequent depth and spacing of the drains. Tile of 4-in. inside diameter will cost $16 to $20 per thousand feet at the factory, and often $25 per thousand delivered at the railway station. If 4-in. tile cost $25 per thousand, 5-in. will cost about $35, 6-in. about $45, and 8-in. about $80 per thousand feet. Labor will vary from 75 cts. to $1.50 or more per day, but as the cheaper labor is considerably less efficient the cost per rod of drain will be more uniform. As an average cost for trenching, laying, and backfilling over the tile, about 50 cts. per rod for a depth of 3 ft. may be assumed; lower prices may be secured on large contracts that make it economical to use a trenching machine or a large force of experienced workmen. Deeper digging and larger tile require more excavation and involve higher prices. There also will be expense for hauling the tile from the railroad, and for engineering work in planning and laying out the drains. Silt wells, surface inlets, and masonry protection for tile outlets must be provided where needed. The total cost of drainage will ordinarily range from $15 to $45 per acre, the lower price mentioned being reached when the spacing of drains is perhaps 150 ft. and the higher figure when the spacing is about 4 rods or a little less. A very common cost for tile drainage is $25 per acre. The farmer can often do a considerable part of the hauling and other labor with his own teams and regularly employed help, especially where the amount of work is not large, saving no small cash outlay. Of course the foregoing prices do not anticipate the excavation of rock, large stones, or other very hard formation in any considerable quantities, for this will quickly multiply the labor cost.

Open ditches cost from 12 to 20 cts. per cubic yard of dirt removed, the price increasing with the size of the ditch because the material must be moved farther. A ditch 3 ft. deep, 2 ft. in top width, and 1 ft. in bottom width would cost 33 cts. per rod at 12 cts. per cubic yard; a ditch 4 ft. deep, with 3-ft. bottom and 6-ft. top, would cost $1.65 per rod at 15 cts. per cubic yard; and a ditch 4 ft. deep, with 4-ft. bottom and 8-ft. top, would cost $2.95 per rod at 20 cts. per yard. If open ditches of the smallest size were used 150 ft. apart, with a collecting ditch of the medium size, the cost of drainage would hardly be less than $7 per acre. The difference between tile and open drains would then be $8 per acre; the interest on such an investment would be 80 cts. per acre at 10 per cent, or 50 cts. per acre at 6 per cent. This amount would not nearly pay for the labor of keeping the ditches clear of weeds, dirt, and other obstructions, not to mention the increase in labor occasioned by having the field cut into small parts. The advantage of using tile becomes greater as the distance between drains is reduced, not only because of the labor of cultivation, but also because of the ground area used for ditches instead of for cropping.

PROFITS.

The actual value of farm drainage is indicated by the testimony of owners who have done this kind of work. Many of them state enthusiastically that drainage has doubled and trebled their crops and has increased the value of the land 50 to 300 per cent. The examples cited herein have been selected as typical of the results from properly draining farm lands in the humid region of the United States. Because the reclamation of large swamp tracts frequently involves considerable expense for clearing and sometimes for soil treatment after drainage, the profits shown below are in no way indicative of those to be obtained from large swamp reclamations. Neither should these results be used in considering the drainage of irrigated land in the arid region.

In the coastal plain of North Carolina about 25 acres that were producing nothing were tile drained for perhaps $250, probably not including costs of teaming and of supervision, and since then have produced a bale of cotton per acre. A field of six acres was drained for about $160, and the owner makes good crops on soil worthless without drainage. In the black prairie belt of Alabama, a field that had not been cultivated in years because too wet was drained with tile; then it produced one bale of cotton per acre and repaid the entire cost of drainage the first year. The following year the field yielded 50 bushels of corn per acre, twice the rate from the other parts of the farm. Another drained field produced one bale of cotton per acre, while the undrained land produced only half a bale. A 10-acre field that yielded practically nothing in 1912 was tile drained, and in 1913 produced 60 bushels of oats per acre; in 1914 the rate was again 60 bushels of oats, in contrast to 10 bushels per acre from the adjoining 15-acre field planted to the same grain. The cost of most of the tile drainage in Alabama has been about $25 per acre, some of it as high as $30 to $35, but increases of 50 to 200 per cent in yields and the assurance of good crops every year instead of only in very favorable seasons are very satisfactory returns. The cost of drainage there has usually been repaid in two to three years by the improved crops. In Iowa, a field of 40 acres too wet for planting was tile drained at a cost of $24 per acre, after which it produced 60 bushels of corn per acre. Another field was drained for $23 per acre, thereby increasing the yield from 15 bushels to 40 and 50 bushels of corn per acre. In Arkansas, on one of the State farms, 1 bale of cotton per acre was secured in favorable years, and nothing at all when the early part of the season was wet; the year following the installation of tile the yield was 1½ bales per acre. In Nebraska a tract of more than 700 acres was tile drained at $24.25 per acre, a pumping plant cost $2 per acre, and as part of a larger district the cost of levees to protect from overflow was $9 per acre. The improvement, for a total cost of $35 per acre, immediately increased the crop on about 80 acres of corn 22 bushels per acre, and on another part the increase in two years was from nothing to more than 30 bushels of wheat per acre.

Owners have found that tile drainage has reduced the cost of farming operations 20 to 50 per cent, so the increased production on land cultivated previous to drainage is clear profit. To find the profit upon draining land that has been abandoned, of course the cost of planting, cultivating, and harvesting must be deducted from the gross receipts for the crops raised. Investigations of the cost of producing cotton and of producing wheat indicate that where expensive fertilizers are not used the cost per acre for growing and marketing varies little if at all with the rate of yield.

To compute the actual money value of drainage requires that certain assumptions be made. If the average production of a field is increased about one-half bale of cotton per acre, worth 10 cents per pound, the income is increased about $25 per acre, equivalent to a 10 per cent dividend on $250, or a return of 71 per cent on a drainage cost of $35 per acre. If drainage increases the yield of corn 25 bushels per acre, worth 50 cents per bushel, the returns of $12.50 per acre would be equivalent to a 10 per cent dividend on $125, or 50 per cent annually on a cost of $25 per acre. However, to capitalize the net increase in value of the crops at the regular rate of interest might be a fair measure of the increase in producing value of the land, but this is the result of drainage added to what may be called the unused fertility of the soil. It will be better to consider the increase brought about by drainage in the market value of the property. In the Piedmont section of North Carolina a 55-acre farm was bought about six years ago for $1,900; ditching was started the first year and tile drainage two years later; in 1913 the crops were worth $2,000, and in 1914 the owner refused $5,000 for the farm. In the mountain section of the same state about 22 acres that grew only saw grass and bulrushes were tiled for $35 to $40 per acre, and the owner now values the land at $150 per acre. Another farmer spent about $200 cash, and probably some of his own time, in tile drainage, and thereby increased the market value of his farm $500 to $800. Another man reports the results as 300 per cent increase in the selling price of the land and 40 per cent in the assessed value; still another, who drained 10 acres for about $140, gives the results as one-third increase in assessed value, two-thirds increase in selling price, and more than 100 per cent increase in production. In eastern Maryland tile work costing $500 increased the farm value $1,000, and work costing about $240 increased the value of another farm $500.

In considering the economy of farm drainage it is proper to compare the anticipated results with the probable returns from otherwise investing the money that the drainage work will cost. When a farmer considers investing some of his savings to increase his business a question often to be met is: Shall he buy more land or improve some of what he already owns? If corn land producing 50 bushels per acre sells for $80 per acre, and he has marsh land which cost $10 per acre that produces nothing, drainage at $30 per acre will be profitable if it will make the marsh produce 25 bushels of corn, provided there are no other costs for preparing the land for cultivation. If the whole cost of drainage and other reclamation work is $50 per acre, and the result 50 bushels, the land has been made worth $80 for a total cost of $60 per acre. If land yielding 40 bushels per acre can be made to produce 50 bushels by drainage at $25 per acre, perhaps it would be true economy to buy more good land at the price stated rather than to drain; for $1,000 spent improving 40 acres would yield 400 bushels, while the same money buying 12½ acres new would yield 625 bushels. The difference in value at 50 cents per bushel would be $112.50. However, the increase in cost of farming the larger acreage might be considerable; if it would amount to as much as $3 per acre it would more than offset the difference in total yield, for there would be no increase in cost of farming on the drained land. Actual comparisons of the profits to be obtained from

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farm improvement and from purchasing improved land will many times show the farmer to be true economy, in spite of seemingly small gross returns. As larger markets raise the prices of agricultural products, land values must increase and larger expenditures per acre for drainage will be profitable.

The preceding discussion is taken from Year Book of the Department of Agriculture and is by R. D. Marsden, Office of Drainage Investigations.

Records of Seepage Losses in Concrete Lined Canals.

(Staff Abstract.)

Seepage losses in concrete lined canals decrease with decrease in depth of water and are far smaller than in mortar lined canals. In 1913 a section of small lined canal was constructed in a sandy formation for experimental purposes. This canal had a bottom width of 2 ft., a depth of 3 ft. to top of lining, and side slopes of 1¼ to 1. It was divided into seven sections, each 8 ft. long in the clear, by concrete walls 4 ins. thick.

When these basins were first filled with water the seepage losses were quite large. After one or two preliminary wettings all the basins were filled on June 5, 1912, and observations continued till June 20. The results are shown graphically in the accompanying diagram, Fig. 1, which gives the depth of the water from the beginning of the experiment to 350 hours thereafter.

A noteworthy point indicated by the diagram is the reduced rate of loss as the depth of water decreased as indicated by the slope of the lines. This tendency is less marked for sections Nos. 5, 6, and 7, which probably indicates that these losses are principally the results of evaporation, which is independent of the depth, as is further shown by the records of evaporation from the Cold Springs Reservoir on this project. The latter showed a loss by evaporation of about 0.03 ft. in 24 hours, and it is probable that the loss from the canal section was greater than this, as it was located on the south slope of a sand pit.

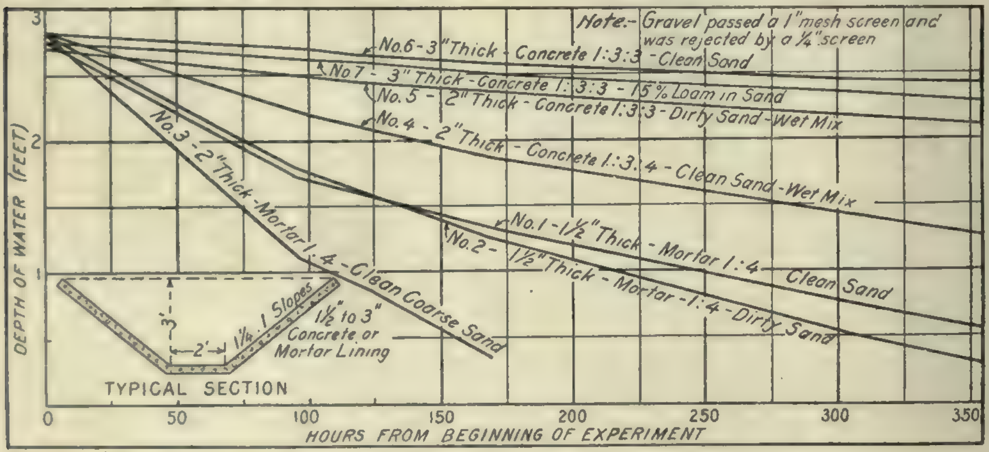


Diagram Showing Seepage Losses in Concrete Lined Canal.

Another noteworthy result of the experiments is the evident superiority of the concrete lining as compared with the mortar lining for preventing seepage losses.

These data are reported in the "Reclamation Record," by H. D. Newell, project manager, Umatilla Project, U. S. Reclamation Service.

Suggested Formula for Computing the Run-off Depth to be Expected from Any Simple Drainage Area.

(Staff Abstract.)

Many attempts have been made to devise a mathematical expression involving various of the factors that modify the maximum run-off rate, for use in estimating run-off when there are not actual gagings that will serve as a fairly reliable guide. A formula has been suggested by S. W. Frescoln for computing the run-off depth to be expected from any simple drainage area. It is as follows:

$$D = CM\sqrt{PF}\,\frac{(B+L)^{\frac{3}{2}} - (B^{\frac{3}{2}} + L^{\frac{3}{2}})}{BL}$$

in which

D = maximum rate of run-off, in inches per 24 hours, to be expected from the rainfall P.
C = a coefficient depending solely upon the physical character of the soil, and determined by experiment.
M = the ratio of total run-off to total rainfall, for the precipitation P, varying with evaporation, deep percolation, lateral seepage from the drainage channels, and duration of flood.
P = the depth of rainfall in inches in 24 hours.
F = the average slope of the ground surface of the drainage area in feet per mile.
L = the mean length of the drainage area in miles.
B = one-half the mean width of the drainage area in miles.

For drainage areas that contain storage reservoirs, a special calculation must be made to eliminate the effect of the reservoirs. Where the main watercourse is formed by the junction of two or more large tributaries, the formula is to be applied to each tributary separately, and the proper value of the run-off depth for the entire area will be the weighted mean of the values for the parts.

APPLICATION OF THE FORMULA.

The values of L, B, and F are determined from the drainage survey, P from rainfall data, M and C by comparison with other drainage basins where gagings and other flood data have been secured.

The value of $\sqrt{F}$ is determined for each simple drainage basin by first dividing the area into units wherever there is a marked change in the surface relief, as where a flat area joins a rolling or hilly section, each unit wholly on one side of the main stream. The mean $\sqrt{F}$ is found with the course which the water will take from each corner of the unit to the outlet of the whole basin and the average of these values is considered the $\sqrt{F}$ for that unit. The value of $\sqrt{F}$ for the whole drainage basin is the mean of the values for the separate units, each weighted according to the area of the unit. Special care is required in dividing the drainage units for a basin consisting of lands rising quickly from a main channel of small slope, that the large slope of the lands near the outlet may not have undue weight in the final value of $\sqrt{F}$. For land as level as some of the pumping districts the slopes of the water surfaces in the ditches must be used for computing $\sqrt{F}$.

The value of C, since it cannot be measured directly, is to be computed by solving the formula for conditions where all the other factors, including D and M, are known. A sufficient number of repetitions of this computation covering several drainage areas having similar soil characteristics should determine reliable values for C if the various modifying factors are correctly involved in the formula.

Extract from Bulletin 193, U. S. Department of Agriculture, by H. A. Kipp, A. G. Hall and S. W. Frescoln, drainage engineers.

Dirt Moving Record.—The Reclamation Record notes the accompanying efficiency record of 1¼ cu. yd., electric drag-line excavators on drainage work on the Boise irrigation project during the month of March:

NO 1 DREDGE, SOLOMON SLOUGH DRAIN.

	Amount excavated.		Av'ge No. of cu. yds. excavated.	
Operator.	Lin. ft.	Cu. yds.	Per hour.	Per shift.
Wirth	4,110	27,621	158.1	987.0
Higley, F...........	4,680	30,947	155.7	998.0
Lilburn, A. J........	4,520	30,065	152.3	1.002.0
Total and average	13,310	88,633	155.3	996.0

Highest run in one shift: Wirth, 1,436 cu. yds.

NO. 2 DREDGE, DIXIE DRAIN AND DRAIN FROM UPPER EMBANKMENT.

	Amount excavated.		Av'ge No. of cu. yds. excavated.	
Operator.	Lin. ft.	Cu. yds.	Per hour.	Per shift.
Bates, S. H.........	3,408	19,997	129.6	831.5
Stone, O.............	4,076	24,786	127.7	953.5
O'Bryan, R..........	3,688	22,781	124.0	813.5
Total and average	11,172	67,564	136.8	866.0

Highest run in one shift: Stone, 1,287 cu. yds.

NO. 3 DREDGE, LAHT AND GRIFFITH DRAIN.

	Amount excavated.		Av'ge No. of cu. yds. excavated.	
Operator.	Lin ft.	Cu. yds.	Per hour.	Per shift.
Martin, W. H.......	3.306	27,630	189.6	1,151.0
Jennrich	3,363	28,836	180.3	1,202.0
Gibson, C. A........	3,318	28,277	171.1	1,178.0
Total and average	9,987	84,743	180.3	1,176.0

Highest run in one shift: Martin, 1,701 cu. yds.

CURRENT NEWS

Jy 27-32. 27

The Doings of the Week.

Business and finance made further progress during the past week. Increased activity was shown by practically every representative industry. The railroads are still placing orders for material and equipment. Orders for war munitions amounting to millions of dollars were placed in this country last week. In the construction field activities have been sustained. A large amount of work is now being advertised by municipalities, especially by the smaller cities and towns and a few of the larger cities. Philadelphia, Indianapolis, Columbus and Cleveland seem to be the leaders this week. An unusual amount of paving work has reached the call for bids stage, while sewerage and waterworks are being sought by numerous small towns. In the steel industry plants are now operating at a greater percentage basis than a month ago. According to reports the American Steel and Wire Company has taken a large European order for the supply of nails, barbed wire, etc., and has been working on a similar order for the Orient. From the railroad construction field comes a report that the Santa Fe Ry. has asked authority from the State Commission of Kansas to issue $10,808,000 bonds, the proceeds to be used in making extensions and improvements to its system in western Texas. The Iron Age prices for finished iron and steel and for sheets, nails and wire for the week ending June 30 were as follows:

Finished Iron and Steel.	June 30.	June 23.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.22½	1.22½
Iron bars, Pittsburgh........	1.25	1.25
Iron bars, Chicago...........	1.20	1.20
Steel bars, Pittsburgh.......	1.25	1.20
Steel bars, New York........	1.419	1.369
Tank plates, Pittsburgh.....	1.20	1.15
Tank plates, New York......	1.369	1.319
Beams, etc., Pittsburgh.....	1.20	1.20
Beams, etc., New York......	1.369	1.369
Skelp, grooved steel, P'gh...	1.115	1.15
Skelp, sheared steel, P'gh...	1.20	1.20
Steel hoops, Pittsburgh.....	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	1.75	1.75
Galv. sheets, No. 28, P'gh...	4.50	5.00
Wire nails, Pittsburgh.......	1.55	1.55
Cut nails, Pittsburgh........	1.55	1.55
Fence wire, base, P'gh.......	1.35	1.35
Barb wire, galv., P'gh.......	2.40	2.40

For structural material f. o. b. Pittsburgh The Iron Age prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 ins. and over, 1.20 cts.

Railways.—The railway field appeared rather encouraging during the past week. Several reports were current of prospective work. Some of the larger systems contemplate considerable betterment and extension work, especially in the northwest. In western Texas the Santa Fe Ry. expects to spend $10,808,000 in making extensions and improvements, authority having been asked of the Kansas Commission. From Riverside, Oregon, comes a report that the Southern Pacific has let a contract for a 30-mile extension from that place to Crane Creek Gap, to cost $1,500,000. A contract has been let to Ward & Lee of Floresville, Texas, for work on the Oklahoma & Texas Southern Ry., which contemplates 450 miles of line in all. The New York Connecting R. R. awarded a contract for grading and masonry for Section 2 to Wilson & English Construction Co., New York, and P. McManus, Inc.

Roads and Streets.—Apparently the only State Highway Commissions to place calls for bids during the week were California, Massachusetts and Washington. The first named is advertising approximately 20 miles of roads and three reinforced concrete bridges, the second has a small amount of work up and the last has asked bids on about three miles of highway.

In the municipal field there are numerous large jobs upon which bids are solicited. Laurel, Miss., has 60,000 yds. of pavement and 35,200 sq. ft. of sidewalk work; Louisville, Ky., will pave 34th St. at a cost of $57,000; Philadelphia is taking bids until July 13 on asphalt pavement to cost $135,000, repaving with wood blocks, $137,000 and repaving with asphalt, $121,000; San Antonio, Texas, has 120,000 yds. to let on July 15; Seattle, Wash., has $200,000 worth of work to be done on Alki Ave., bids until July 9. Some of the contracts let since our last issue and worthy of mention are: Canton, O., five jobs for $139,438; Philadelphia, improvement of the S. Broad St. plaza, for which Edwin H. Vare is low, at $123,565; Lakewood, O., $65,000 asphalt job to Cleveland Trinidad Paving Co.; Meriden, Conn., at about $131,000 for paving Main St.; State of Ohio let contracts for about 11 roads, the contract prices aggregating $181,000; Columbus, O., asphalt paving jobs to cost $231,000.

Bridges—Bids are now being asked on some bridge work by the County Commissioners at Columbus, O.; by the State Highway Commission at Richmond, Va., for bridge work in the vicinity of Surry; by the King County Commissioners, Washington, for bridge over Durarnish River, to cost $25,000; and by the Dominion Department of Public Works, Ottawa, Canada, for 4-span bridge over Quinze River. The Thompson Bridge Co., San Francisco, will build a Strauss trunnion bascule bridge and substructure over Channel St. waterway on Fourth St., for that city. The Commission of Indian Affairs has let a contract to the Kansas City Structural Steel Co. for construction of a bridge near Topock, Ariz. The Pennsylvania Ry. has awarded T. L. Eyre a contract for a 1,600-ft. reinforced concrete and steel bridge over the Schuylkill River, near Manayunk, Pa.

Drainage and Irrigation.—There were no particularly large jobs in the irrigation or drainage field up for letting this last week. The Burleson County Improvement District No. 1, Caldwell, Tex., is readvertising its 360,000-yd. earthwork and levee job, the bids to be in by July 31. Bids are being asked by the U. S. Reclamation Service for outlet structures for Reechelus Reservoir, Yakima Project, and for Sherburne Reservoir. In the contract let line, Howard Kenyon, Houston, Tex., will construct 45 miles of ditches for the Seadrift Drainage District No. 3, Port Lavaca, Tex., and V. Peterson, Des Moines, Ia., three sections of ditches for the Annis District, Logan, Ia.

Waterworks.—A number of good waterworks jobs are up for letting this week. At Cambridge, O., bids are asked until Aug. 5 for a 200,000,000-gal. reservoir, 9 miles of pipe lines, pumps, etc.; at West Linn, Ore., 42,000 ft. of supply mains are to be laid and a 2,000,000-gal. concrete lined reservoir and concrete standpipe constructed; at Hilton, N. Y., a system is to be installed as well as at Keota, Ia., and several other smaller towns. Grinnell, Ia., Covington, Ky., St. Louis, Mo., and New Boston, O., have work in this line to let.

Sewerage.—The Sewerage Commission of Milwaukee, Wis., has ordered 9 tanks with a capacity of 2,000,000 gals., constructed, to be used in the experiment station on Jones Island. Baltimore is calling for bids on Storm Water Contract No. 45, to include masonry drain of large diameter. Syracuse, N. Y., wants bids on the Huntley System No. 2, to cost about $112,000. Lincoln, Nebr., is advertising a $40,000 job for Sanitary District No. 1. Indianapolis let contract for the 38th St. overflow sewer for $78,210; Columbus, O., for additions and improvements to sewage disposal plant for $197,996, and for sewers to cost over $81,000.

Buildings and Rivers and Harbors.—As usual there are many calls for bids on building work. The government has several fair-sized jobs on which bids are now being asked; at Boston bids are receivable until July 27 for an addition to the State House; at Schuyler, Nebr., a high school is to be constructed at a cost of $40,000. In the rivers and harbors field a good job is being advertised by the Third Mississippi River District, Vicksburg, for about 1,415,000 cu. yds. of levee in the Lower Yazoo Levee District, above Greenville, Miss.; also for dredging at Duluth, Port Chester Harbor, New York, and at Norfolk, Va. Several contracts were let at Memphis for work for the St. Francis District and one at Philadelphia for dredging a channel in the Delaware River. The big building contract of the week appears to have been let at Akron, O., for two 7-story additions to present buildings of the Goodyear Rubber Co. Others are: Factory building at Cleveland for Schwarzenberg & Gaede Bros., to cost $250,000; 5-story building at Middlebury, Vt., for Middlebury College, to cost $110,000.

Highway Work in Pennsylvania 1915-16.

The State Highway Department has completed the apportionment of state-aid funds among the counties and has determined the amount available for state-aid highway construction during the years 1915 and 1916.

The important factor in the apportionment of the state-aid money for this two-year period is that in each county the estimated amount necessary for the maintenance of state-aid highways previously constructed has been deducted.

State Highway Commissioner Cunningham and Chief Engineer Uhler take the view that it is folly for the state to expend money in state-aid construction only to se state-aid highways deteriorate from lack of care, consequently the maintenance division of the department has estimated the amount of money necessary for the maintenance of previously constructed state-aid highways during 1915 and 1916 in each county, and this amount is deducted from the sum available for state-aid construction.

In many counties the state-aid appropriation from the legislatures of 1911 and 1913 has not been used and in each instance where this is the case the balance from these two legislative appropriations is added to the apportionment of the appropriation made by the 1915 legislature. In some of the counties contracts are outstanding which will use up all of the balance from the 1911 and 1913 funds, as well as the 1915 apportionment. These counties, of course, face a deficit in state-aid appropriation and, in some instances, will not even be able to have the necessary state-aid maintenance.

Structural Engineers' Bill.

The structural engineers' bill, which was fiercely contested by the organized architects of Illinois when it was introduced in the legislature at Springfield, has finally been signed by Governor Dunne. It is likely that court action will be brought by the architects, the point to be raised being that July 1 having passed prior to the executive action, the new law can not go into effect before July 1, 1916.

Charges of graft were made while the bill was going through the house, and a house investigation was made, nothing coming of the charges.

The Lighter Side of Engineering and Contracting

IN making the preliminary surveys for a railroad the line was run so that it passed directly through the middle of a large barn. The right of way agent called upon the owner and showed him a blue print of the route. The latter studied it for a while and then remarked: "She goes right through my building, don't she?" The agent assured him that it did. The farmer was indignant. "By Judas Priest!" he exclaimed. "You fellows have got nerve. Do you think I'm going to get up at all hours of the night to open and shut them barn doors so's to let your blamed old trains through?"

On the Firing Line with Skinner Mulvey.

A ST. LOUIS contractor of high local repute as a good after-dinner speaker was invited to address the Engineers' Club on The Funny Side of the Contracting Business. He declined to address this body on that subject for two reasons. "In the first place," said he, "contracting is a mighty serious business to those who are engaged in it, and, in the second place, the only humor in any way connected with the contracting game is supplied by the engineers."

BACK in the '90s R. M. Quigley had a contract for constructing the Alabama & Florida R. R. The cook for his commissary at Georginia, Ala., was a colored gentleman, John Lowery by name. Lowery was left in charge of the Commissary for a short time. The responsibilities of the position must have weighed heavily on him for when the store keeper returned he found the following sign posted on the door:

"Please Dont Come in This House unLess you are on Bisnes no Loaffen are Loud in this house Please goo to the office and Ask for what your Want this is A first Class house and the Bosman Do not are Louw no loafing in this house you will Carry Sumthing out that you did not Bie and if you are Cot Doin Sumthing Rong at this house you Will Suffer for it and I Will tell you the Best thing that you Can Due Dont Turch any thing in this house unless the Bosman tell you So the Best thing that you Can doe Dont Lay A Round inside Off this house.

A CERTAIN wealthy contractor who resembles a camel in the respect that he can go 12 days without water, met some old friends a short time ago. An irrigation convention was promptly organized and a five-day session resulted. After his friend had departed the contractor thought it was about time for him to return home. So he took a taxi and drove up to his house. The servant came to the door. The contractor gravely pulled out his card case and handed his card to the man. "Take this in to Mrs. ———," he said, "and ask her if she will see me."

THE office of the physician in charge of the examination of laborers for government work in an eastern city is located in the Postoffice building. Workmen applying for jobs are given pink tickets which they hand to the doctor when they come to him for the physical test. Two or three weeks ago the medical man heard an argument going on in the outer room where the applicants undress preparatory to the examination. Finally he heard the clerk exclaim: "Now see here, you strip off your clothes or get out." A minute later a big Italian, naked as Adam, bounced into the doctor's office and handed him a pink card calling for the delivery of a registered letter.

THE dredge "Algoma" was scooping out the mud in the Milwaukee River. A couple of Irishmen stood on a nearby bridge and intently watched the work. Finally one of them remarked: "How'd you like to be working over there on that boat, Clancy?" "Fine," replied Clancy, "Oi'd like the 'job' but Oi'd hate like hell to be one of the fellows under water that's filling up the scoop."

WORKING with colored labor in the South has its humorous compensation as well as its financial drawbacks. The following dialogue occurred between two darkies who, in working in a trench, kept getting in each other's way.

"Niggah," warned one, "don't mess wid me, 'cause when you do you suah is flirtin' wid de hearse."

"Don' pesticate wid me, niggah," replied the other, shaking his fist, "doan' fo'ce me t' press dis upon yo', 'cause 'f I does I'll hit yo' so ha'd I'll sep'rate yo' fum amazin' grace to a floatin' opportunity."

"If yo' mess wid me, niggah, I'll jes make one pass an' dere'll be a man pattin' yo' in the face wid a spade tomorrow mornin'."

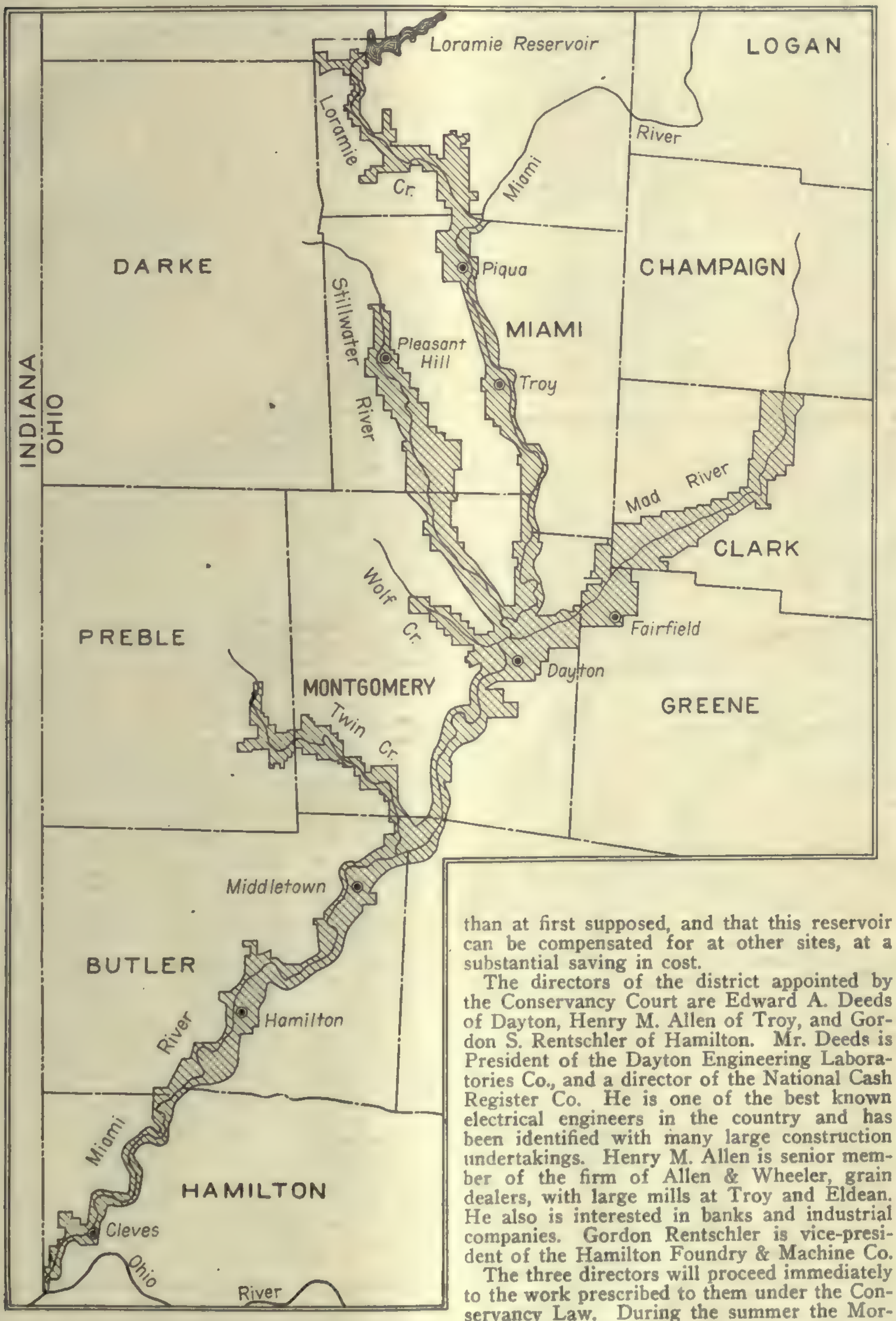
Skinner Mulvey says: I'm gettin' too old fer this wine, wimmin and song business; durned if I don't cut out th' song part.

MIAMI CONSERVANCY DISTRICT ESTABLISHED.

Directors Will Now Proceed with Necessary Details.

Recommendations for Construction to be Submitted in Fall.

The flood prevention development for the Miami Valley, Ohio, has been brought a step nearer the actual construction stage. On June 24 the Miami Conservancy Court convened at Dayton to consider the petition to organize the Miami Conservancy District. On motion of the petitioners to amend their original petition to exclude Logan County and part of Shelby County, the court of ten judges voted in favor of this amendment. The court of nine judges, Logan County having been excluded, then proceeded with the hearing on the amendment by a vote of five to four. The judges of Hamilton, Butler, Warren, Preble and Montgomery Counties voted to establish the district, and those of Miamifi Greene, Shelby and Clark counties dissented from the majority. The court's action in excluding Logan County is due to the fact that the detailed surveys and studies of various reservoir sites made by this company for the Flood Prevention Committee have developed that the reservoir originally petition to organize the district, and on June 28 authorized the organization of the district contemplated in Logan County is less efficient than at first supposed, and that this reservoir can be compensated for at other sites, at a substantial saving in cost.



Map of the Miami Conservancy District.

The directors of the district appointed by the Conservancy Court are Edward A. Deeds of Dayton, Henry M. Allen of Troy, and Gordon S. Rentschler of Hamilton. Mr. Deeds is President of the Dayton Engineering Laboratories Co., and a director of the National Cash Register Co. He is one of the best known electrical engineers in the country and has been identified with many large construction undertakings. Henry M. Allen is senior member of the firm of Allen & Wheeler, grain dealers, with large mills at Troy and Eldean. He also is interested in banks and industrial companies. Gordon Rentschler is vice-president of the Hamilton Foundry & Machine Co.

The three directors will proceed immediately to the work prescribed to them under the Conservancy Law. During the summer the Morgan Engineering Co., the engineers for the district, will draw up in more detailed and final form the actual working plans for the flood prevention work. In the fall, probably, the directors will be in a position to submit to the Miami Conservancy Court their complete report embodying their recommendations as to the best methods for carrying out the development.

DREDGING AND ROCK REMOVAL.

Bids to Be Opened July 24 for Deepening St. Johns River, Florida.

About $250,000 to be Expended.

A dredging and rock removal contract calling for an expenditure of about $250,000 is now being advertised by the U. S. Engineer in Jacksonville, Fla. The work is located in St. Johns River, Florida, between Jacksonville and Mayport. The latter place is near the mouth of the river. Jacksonville is about 25 miles above the mouth.

The mean range of tide varies from about 4 ft. at Mayport to about 1 ft. at Jacksonville. The maximum velocity of the ebb tide current is about 4½ miles per hour at Mayport and 1⅛ miles per hour at Jacksonville. The maximum velocity of the flood tide current is slightly less than the ebb.

The channel between the ocean and Jacksonville has a least available depth of 24 ft. at mean low water and a width of 300 to 600 ft. At the localities where work is contemplated under these specifications, the river varies in width from ¼ mile to 1 mile. In the wider portions, during strong winds, waves 3 ft. in height are not uncommon. The working season extends throughout the year.

The entire area where work is to be done has been dredged previously and as much of the material overlying the rock has been removed, as it was practicable to accomplish with the usual type of hydraulic dredge. In some places the rock is bare, while in other places as much as from 2 to 6 ft. of sand, shell and mud cover the overlying rock.

Work will be required at the following points, the distances given being the rule above Mayport: Mile Point Cut, about 1½ miles; White Shells cut, 3¼ miles; Dames Point cut, 10½ miles; Six Mile Creek cut, 17½ miles, and Arlington cut, 20½ miles, and at Mile Point, near the city of Jacksonville. The rock and overlying material is to be removed to a minimum depth of 30 ft. The total estimated quantity is 179,928 cu. yds. place measurement.

The material to be removed is believed to be a shell limestone of varying degrees of hardness, overlaid in most places with sand, shell and mud to a depth varying from 1 ft. to 3 ft. or more. Over a considerable portion of the area to be dredged the rock surface is below the depth of 30 ft. and the material to be removed is only the overlying material that could not be removed under previous contract on account of the underlying rock interfering with the operation of the dredging mechanism employed. Some filling may have occurred since the previous dredging was completed.

If the work is done by the hydraulic process the material excavated must be conveyed and deposited at such places abreast of or near the site of the dredging, as the contracting officer may designate. The maximum distance to which the material must be transported will not exceed 2,500 ft.; the minimum distance will not be less than 1,500 ft., and the average distance will not exceed 2,000 ft.

If the plant engaged in the work requires the use of dump scows the excavated material must be transported and deposited either in the dumping ground in Shipyard Reach, about 6½ miles above Mayport, or in the dumping ground east of Beacon No. 19, about 17 miles above Mayport. The maximum distance will not exceed 6½ miles and the average distance will not exceed 5¼ miles. In no case will dumping from dump scows be required in less than 10 ft. of water.

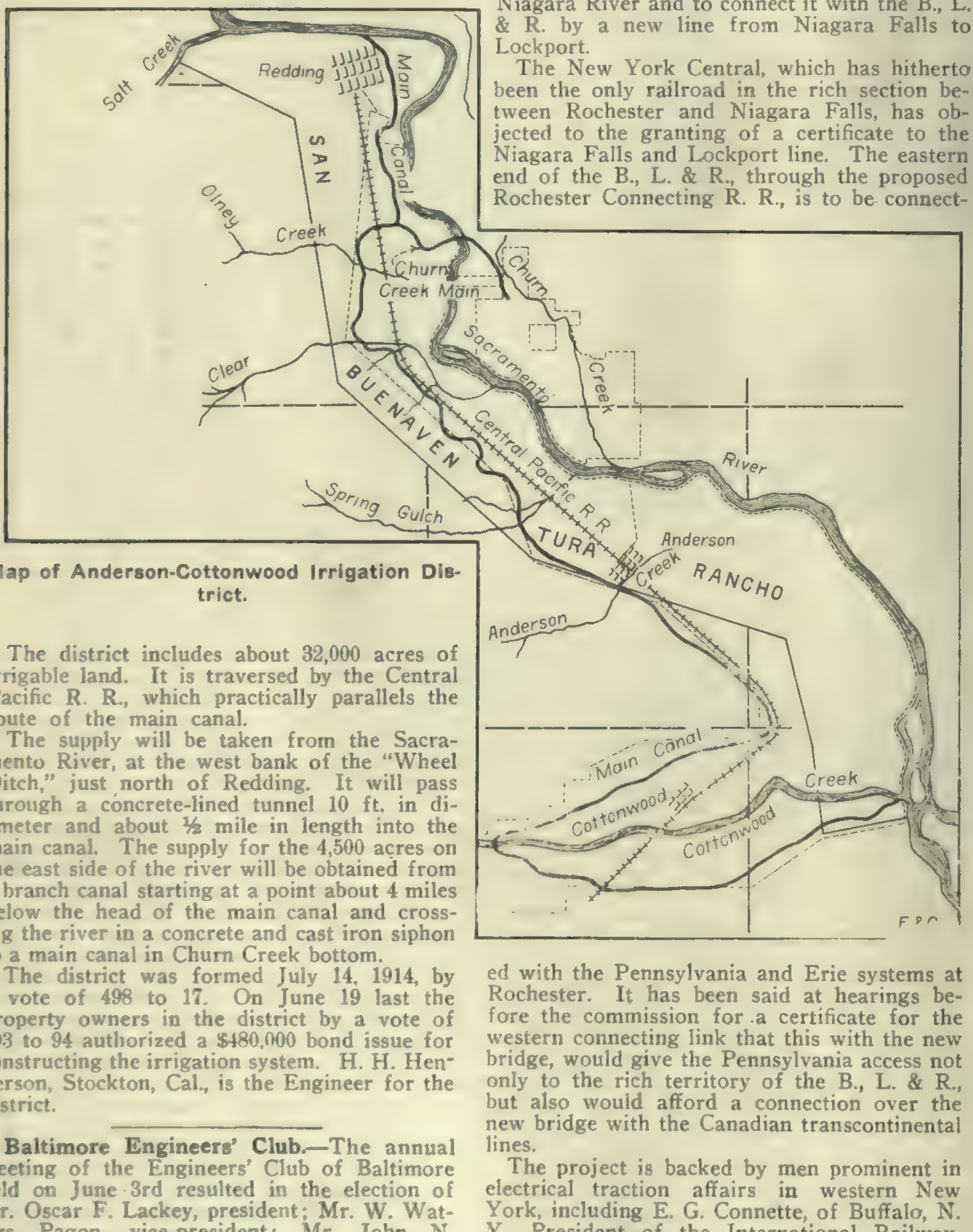
Bids for dredging and rock removal in St. Johns River, Florida, will be received at the U. S. Engineer Office, Jacksonville, Fla., until noon, July 24.

IRRIGATION PROJECT IN SHASTA COUNTY, CAL.

Expenditure of $500,000 Proposed by Anderson-Cottonwood District.

Reclamation of 32,000 Acres Near Sacramento River.

Plans have been prepared for an irrigation project in Shasta County, California, that will call for an expenditure of nearly half a million dollars. This development will be known as the Anderson-Cottonwood Irrigation District. Its northern boundary commences near Redding and runs northwest a few miles, thence south. The west boundary strikes angle at Clear Creek, turning southeast until the town of Anderson is reached, thence it extends to a point southwest of Cottonwood. The southern boundary runs east to Sacramento River. The eastern boundary runs north along Sacramento River on west branch until immediately north of Anderson Free Bridge, when the district extends across the river. The boundary then runs along east branch of river a few miles north of Clear Creek; here it runs back to west bank of river.



Map of Anderson-Cottonwood Irrigation District.

The district includes about 32,000 acres of irrigable land. It is traversed by the Central Pacific R. R., which practically parallels the route of the main canal.

The supply will be taken from the Sacramento River, at the west bank of the "Wheel Ditch," just north of Redding. It will pass through a concrete-lined tunnel 10 ft. in diameter and about ½ mile in length into the main canal. The supply for the 4,500 acres on the east side of the river will be obtained from a branch canal starting at a point about 4 miles below the head of the main canal and crossing the river in a concrete and cast iron siphon to a main canal in Churn Creek bottom.

The district was formed July 14, 1914, by a vote of 498 to 17. On June 19 last the property owners in the district by a vote of 503 to 94 authorized a $480,000 bond issue for constructing the irrigation system. H. H. Henderson, Stockton, Cal., is the Engineer for the district.

Baltimore Engineers' Club.—The annual meeting of the Engineers' Club of Baltimore held on June 3rd resulted in the election of Mr. Oscar F. Lackey, president; Mr. W. Watters Pagon, vice-president; Mr. John N. Mackall, chairman of House Committee, and Messrs. R. Keith Compton, William Walter Crosby and Ezra B. Whitman as members of the Board of Directors.

At the organization meeting of the new Board of Directors held on June 10th, the Board elected Mr. Wm. D. Janney to succeed himself as secretary-treasurer, and the president appointed chairmen of the standing committees as follows: Finance, Mr. Wm. F. Strouse; Publication, Mr. Herman Eisert; Publicity, Mr. Layton F. Smith; Library, Mr. C. J. Tilden; Membership, Mr. Edward F. Ruggles; Tellers, Mr. J. Talbott Todd; Auditors, Mr. Albert H. Wehr.

The first meeting of the Club for the ensuing season will be held on the first Thursday in September. All communications should be addressed to Wm. D. Janney, sec'y-treas., 4-6 West Eager Street, Baltimore, Md.

Important New Connecting Railroad Project.

The application of the Rochester Connecting R. R. for a certificate of public convenience and necessity for its 2½ miles of line in the outskirts of Rochester, N. Y., brings before the up-state Public Service Commission of New York the final phase of one of the most important movements for a new railroad that has been made in this state for several years. The Rochester Connecting R. R. recites in its petition its connection with the Buffalo, Lockport & Rochester, at present an electric line, which is also connected with the proposal to build a new international bridge across the Niagara River and to connect it with the B., L. & R. by a new line from Niagara Falls to Lockport.

The New York Central, which has hitherto been the only railroad in the rich section between Rochester and Niagara Falls, has objected to the granting of a certificate to the Niagara Falls and Lockport line. The eastern end of the B., L. & R., through the proposed Rochester Connecting R. R., is to be connected with the Pennsylvania and Erie systems at Rochester. It has been said at hearings before the commission for a certificate for the western connecting link that this with the new bridge, would give the Pennsylvania access not only to the rich territory of the B., L. & R., but also would afford a connection over the new bridge with the Canadian transcontinental lines.

The project is backed by men prominent in electrical traction affairs in western New York, including E. G. Connette, of Buffalo, N. Y., President of the International Railway, and the petition for the Niagara frontier link of the new road is supported by petitions of the local authorities, boards of trade, and prominent manufacturers. The Niagara link has already been given a hearing before the Public Service Commission and the Rochester connection will be heard within the next few weeks.

A 1,415,000-CU. YD. LEVEE LETTING.

Bids to Be Opened July 12 at Vicksburg, Miss.

Work in Lower Yazoo Levee District.

Bids will be opened in a few days at the U. S. Engineer's Office, Mississippi River Commission, Third District, Vicksburg, Miss., for constructing about 1,415,000 cu. yds. of levee. This work is located in the Lower Yazoo Levee District, above Greenville, Miss. It consists of enlarging and extending the spur levee, which extends from station 3563 of the main levee, down Ashbrook Neck. It involves 30,000 cu. yds. of enlargement, 1,256,000 cu. yds. of new embankment and 129,000 cu. yds. of stumpage. The improvement is divided into 10 sections, the yardage of each being as follows:

Section.	Stations.	Cu. yds.
1	0- 34	148,000
2	34- 50	139,000
3	50- 67	141,000
4	67- 82	141,000
5	82- 99	134,000
6	99-124	136,000
7	124-160	141,000
8	160-190	131,000
9	190-229	155,000
10	229-263	149,000

From Station 0 to Station 18 the enlargement will be made entirely on the lower side of the levee with material taken from that side and beyond the old pits where there are already down to grade. This enlargement will bring the old spur to a 6-ft. crown with 2½ to 1 slope on the lower side.

The new embankment begins at Station 18 and 96. From Station 18 to Station 28 the material will be taken from borrow pits, on account of the levee crossing bayou at Station 20. From Station 28 to Station 130 material will be taken from borrow pits on the upper or lower side of the levee or both. From Station 130 to the outer end of the levee, material will be taken from borrow pits 500 ft. long alternately on the upper and lower side of the levee. No material will be taken within 200 ft. of the outer end of the levee on either side, nor will any material be taken from the bottom of deep bayous on the upper or lower side of the levee.

The borrow pits on both sides of the levee will begin 40 ft. out from the toe. The side slopes next to the embankment will not be steeper than 1 on 2 down to a depth of 3 ft.; from the point out it may be deepened with a slope of 1 on 50. From Station 28 to Station 130, transverses will be left every 400 ft. on the upper side of the levee. These will be at least 14 ft. wide on top with side slopes of 1 on 2

The new dike will have a 6 ft. crown and side slopes of 2½ on 1. The entire line is through heavy timber and some underbrush. The contractor will be required to clear the ground to be occupied by the embankment at once.

Bids will be received on each section and for the entire work, and will be opened at 11 a. m., July 12, at the office of the Third Mississippi River District, Vicksburg, Miss. Maj. J. R. Slattery is U. S. Engineer.

Wanaque River Water Supply Project.—The State Water Supply Commission of New Jersey will hold the final hearing July 1 on the acquisition of the Wanaque River for potable water supply purposes. This development was outlined in our last issue.

Payments on State Road Contracts in Ohio.—The Attorney General of Ohio has issued a ruling that the State Highway Commissioner may enter into contracts in anticipation of the moneys that will come into the State Treasury in August, 1915, provided such contracts are so arranged that it will not be necessary actually to make any payments to contractors from the proceeds of the August settlement until the funds have come into the State Treasury.

$300,000 to Be Expended for Flood Protection Work at Olean, N. Y.

The city of Olean, N. Y., in common with hundreds of other towns throughout the country, suffered severely from floods in March, 1913. Following this disaster, a Flood Abatement Committee was appointed by the Chamber of Commerce. This committee was composed of men who had no direct interest in the abatement of the floods.

It began by applying to the Federal Government for information regarding work of this character that had been done elsewhere in the United States. As a result of the research which followed, and the recommendaations of Engineer Geo. H. Diehl, the report of the committee was adopted by the Mayor and Common Council, and a bill introduced in the State Legislature in January, 1914, asking for an appropriation of $150,000 on condition that the city of Olean bond itself for like amount.

This bill was vetoed by Governor Glynn, but again passed the Legislature in 1915, and on May 24th was signed by Governor Whitman. The local bond issue was carried on June 18th by a vote of six to one. Thus $300,000 will at once become available for straightening, dredging and diking the Allegany River, Olean Creek, and their tributaries within the corporate limits of the city of Olean.

The work will be done under the direction of the Superintendent of Public Works, and the bill provides for a local commission of five men to look after Olean's interests. The rights of way have been secured and the preliminary plans completed. The intention is to start the work without a moment's unnecessary delay.

Exhibition of Street Cleaning Apparatus.—The New York Department of Street Cleaning will hold its second annual exhibition of street cleaning apparatus and appliances in the First Regiment Field Artillery Armory, 68th Street and Broadway, New York City, during the week beginning Monday, October 11, 1915.

The street cleaning apparatus eligible to entry in the forthcoming exhibition includes all sorts of brooms, brushes, sweeping machines, flushing machines and other equipment or appliances used in cleaning streets and removing snow; carts, wagons, motor trucks or other vehicles used for collecting garbage, ashes, rubbish and street sweepings; conveyances for transporting refuse, by water or by rail; methods for the disposal of garbage, ashes, rubbish and street sweepings, including garbage reduction work, garbage crematories, incinerators, destructors, etc.

Cost of Applying Dustoline at Newport, R. I.—William Hamilton, Street Commissioner at Newport, reports that 1914 was the eighth year his department has treated the roadway of certain streets with Dustoline. This clearly demonstrates the value of this material as a dust-layer and that it is giving entire satisfaction in Newport. Six tank cars containing a total of 45,290 gals. were purchased in 1914. The total cost of applying the Dustoline was $3,970. This sufficed to lay the dust on 32 miles of roadway of an average width of 20 ft. at an average cost of $124 per mile.

Subway Construction at Philadelphia May Be Started Soon.—Bids may be asked this summer on the first contracts on the rapid transit developments of the city of Philadelphia, Pa. The Common Council on June 23 passed the ordinance authorizing the $6,000,000 transit loans. The measure will be adopted this week by the Select Council, and after its approval by the Mayor the appropriation ordinance will be passed. This will make available $6,300,000 for the commencement of the work. Of this sum it is proposed to allot $3,000,000 to the Brown St. subway and a like amount to the Frankford elevated line. A. Merritt Taylor is Director of Transit.

An 11-Mile 6-ft. Steel Pipe Line for Jersey City, N. J.

Plans are completed for a new pipe line to supplement the water supply for Jersey City, N. J., and it is expected that contracts will soon be advertised. There will be two contracts, the first for an 11-mile 72-in. steel pipe line extending from Jersey City, across the meadows and over the hills to Brookdale, and the second for a double line of 48-in. cast iron pipe under both the Hackensack and Passaic Rivers; about 3,000 ft. of single pipe in all.

The proposed steel pipe line will run parallel to the present Jersey City-Boonton conduit. Across the meadows it will lie in a trench cut in the old embankment and will be covered with 3 ft. of fill. On the uplands it will be about 3 ft. underground and 12 ft. center to center from the old pipe. The line runs through the Lackawanna R. R. shops at Kingsland, over the hill to Lyndhurst, and down to the Passaic River. On the other side of the river it continues in a northwesterly direction, skriting the north edge of Nutley and crossing the old Morris Canal to Brookdale on the east slope of the Watchung Mountains.

It is planned to use a flexible jointed pipe for the two river crossings. Under the Hackensack where the bottom is soft mud, the pipe will rest on pile bents in a trench. Under the Passaic, which has a hard sandy bed, it will lie directly on the bottom of the trench. Proposals for doing the submarine work by alternate methods will be considered.

The Chief Engineer of Jersey City is Chas. A. Van Keuren and the Consulting Engineer for this work is J. Byers Holbrook, 52 Vanderbilt Ave., New York City.

New Map of Pittsburgh.—The Pittsburgh Industrial Development Commission has just completed a large industrial map of Pittsburgh and vicinity, which is said to be the largest and most complete of its kind. The map was entirely "Made in Pittsburgh," is 6x4 ft., and printed in four colors. It represents more than a year's work by engineers, draftsmen and surveyors employed especially by the Commission. George H. Lehman, engineer of the Flood Commission and of the Lake Erie and Ohio River Ship Canal, directed the work.

Based on the United States Geological Survey, the map was compiled largely by original field work. It has been compiled on a scale of four ins. to a mile, and shows, not only all streets, parks, roads, railroads, and street car lines, but also is remarkable in the fact that it shows every manufacturing plant in the district having railroad connections. Industrial plants are shown in dark blue; railroad terminals and tracks in black; rivers and lakes in pale blue; and street car lines in red.

The map of the city proper covers a radius of 18x13 miles. Included is an insert map of the Pittsburgh district, covering an area of 53x65 miles.

Motion Pictures of Steel Production.—In the exhibit of the United States Steel Corporation at the Panama-Pacific International Exposition, more than six miles of motion picture film traces all the operations required to convert the reddish iron ore into finished products. Those familiar with motion picture film know that each foot contains 16 small pictures, ¾ by 1 in. each. In six miles of film, therefore, there are somewhat more than 500,000 individual pictures each slightly different from the one immediately preceding. In these 500,000 successive pictures is shown the entire "Story of Steel." A regular schedule is followed: At 11:00 in the morning the mining pictures are shown, beginning with the prospecting for iron ore, the "stripping" of barren soil which covers the ore deposits, the actual mining of the iron ore and final loading of the ore into gigantic, specially-designed ore-boats. Then follows the transportation of the ore and the unloading at the blast-furnaces. As coal is required to make coke (which is used for fuel in blast-furnaces) the next pictures are those showing he mining of coal; and subsequently the making of coke, both in bee-hive and by-product coke ovens. In proper sequence follows the refining of the iron ore into crude iron (pig iron containing about 6 per cent of impurities) and the further refining of this crude iron into highly refined steel, which contains only one-half per cent impurities. This refining of crude iron into steel, is shown in three processes, viz.: open-hearth furnace, Bessemer converter, and electric furnace. Finally pictures are shown of the rolling mill and finishing operations. The spectator, at the conclusion of these films, has seen practically every important step involved in the transformation of iron ore into finished steel products, including pipe, seamless tubing, rails, cylinders, wire, wire fences, sheets, etc.

PERSONALS

Mr. Frank R. Farnham has joined the staff of Walter B. Snow, publicity engineer and advertising agent, Boston. Mr. Farnham was previously with the McGraw Publishing Co., in charge of the copy service department for Engineering Record, Electrical World, Electric Railway Journal, and Metallurgical and Chemical Engineering.

Mr. B. G. Slining, for the past three years and a half vice-president of the Southwestern Engineering Company, of San Antonio, Texas, has severed his connection with that firm, He leaves for Chicago, where he will be until about August 15th, and then will return to San Antonio to take up the investigation of several hydraulic developments.

J. T. Breckon, water works engineer for the City of Vancouver, B. C., has tendered his resignation to the city council, to take effect July 31st. Under his supervision the Point Grey partnership pipe was completed, including the laying of two 2,000 ft. cast iron mains across the First Narrows. Mr. Breckon will resume private practice as consulting and construction engineer.

Mr. William C. Jones has been chosen as superintendent of public works for Winston-Salem, N. C., and will have supervision of all street, sewer, light and water work. Mr. Jones is a civil engineer and began his career as instrumentman in 1904. In 1905 he was appointed assistant engineer for the Carolina, Clinchfield and Ohio. In 1909 he became resident and locating engineer for the Winston-Salem Southbound Railway Co. From 1911 to 1914 he was superintending engineer on contract No. 55 of the Catskill aqueduct. Since 1914 he has been valuation engineer on the Winston-Salem Southbound.

Mr. Clarence S. Jarvis, civil engineer, formerly of Provo, Utah, has been appointed chief engineer of the Sevier River Land and Water Co., with headquarters at 311 McCornick Building, Salt Lake City. The project of the company is situated in Millard county, Utah, along the line of the Salt Lake Route. The plan is to eventually reclaim 60,000 acres of arid land. About 50 per cent of the system is now completed, and 10,000 acres are now supplied with water. Mr. Jarvis has had considerable experience along similar lines. He was engineering aid in the U. S. Reclamation Service from 1906 to 1908. Since that time he has been chief engineer of the Provo Reservoir Co. He was construction engineer on the Sevier Bridge dam for the Sevier River Land and Water Co., enlarging the dam and increasing the storage from 104,000 acre-feet to 250,000 acre-feet.

Mr. C. E. Smith, until recently assistant chief engineer of the Missouri Pacific-Iron Mountain System, has opened an office as consulting engineer at 2075 Railway Exchange Building, St. Louis, Mo. He will specialize in valuations, terminal problems, grade crossing elimination and bridges. He is also prepared to handle municipal engineering work of any kind. Mr. Smith has had seventeen years of actual engineering experience, some of which, prior to his graduation in 1900 from Massachusetts Institute of Technology, was obtained on the New England Railroad as rodman. From 1898 to 1901 part of his time was spent as assistant city engineer for Putnam and Willimantic, Conn. From 1901 to

1903 he was bridge designer for the New York, New Haven & Hartford Railroad, and the following year he was with the Bureau of Yards and Docks, Washington, D. C. After one year as assistant bridge engineer for the Lake Shore & Michigan Southern, he was employed on text books and as instructor by the International Correspondence School. After a brief service as field assistant for the U. S. Geological Survey, occupied in investigating and reporting the effects of the earthquake and fire at San Francisco and reporting results of work at testing laboratories at the World's Fair Grounds in St. Louis, Mr. Smith was appointed bridge engineer and later assistant chief engineer of the Missouri Pacific.

CONTRACTORS.

Mr. F. N. Bingham, formerly superintendent of paving for the city of Spokane, Wash., has resigned to become a member of the firm of Clifton-Applegate Co., general contractors, Hutton building, Spokane. He will also be superintendent of paving and sewer work, of which the company has a large amount on hand in the city of Anaconda, Mont. Mr. Bingham was asphalt chemist in the office of the city engineer of Kansas City, Mo., during the years 1908 and 1909. The following year he occupied a similar position at Spokane. During 1911 and 1912 he was consulting paving chemist for Portland, Oregon. Since that date he has been superintendent of paving for Spokane. Mr. Bingham was a delegate to the first meeting of the Association for Standardizing Paving Specifications held in Chicago in 1909, and represented Spokane at both the New York and New Orleans meetings of this society, serving on the Asphalt Committee. He is a graduate of the University of Iowa, class of 1898, and is a member of the Pacific-Northwest League of Municipalities, the American Chemical Society and other bodies interested in good pavements.

Mr. H. E. Bilger, road engineer of the Illinois State Highway Department was granted the degree of Master of Science, pro merito, by Bucknell University, Lewisburg, Pa., June 16, 1915. Mr. Bilger is a graduate of Bucknell with the degree of Ph. B., and is also a graduate of the University of Missouri with the degree of B. S. in C. E. He is a member of the American Society of Civil Engineers. Mr. Bilger has had an extensive engineering experience in the service of the Chicago & Alton, New Jersey Central, Vandalia, and Chicago and Northwestern railroads, and in municipal and industrial projects in western Pennsylvania. For six years following June, 1907, he served the Illinois Highway Commission in the capacity of assistant engineer and division engineer. He resigned to accept the position of senior highway engineer with the U. S. Government. In this capacity he was assigned to the southwestern States on the construction of object lesson roads, and in the analysis of country road conditions and the formulation of reports thereon for the basis of bond issues for road improvement. In April, 1914, he resigned to accept his present position with the Illinois State Highway Department, which he won by open competitive examination with 103 applicants. He now has immediate technical charge under the general direction of the chief state highway engineer of all road work coming under the supervision of the department.

OBITUARIES

William M. Hughes, civil engineer, died at his home in Chicago, June 27. He was consulting engineer for the Nickel Plate road for three years and at one time was city bridge engineer for Chicago.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examinations to be held on Sept. 15, 1915.

Aid, Coast and Geodetic Survey.
Assistant inspector of boilers.
Assistant inspector of hulls.
Copyist topographic and topographic draftsmen, Departmental Service.
Junior engineer, Engineer Department at Large.
Junior chemist, Departmental Service.

The following examinations will be held October 13, 1915:

Civil engineer and draftsman.
Mechanical and topographic draftsmen, Panama Canal Service.
Ship draftsman, Navy Dept.
Engineer, Indian service.
Junior engineers, civil, mechanical, electrical and mining.

The Chicago Civil Service Commission announced the following examination:

Foreman, garbage plant, $1,500-$1,620, July 29.

NEW CATALOGUES

TANKS.—Paper, 3½x8 ins.; 4 pp. Walter A. Zelnicker Supply Co., St. Louis.

Bulletin 173, Zelnicker Tank Stock List, giving data as to capacity, dimensions, etc., of the numerous kinds of tanks now in stock.

CONCRETE CULVERTS.—Folders. Schultz & Hodgson, 918 Association Building, Chicago.

Folders introducing the Hall Interlocking Concrete Culvert. Shows views of old methods and explains installation of the new. O. S. Hall is inventor and the above company agent.

STEEL SASH.—Paper, folder. Trussed Concrete Steel Co., Youngstown, O.

Describes and illustrates some interesting tests of steel sash made by the Edison Co. after the recent big fire at their plant. The tests resulted in the adoption of United Steel Sash for the new plant at West Orange, N. J.

DOMESTIC WATER SUPPLY OUTFIT.—Paper, 6x9 ins.; 4 pp. The Hill Machine Company, Anderson, Ind.

Bulletin No. 14, describing a complete electric pneumatic water supply outfit for domestic service, consisting of pump, motor and pressure tank on iron sub-base. Illustrated.

ARMORED ROPE.—Paper, 3½x6¼ ins., 32 pp. Waterbury Company, 80 South Street, New York City.

Illustrated and descriptive price list of Waterbury Armored wire rope (Gore Patent), designed for use where rope comes in contact with abrasive substances, and for general hard service.

FLUSHERS AND SPRINKLERS.—Paper, 6x9 ins., 18 pp. The Tiffin Wagon Co., Tiffin, Ohio.

Describes and illustrates Tiffin flushers, sprinklers and other municipal vehicles including dumping wagons and carts, garbage wagons, etc. Gives specifications for horse-drawn and motor vehicles and shows construction of special parts.

MOTOR TRUCKS.—Paper, 8¾x11 ins.; 42 pp. The Locomobile Co. of America, Bridgeport, Conn.

Describes Locomobile Worm Drive Motor Trucks, their construction details and operation, and shows photographic views of installations, illustrating the efficiency and variety of service claimed for the trucks.

METERS.—Paper, 6x9 ins.; 20 pp.; Simplex Valve & Meter Co., 112 N. Broad St., Philadelphia, Pa.

Bulletin No. 13, describing "Simplex Meters," meter register, Venturi tube installation with Simplex register, indicating and recording meter, Simplex manometers, pitot tube, etc. Illustrated with diagrams and halftones, and gives formulae and tables for Venturi meter calculation.

BITULITHIC.—Paper, 6x9 ins.; 46 pp. Warren Brothers Co., 59 Temple Place, Boston, Mass.

Reprint of text of the decision of the Supreme court of New York to the effect that patented pavements can be specified and that Bitulithic is a kind of pavement and not merely a brand of material. The case in which decision was rendered concerned the city of Rochester, where Bitulithic had been specified by the Council.

COPPER BEARING STEEL.—Paper, 10x7 ins., 32 pp. American Sheet and Tin Plate Co., Pittsburgh, Pa.

A discussion on corrosion and an exposition of the qualifications of Keystone Copper-Bearing Steel by D. M. Buck, metallurgical engineer of the above company. Gives results of a number of corrosion tests and shows photographs of sheets tested.

CEMENT BAG CLEANER.—Paper, folder. Century Cement Machine Co., 66 Brown's Race, Rochester, N. Y.

Describes the Century Bag Cleaner, a machine which cleans and counts cement bags. Points out the saving of cement, bags, freight on return of bags, and health of workmen, resulting from a thorough cleaning of the bags. Describes construction and operation of machine. Illustrated.

AIR COMPRESSORS.—Paper, 6x9 ins. Two circulars, 8 and 14 pp., resp. The Gardner Governor Co., Quincy, Ill.

Circular A-C6, 8 pp., describes the Gardner Horizontal Duplex air compressors and Circular A-C5, the Gardner Horizontal single-cylinder air compressors. Both are well illustrated and contain detailed description of all parts of the machines, and tables of sizes and capacities.

SLOTTING MACHINES.—Paper, 6x9 ins., 24 pp. Newton Machine Tool Works, Inc., 23d and Vine Streets, Philadelphia, Pa.

Catalogue No. 49, showing the Newton line of standard and special slotters; all dimensional data and information as to special features are given in tabular form accompanying cuts. The line includes small crank-driven machines and larger screw, rack, belt, pneumatic clutch and reversible motor machines.

LOCOMOTIVES.—Paper, 9x6 ins.; 32 pp. The Baldwin Locomotive Works, Philadelphia, Pa.

Record No. 80, describing and illustrating 29 designs of locomotives suitable for plantation service. They vary in type and capacity from eight, four-coupled engines for switching service and short hauls to large engines of the consolidation type qualified for road service. Data as to dimensions, capacity, etc., are given.

MATERIAL HANDLING MACHINERY.—Paper, 6x9 ins.; 44 pp. Orton & Steinbrenner Co., 608 S. Dearborn St., Chicago.

Catalogue No. 11, illustrating a few of the many types of locomotive cranes and buckets manufactured by the Orton & Steinbrenner Co., and calling attention to advantages and special features of the various models. Shows locomotive, gantry and cantilever cranes, drag-line excavators, clam-shell and orange-peel buckets, coal crushers, etc.

GRANITE BLOCK PAVING.—Paper, 7x10 ins.; 16 pp.; Granite Paving Block Manufacturers' Association of the U. S., Inc., 54 Devonshire St., Boston, Mass.

"Permanent Paving" is the title of this book giving facts and illustrations covering improved granite block paving. Shows streets in many cities paved with this material and gives service and maintenance data tending to prove the great economy and civic value of improved granite blocks for this purpose.

COPPER ROOFING.—Paper, 3½x6¼ ins.; 44 pp.; American Sheet and Tin Plate Co., Pittsburgh, Pa.

"Copper and Its Effect upon Steel for Roofing Tin" is the title of this booklet which describes the experiments leading up to the introduction of copper bearing open hearth roofing tin, shows photographs of typical roofs, and gives tables showing loss of weight due to corrosion, instructions for constructing and painting tin roofs and tables of weights, costs, wind pressure, etc.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Engineers and Politics.

A constantly increasing number of engineers is to be found in administrative positions of public nature, but as yet very few have sought membership in city councils, and state legislatures. We believe voters will welcome the candidacy of engineers for such positions. Certainly there is need of technically trained men in legislative bodies.

We note the election of a prominent consulting engineer, Mr. Fred Lavis, as one of the trustees of the Village of Searsdale. It is significant also that the president of the same board of trustees is Mr. F. H. Bethel, vice-president of the New York Telephone Co., a man of broad technical as well as executive experience.

In writing about a recent political meeting an engineer commented upon the favorable remarks that the audience made after an engineer had addressed them. He had talked well and to the point—in marked contrast with one of the other speakers, a United States senator. The other day the editor listened to a speech by a senator who is an aspirant for the presidency. As the speech progressed it became more and more apparent that the orator belonged to a bygone day, a day when to be considered "great" one had merely to qualify as a linguist with a gift of grandiloquent utterance. Twenty years ago his periods would have met "loud applause." As it was a gentle handclapping—and not always that—was given, more in courtesy than in approval.

The public, even at its shallowest, is gaining depth; and, with the assistance of men of scientific training, there should be a rapid dredging of the political stream, until intellectual vessels of deeper draft than flat-bottom, side-paddlers may navigate it.

Accident Prevention and the Need for Attention to Minor Injuries.

Those engaged in construction work are realizing to an increasing extent that proper attention to the safety of workmen is an exceedingly important factor to successful operation. Since the passage of numerous workman's compensation acts, which place definite responsibility for injuries on the employer, it has become essential to success for contractors to exercise every precaution to prevent accidents and to determine the cause and extent of every injury to an employe. It is well known that workmen cannot always be relied upon to report minor injuries at the time such injuries occur, and it is therefore necessary for foremen and superintendents to be constantly on the lookout for minor injuries. Unless every injury is reported there is danger that the employer will be compelled to pay excessive damages, either through fraud on the part of unscrupulous employes, or through carelessness in neglecting to give prompt attention to injuries. Many contractors carry accident insurance on their workmen, but employers are not alert to their own interests if they permit this to influence them in their attention to preventive measures. Unfortunately, it is often necessary to impose penalties for failure to report accidents in order to make such regulations effective.

The fact that employers are responsible for accidents to their employes has forced the former to exercise greater care in the selection of workmen, with the result that many men are now denied employment on account of deficiencies which incapacitate them for a particular kind of work. This is making it increasingly difficult for skilled laborers who are not normal to secure work at the trade mastered by them. Such men either become a burden on the community or are forced into lines of work for which they are poorly fitted. It has been suggested that legislation should be enacted which would permit the employment of a man without the employer being liable for injury caused, or contributed to, by recognized deficiencies, and we believe fair legislation along this line would be beneficial both to the employer and to the employe. Even though a man may possess deficiencies which tend to incapacitate him for a particular kind of work, it may be advisable for him to assume all risks rather than to attempt to learn a new trade. It will be recognized, however, that such legislation will require careful consideration if the community is to be protected against loss.

Contractors who have had wide experience recognize the importance of safeguarding employes and of giving attention to all injuries no matter how trivial they may appear to be; but those just entering contracting work and possessing limited capital are too often inclined to assume unwarranted risks. If employers were always as prompt to recognize ability displayed in accident prevention as they are to condemn and penalize those responsible for accidents, progress would be satisfactory.

The Engineering Student and His Text Books.

The engineering student has often been advised to keep his text books for reference when he becomes rusty, after leaving college, on some theoretical point. Moreover, such books form the beginnings of such a technical library as every engineer should have. Despite these indisputable points it has long been the custom for many students to sell their books as rapidly as they have "passed off" the several subjects given in the undergraduate course. This sale of books flourishes, as it apparently decreases the expense of obtaining an academic training in engineering, and decreases the capital investment of the embryo engineer. The practice is also popular as it tends to reduce the bulk and weight of the personal effects which the engineer, in his early days, usually has to move from place to place at short intervals.

Bad as the plan of selling text books is, it now appears that in at least one engineering college some of the students are becoming so forehanded in ridding themselves of books that they do not buy them at all. Thus we learn that in that institution a class of 120 students in surveying purchased only 50 new text books. It was not thought that enough second-hand books were available to make up the difference—clearly a good many of the class did not buy books. In another case at the same institution a new text book was introduced and enough were ordered by the college book store to supply the entire class. After the last purchase was made there were still 17 books remaining unsold. This class was in two sections, meeting at different times, and an attempt was made to force the purchase of the remaining books by requiring each student to produce a book in class. However, some of the books were not sold, a few of the students evidently holding certain copies in partnership. One student was detected with his name written in the back of a book which bore another man's name in the front. This incident is given to show the length to which at least one member of the class was willing to go to avoid the purchase of the prescribed text. The authorities did not consider it wise to force the matter further, and a few of the books were not sold.

All this would hardly call forth comment in this place if it did not reveal again the familiar and fallacious belief that graduation in itself is sufficient to the making of a competent engineer. Apparently the students are willing to sell their books as soon as possible, or to avoid buying them at all, because they think they can still get passing grades and eventually graduate, which, of course, they can. Graduation is held sufficient, in the undergraduate mind, and is looked upon as putting an end to study. Therein lies the mischief. The best engineers always remain students, and every effort should be made to impress this fact upon undergraduates. They should be compelled to buy the prescribed books and should be urged to keep them, even though this requires storage for a few years following graduation. Possession of old text books is always an inducement to further study; conversely, the lack of such books makes further study exceedingly difficult, if not practically impossible.

When Is It Economic to Retire an Old Plant Unit?

Either because of the "progress of the art" or because of economic inadequacy, old plant units are frequently retired although physically in good condition. Engineers are repeatedly called upon to solve economic problems involving an answer to the question of proposed retirement of old machinery and structures. It would therefore seem that engineering literature would contain many discussions of this question, and certainly that the theory, at least, would be fully and correctly given somewhere in print. The fact is that there are almost no printed discussions of this problem, and such as there are will be found to be either incomplete or actually erroneous. Incompleteness has invariably occurred in the treatment of functional depreciation as a factor in this problem.

We publish in this issue an article by Halbert P. Gillette, entitled "A Rational Method of Calculating Depreciated Value." In the body of that article is a brief discussion of the economic retirement problem, and the author deduces a correct general formula for such problems. Having first derived a rational general formula for calculating depreciated value, the author reasons that when the depreciated value falls below the salvage value, the old plant unit should be retired. Applying this condition to his depreciation formula he deduces a formula to use in solving problems as to economic retirement of old plant. Expressed in words his formula is this: An old plant unit should be retired in favor of a new plant unit when the sum of the equated annual operating expenses and interest on the salvage value of the old plant unit is greater than the sum of the equated annual operating expenses, the functional depreciation annuity and the interest on the first cost of the new plant unit.

It will be necessary to read the article to understand the exact meaning given to the expressions "operating expenses," etc.

It will be noted that in his definitions, Mr. Gillette includes taxes and natural depreciation in "operating expenses," but carries functional depreciation as a separate item. It should be particularly noted that the "interest rate," as he defines it, includes "risk insurance" and "proprietary supervision" not covered in "operating expenses" or in functional depreciation annuity. It follows, therefore, that a bond interest rate is not a proper interest rate to use in solving plant retirement problems, yet bond interest rates have been repeatedly used in such cases. Usually, also, functional depreciation has not been properly considered, if considered at all.

It is commonly said that a new machine should not replace an old machine that is physically good unless the new machine will show an annual saving in operating expense sufficient to pay interest charges not only on the new machine but upon the original cost of the old machine. Mr. Gillette points out the fallacy in this general contention, but he shows that there are conditions under which functional depreciation may be wisely amortized "after the fact."

GENERAL

A Rational Method of Calculating Depreciated Value.

BY HALBERT P. GILLETTE,

Editor-in-Chief, Engineering and Contracting.

INTRODUCTION.

Depreciation is not a subject that has lacked discussion. On the contrary, it has been almost "talked to death." The very mass of printed matter on depreciation is evidence not only of the importance of this phase of economics, but of the disagreement among economists on its proper treatment. About 1,000 titles are listed in the "Bibliography on Valuation of Public Utilities," compiled by the American Society of Civil Engineers. More than 250 of these titles contain words denoting or connoting depreciation. A study of these articles shows divergence of opinion among engineers, accountants and economists in general, a divergence that is little short of amazing when one considers the apparent simplicity of the subject and its lack of novelty. It is true that many of the differences among writers arise from a failure to agree on definitions, but the most important differences lie deeper than the symbols of reasoning and go to the reasoning itself.

For a long time it has been recognized that there are several distinct causes of depreciation, but it has not been generally recognized that a correct method of estimating depreciation resulting from one cause may be an incorrect method to apply where a different cause of depreciation exists. Inspection, for example, may serve to disclose the degree of decay or rust, but may not serve to indicate the degree of loss of value due to inadequacy or obsolescence. Or, again, the percentage of expired natural life may be a correct factor in estimating accrued natural depreciation, whereas expired life has, in itself, nothing whatever to do with loss of value due to obsolescence. And because of this last fact, it is quite certain that in rate making cases hundreds of millions of dollars of accrued depreciation have been deducted in excess of the correct amount.

Attempts have been made to discredit all depreciation formulas by calling them "purely theoretical." The expression "theoretical depreciation" has been used in the endeavor to disparage certain methods of calculating accrued depreciation. But some sort of theory is essential to the systematic determination of values. Hence it avails nothing to tag a given method or a given result with the adjective "theoretical." Incorrect or incomplete theories of valuation must be exposed. Correct and complete theories must be established. This is one of the functions of engineers.

As an initial step in deriving a theoretically correct depreciation formula, it can easily be shown that the "straight line depreciation formula" never gives more than an approximation to the truth, and often yields results far from correct. As a second step, it can be shown that the "sinking fund depreciation formula" is never correctly applicable to a composite plant unit either when the curve of repair costs is rising or when loss of value due to inadequacy or obsolescence has occurred. As a third step, it can be shown that the lives commonly assigned to plant units are not *natural* but functional lives and therefore not usable either in the "straight line formula" or in the "sinking fund formula." By establishing these facts it follows that nearly all property that has been appraised for public utility commissions has been assigned a depreciated value far below its true depreciated value. As an illustration, let us take bare copper wire, which is commonly assigned a "life" of 15 to 20 years in telephone or electric transmission service. The fact is that the natural life of such wire is so great that no man has ever recorded it. The "life" of 15 or 20 years, therefore, is purely a functional life, dependent upon economic inadequacy and the like. If, therefore, a given lot of old copper wire is serving a purpose as economically as if it were new, it cannot be said to have depreciated functionally. And as the natural life of copper wire may be hundreds of years, the old wire has not depreciated to any measurable degree naturally. In brief, under these conditions, it has not depreciated at all unless the price of copper has dropped. Yet, it is a common thing to see an estimate of depreciated value of copper wire put at 65 to 75 per cent its cost new simply because it is a few years old. The same error is to be seen in the case of depreciated values assigned to buildings, to rolling stock, to machinery, and, indeed, to nearly every class of plant units. *An average functional life is not only treated precisely as if it were a natural life, but is applied to particular cases where no average is applicable at all.*

The "life" of water works pumps is said to average 20 years. Many engineers and nearly all laymen think that this means that the average pump *wears* out in 20 years, but even where they know better they make the mistake of substituting the 20-year functional life in a formula that is not applicable except where natural life is involved, such as the "sinking fund depreciation formula." Thus we may have a correct definition of depreciation followed by an incorrect use of "life" data in a depreciation formula.

Mistakes in the understanding or use of a theory, however, form no sound reason for rejecting all theories. But they do justify a careful scrutiny of all theories to the end that a correct theory may be developed and correctly applied. The object of this article is to further the advance toward correct and complete generalizations relating to depreciated value.

DEFECTS IN THE TWO COMMON DEPRECIATION FORMULAS.

Two formulas for calculating accrued depreciation are in common use, the "straight line formula" and the "sinking fund formula." According to the straight line formula, the accrued depreciation of a plant unit is found by multiplying its "cost new minus salvage value," by the quotient of its age divided by the average life of similar plant units. Hence a plant unit having a 20-year life would depreciate 5 per cent annually.

According to the sinking fund formula for accrued depreciation, the accrued depreciation at any given age is equal to the amount accumulated in a sinking fund established (through annuities and interest thereon) for redemption of the "first cost minus the salvage value of the plant unit" at the end of its life. Obviously the sinking fund formula gives less accrued depreciation than the straight line formula.

We may be sure that the straight line formula and the sinking fund formula cannot both be theoretically correct. One must be merely an approximation if the other is correct. Which, if either, is correct?

Accrued depreciation is loss of value of an existing plant unit. It occurs in the course of time, but not necessarily *because* of the lapse of time. Depreciation is caused by two distinct sets of forces; (1) The forces of nature and (2) the forces of society. The former may be said to cause *natural depreciation*, such as results from rust, wear, rot, fire, etc. The latter may be said to cause *functional depreciation*, such as results from invention, growth of business, public enactments, fall in prices, etc.

Accrued natural depreciation increases as time increases, if the forces of nature have a progressive effect. In the case of rot, rust, wear, etc., the resulting accrued depreciation can often be determined from consideration of the age of the plant units, provided the amount of previous repairs is known. But in the case of functional depreciation, age of plant has no direct relation to its accrued depreciation. Invention may render a new plant almost valueless, even before it has seen service or but shortly after its initial use. Growth of business, which causes inadequacy, may be rapid or slow, largely dependent on the vigor of the management of the property, partly on a rise in general prosperity (itself largely a result of invention), and for other reasons not directly related to the lapse of time. Clearly, then, it is not logical to insert a *functional life* in either the "straight line" or the "sinking fund" formulas for accrued depreciation. Natural life is to be inserted in these formulas if they are to be applied at all. Yet how rarely has this vital distinction been drawn. Tables of "average life" of plant units commonly used by appraisers contain lives that are for the most part functional lives, in some part composite lives, and only in small part natural lives. The data in these tables were originally compiled, for the most part, as a basis for calculating depreciation annuities, with which to establish depreciation funds—a thing entirely distinct from accrued depreciation. Thus a fire insurance fund might be established exactly as functional depreciation fund is established. A building not yet burned has certainly not lost value because a fire insurance fund exists to insure it. In perfectly analogous manner, a plant has not lost value because of a functional depreciation fund that exists to insure it against obsolescence and inadequacy.

We see, therefore, that the two common depreciation formulas have been misused, usually with resulting depreciated values far below the real depreciated values. Let us next examine the formulas themselves to see whether they are defensible at all.

If the straight line depreciation formula be applied to a 10-year-old cedar pole having a total natural life of 20 years, its depreciated value is 50 per cent of its cost new. Assuming the pole to cost $10 new and to have no salvage value, it would be worth $5 at the end of ten years, according to that formula. If this deduction is correct, it should be impracticable for a purchaser to use the pole during its remaining life at a less annual cost than would be incurred if he bought a new pole. Let us, therefore, compare the annual costs.

	Old pole.
Interest, 5% of $5	$0.25
Depreciation, 10% of $5	0.50
Total annual cost for old pole (10 years remaining)	$0.75

	New pole.
Interest, 5% of $10	$0.50
Depreciation, 5% of $10	0.50
Total annual cost for new pole	$1.00

Hence, the old pole, purchased on a straight line depreciation formula, can be used at a less cost per annum than a new pole. This absurd result indicates that the straight line formula gives too low a value. The proof of absurdity is complete if we show that a sinking fund annuity applied to each price ($5 and $10) yields likewise different annual costs.

	Old pole.
Interest, 5% of $5	$0.25
Depreciation annuity, 7.95% of $5	0.39
Total annual cost for old pole	$0.64

	New pole.
Interest, 5% of $10	$0.50
Depreciation annuity, 3.02% of $10	0.30
Total annual cost for new pole	$0.80

Hence a sinking fund cannot be used to secure equal annual costs where depreciated value is derived by the straight line formula, and in no case is it possible to use a new pole at less annual cost than an old pole, if the old pole is purchased at depreciated value calculated by the straight line formula. Therefore, a rational seller would never part with a pole at a depreciated value thus calculated, unless under some sort of compulsion.

Let us now apply the same sort of reasoning to the sinking fund depreciation formula, assuming the same conditions as to age and cost new of pole. A 5 per cent sinking fund established to redeem a $10 pole in 20 years would amount to $3.80 in 10 years. Hence the sinking fund depreciation formula gives $10.00—$3.80=$6.20 as the depreciated value of the pole. Then for the old pole, we establish a sinking fund to redeem the $6.20 in the remaining 10 years, which requires an annuity of 7.95 per cent.

	Old pole.
Interest, 5% of $6.20	$0.31
Depreciation annuity, 7.95% of $6.20	0.49
Total annual cost for old pole	$0.80

	New pole.
Interest, 5% of $10	$0.50
Depreciation annuity, $3.02% of $10	0.30
Total annual cost for new pole	$0.80

Whatever be the age of the old pole, a similar calculation shows a constant annual cost of $0.80. It follows, therefore, that a rational seller would part with the pole at a depreciated value established by the sinking fund formula, provided he were put to no loss from causes incident to the sale.

Note carefully that in the above examples nothing but natural depreciation is involved and that no repairs or renewals of parts occur. If repairs to a composite plant unit are involved in the problem, neither of these two formulas is correctly applicable. And, as shown above, neither is correctly applicable if functional depreciation is involved.

The sinking fund depreciation formula takes no cognizance of maintenance expense, which constitutes a serious defect in the formula when applied to classes of plant units that have a rising curve of repairs. Curiously enough this defect in the formula has been spoken of as if it were a merit. It has been said, for example, that a sinking fund depreciation curve follows closely the curve of actual loss of value, dropping slowly in the early years but dropping very rapidly toward the close of life of the plant. In brief, the argument has been that actual loss of value coincides closely with a sinking fund depreciation curve. Granting that it did, the result would be entirely fortuitous. In fact, however, repair "curves" are not regular curves but jagged lines. One of the prime objects of a depreciation reserve is to secure equality of annual charges for upkeep by providing a reservoir that prevents violent fluctuations in annual maintenance charges. Normally the repair costs on a machine rise as the machine grows older, but, instead of providing for this rise, the sinking fund depreciation formula, as commonly used, entirely ignores it. Thus, the sinking fund formula gives as high a percentage of depreciated value for an automobile as for a horse, if each is assumed to have the same life and if both are the same age. Yet the automobile has a rapidly rising curve of repairs, while the horse has no repairs.

If a sinking fund were calculated for every renewable *part* of a composite plant unit, of course the sinking fund depreciation formula could be correctly applied in the case of natural depreciation. But this is obviously not the common method of applying the formula. It will be shown that the sinking fund depreciation formula is a special form of a much more general and perfectly correct depreciation formula. Under certain limitations, therefore, it has a field of usefulness.

THE BASIS FOR AN ECONOMIC DEPRECIATION FORMULA.

As above indicated, a perfectly general formula for determining depreciated value must contain factors that provide properly for the effects both of natural and functional depreciation. Such a formula must also provide for the current repair expenses needed to enable the plant to give economic service.

The commercial value of the entire property (plant, organization and attached business) is the present worth of its prospective net earnings. This value is deduced by capitalizing the net earnings, that is, by equating both the annual gross income and the annual operating expense, subtracting the latter from the former and dividing by a rate of interest expressed as a decimal. But if the annual gross income is assumed not to be affected by any change in the plant, and *if changes in net earnings effected by changes in plant are regarded as affecting only the value of the plant* (remember this proviso), it is rational to say that the criterion of value of a given plant unit is the value of an alternative plant unit of the most economic design. This, indeed, is the only criterion of *plant value* that can be logically maintained. If there have been no improvements in plant design and no growth in plant output, then the annual cost with a new plant unit of the same design and capacity as the old plant unit becomes the criterion of the value of the old plant unit. But if improvements in design have occurred, or if in any way a more economic plant unit is securable, then the annual cost with the most economic plant unit available becomes the criterion.

It should be constantly kept in mind, however, that we are dealing now only with *plant value*, and that the total *property value* may be materially affected by any change in plant. Our criterion of plant value is the cost of an alternative plant, but where an alternative plant also involves an alternative income and its collateral alternative cost of establishing that income, it is clear that any difference in plant value may be more than offset by the consequent difference in the value of the attached business. It will be shown later that functional depreciation of plant value is often accompanied by appreciation of the total *property* value.

EQUATED ANNUAL COSTS.

Before a rational comparison can be made between alternative plants, it is essential to express all costs either as equated annual costs, or as capitalized annual costs that have been equated. To *equate* as here used, means to secure a true average by a sinking fund method of calculation. When, for example, the cost of repairs is irregular, varying from year to year, no rational comparison of repair costs can be made until they are equated to an average annual amount. This cannot be accurately done by adding all the annual repairs together for a term of years and dividing by the number of years in the term. The correct process is as follows:

Calculate the total cost of repairs of the first year at compound interest up to the end of the last year of economic life of the unit in question. Calculate similarly the cost of repairs of the second, the third, etc., years up to the end of the last year. Add all these compounded costs together and multiply by the annual deposit in a sinking fund which started at the beginning of the life will redeem $1 at the end of the life of the plant unit. The product is the equated annual cost of repairs.

If the annual cost of repairs is actually uniform, year after year, throughout the life, say $100, the above given rule gives $100 as the result, thus checking the correctness of the rule.

If the repairs all come at the very end of the life, and thus constitute an entire renewal, obviously the rule gives the correct answer, namely the sinking annuity required to redeem the investment at the end of the life.

DEDUCTION OF THE ECONOMIC DEPRECIATION FORMULA.

In the following discussion the term "old plant" will be used to designate the existing plant unit or group of units whose depreciated value is to be determined, and the term "new plant" will designate the most economic new plant unit having the same annual output as the old plant unit. Wherever the word "annual" occurs, it is intended to mean "equated annual" or true average annual. Where the word "annual" occurs in reference to the old plant, it relates to the average for the *remaining* years of its life, but where the word "annual" occurs in reference to the new plant, it relates to the average for its *total* economic life. Small letters relate to the old plant, and capital letters relate to the new plant.

Let—

a = Age of old plant in years.
C = First cost of the new plant.
c = First cost of the old plant.
D = Depreciation annuity rate for the *total* natural life.
d = Ditto for *remaining* natural life.
E = Equated annual operating expenses (including taxes) during entire life of the new plant, inclusive of repairs and cost of natural depreciation, but exclusive of functional depreciation annuity.
e = Ditto for old plant during its remaining life.
F = Functional depreciation annuity rate for new plant.
f = Functional depreciation annuity rate for old plant.
K = Total equated annual cost during *entire* life of the new plant.
k = Total equated annual cost during *remaining* life of the old plant.
N = Total life of new plant in years.
n = Remaining life of old plant in years.
R = Interest rate plus functional depreciation rate.
r = Interest rate, including risk insurance and proprietary supervision not included in F, f, E. e.
S = Salvage value of new plant.
s = Salvage value of old plant.
U = Unit cost of product of new plant.
u = Unit cost of product of old plant.
v = Depreciated value of old plant.
Y = Number of units annual product with new plant.
y = Ditto with old plant.

Then we have:

$$(1) \quad U = \frac{K}{Y} = \frac{E + (C-S)\,F + r\,C}{Y}$$

$$(2) \quad u = \frac{k}{y} = \frac{e + (v-s)\,f + r\,v}{y}$$

The old plant must have a depreciated value, v, such that the unit cost, u, of its product must equal the unit cost, U, of the product of the new plant. Were u more than U, it would be more profitable to buy the new plant. Were u less than U, it would be more profitable to buy the old plant. But a condition of equity exists only when it is as profitable to buy the old plant at the value, v, as to buy the new plant at the cost C. This condition of equity is satisfied when $u = U$.

Then—

$$(3) \quad \frac{E+(C-S)\,F+r\,C}{Y} = \frac{e+(v-s)\,f+r\,v}{y}$$

$$(4) \quad v = \frac{y}{r+f}\left(\frac{E+(C-S)\,F+r\,C}{Y} - \frac{e-fs}{y}\right)$$

Equation (4) is the most general expression of the economic depreciation formula, but it may be reduced to much simpler terms for ordinary use. Usually $Y=y$, and $S=s$, or if these are not exactly equal the equality is so close that v is not appreciably affected by assuming perfect equality. Also it often happens that F and f

are equal or nearly so. Assuming these equalities, we have:

$$(5)\quad v = C + \frac{E-e}{r+f} = C - \frac{e-E}{R}.$$

Equation (5) is the economic depreciation formula in a simplified but still very general form. Expressed verbally, equation (5) is:

Assuming equal gross income, equal annual output, equal salvage value and equal prospective functional life for new and old plant units, the depreciated value of an old plant unit is equal to the cost of a new plant unit of most economic design minus the capitalized difference in their equated annual operating expenses during the prospective economic life.

It will be noted that the rate of capitalization (R) is the sum of the interest rate (r) and the functional depreciation rate (f) when the operating expenses (e and E) do not include functional depreciation annuities. This is an important point, and one that is frequently overlooked in capitalizing incomes and expenses.

Formula for Accrued Natural Depreciation: —When functional depreciation is non-existent, we have $f = O$, and then the depreciation formula, equation (5) becomes:

$$(6)\qquad v = C - \frac{e-E}{r},$$

In this case C is the cost new of a plant unit of the same size and class as the old unit whose depreciated value is v. E is the equated annual operating expense, including the depreciation annuity required for a sinking fund to redeem the full wearing value $(C-S)$ during N years *total natural* life of the unit; and e is the equated annual operating expense, including the depreciation annuity required for a sinking fund to redeem the remaining wearing value $(v-s)$ during the *remaining natural* life of n years.

If annual operating expenses other than depreciation are M, and are the same for a new as for an old plant unit, we have:

$$(7)\quad E = D(C-S) + M.$$

$$(8)\quad e = d(v-s) + M.$$

Substituting in equation (6), and remembering that $s=S$, we have:

$$(9)\quad v = \frac{rC - d(v-S) + D(C-S)}{r}.$$

$$(10)\quad v = S + \frac{D+r}{d+r}(C-S).$$

Equation (10) gives identically the same results as the ordinary sinking fund formula for depreciation, which is:

$$(11)\quad r = S + \left[1 - \frac{(1+r)^{a}-1}{(1+r)^{N}-1}\right](C-S)$$

That equations (10) and (11) give identical results may be shown by the use of sinking fund tables in the solution of specific numerical examples. In view of the importance of the subject, a strict mathematical proof may be demanded by some engineers. Accordingly it is given herewith.

Proof of Identity of Equations (10) and (11):

$$(12)\quad n = N - a.$$

$$(13)\quad D = \frac{r}{(1+r)^{N}-1}$$

$$(14)\quad d = \frac{r}{(1+r)^{N}-1} = \frac{r}{(1+r)^{N-a}-1}.$$

Substitute these values of D and d in equation (10).

$$(15)\quad v = S + \left[\frac{\dfrac{r}{(1+r)^{N}-1}+r}{\dfrac{r}{(1+r)^{N-a}-1}+r}\right](C-S)$$

$$= S + \left\{\frac{(1+r)^{N}[(1+r)^{N-a}-1]}{(1+r)^{N-a}[(1+r)^{N}-1]}\right\}(C-S)$$

Multiplying both numerator and denominator by $(1+r)^{N-a}$ we have:

$$(16)\quad v = S + \left[\frac{(1+r)^{N}-(1+r)^{a}}{(1+r)^{N}-1)}\right](C-S)$$

$$= S + \left[1 - \frac{(1+r)^{a}-1}{(1+r)^{N}-1}\right](C-S)$$

Since equation (16) is the same as equation (11), it follows that equation (10) gives the same value for v as does equation (11), which was to be proved. Hence the special case, equation (10), of the general depreciation formula, equation (6), is seen to be another form of the sinking fund formula for depreciation. Hence the sinking fund formula is correctly applicable only where *natural* depreciation is involved and only where current repairs are uniform or absent.

CRITERION FOR RETIRING OBSOLETE OR INADEQUATE PLANT.

The general formula for depreciated value, equation (3), may be used as a criterion for determining whether a plant unit has ceased to be economic and should be retired. The condition for such retirement is that the depreciated value, v, shall be equal to or less than the salvage value, s; for if the depreciated value, v, has reached so low an amount that the plant has no greater value as an economic producing instrument than its salvage value, then it is worth more to its owner as merchandise than as a productive instrument.

Hence if we let $v = s$ and $y = Y$, equation (3) becomes:

$$(17)\quad E + (C-S)F + rC = e + rs.$$

When the equality of (17) is destroyed because the left hand member of (17) is less than the right hand member, the old plant should be retired in favor of the new plant.

Equation (17), derived from equation (3), served to test the correctness of the reasoning used by Mr. I. J. Thorp, who had deduced a method of determining when to retire telephone plant units. Mr. Thorp's method was seen to be correct although he had not segregated functional from natural depreciation.

In this connection, it may be well to note that many engineers suppose that a new invention or design must always show enough saving over a device that it replaces not only to pay interest on the new invention or design, but on the old device that has been rendered obsolete. In one form or another, this is an opinion commonly met, yet, as a general proposition, it is demonstrably erroneous. A demonstration of the error is had in the demonstration of the truth of equation (17), for that equation does not contain the original cost of the old plant. However, it does contain a functional depreciation factor, F, the significance of which is this:

The *profit* from progress *in general* must pay for the *cost* of progress *in general.* This, however, is quite a different proposition from the ordinary but erroneous proposition: The profit from this *particular* new device must pay interest on the *particular* old device that it supplants.

The curious logical error arising from confusing *general* improvement with a *particular* improvement could scarcely have gained ground had it not been for the existence of monopoly and partial monopoly conditions. In the presence of perfectly free competition, it would be absolutely impossible to make a particular new plant carry the interest load of the particular old plant displaced by it. Under such conditions all plants —plants in general—would be charged with an annual amount to cover the *average* cost of functional depreciation of *all* plants, precisely as all buildings are charged with an annual fire insurance cost. Out of the general fire insurance fund must come the capital for renewing a burned building. Likewise, out of a functional depreciation fund would then come the capital to replace that destroyed by social progress.

This economic problem, although but one phase of the problem of depreciated value, is one that would require a long paper for its adequate presentation.

AMORTIZATION BEFORE OR AFTER DEPRECIATION HAS OCCURRED.

Contention is often made that depreciation should be amortized *after* a renewal has been made and not *before.* Where only natural depreciation is involved, there is little to support such a contention. But where functional depreciation is involved, the contention takes on more force. It is then reasoned as follows:

Functional depreciation of a particular old plant is always attended by functional appreciation of the property due to the economic advantage of the new plant that displaces the old. The cost of this depreciation is less than the profit of the appreciation, and out of this profit must be paid the cost of depreciation. Therefore no charge should be made for functional depreciation until there is a gain accrued with which to meet the charge, that is, until the saving effected by the new plant provides funds with which to amortize the investment in the plant displaced.

Thus, it is contended, does the burden fall where and when it is due, whereas to anticipate functional depreciation by setting aside annuities before the functional depreciation occurs, results in assessing costs prior to the enjoyment of benefits.

It is but one step from this conclusion to the next: Functional depreciation is non-existent until the old plant is actually removed. In other words, functional death does not occur until the inadequate or obsolete plant is permanently retired.

This last proposition is seriously supported by many men, but is untenable. On the other hand, there is some justification for the view that functional depreciation should be amortized *after* the fact, although the justification is upon grounds not hitherto clearly set forth.

Before correct answers can be given to the questions here involved, it is necessary to distinguish sharply between the economics of free competition and the economics of full or partial monopoly. It is also necessary to distinguish between economic improvements caused by forces *exterior* to an owner or employe of a plant and economic improvements caused by the owner or employe of a plant—*interior* forces. Competition and other exterior forces may compel an action; but complete, and often even partial monopoly, may lead to non-action.

An invention made by men exterior to a public utility company, for example, may force the company to buy the improved apparatus in order to protect itself from possible competition, or in order to meet existing competition. In such an event, functional depreciation cannot always be amortized out of subsequent gains. This is the condition that exists for most manufacturers, and makes it imperative for them to insure themselves either through a functional depreciation annuity or through large profits *prior* to the occurrence of the anticipated improvement. Even they can usually amortize some of the functional depreciation *after* the fact, because of the partial monopoly that every well established business enjoys.

Functional depreciation caused by forces over which the owner of a plant has little or no control is closely akin to loss of property by fire. It should be insured against as far as possible and in advance. If such depreciation strikes the man who has built up no reserves against it, his propery is as surely and almost as swiftly swept away as by a conflagration. Hence the fallacy of the generalization that all functional depreciation should be amortized after the fact. Hence, too, the fallacy that *no* property has functionally depreciated until it has actually been retired. Such generalizations evidently need decided qualifications, to which we now come.

Invention by men *exterior* to a plant is to be provided for by a functional depreciation reserve built up prior to the invention, as far as possible. Invention by men *within* the plant usually needs no such protection. This distinction is vital to any complete theory of accrued depreciation and depreciation reserves. Invention from *without* may cause a sudden and irretrievable loss of value to a given plant. Invention from *within* also causes destruction of existing property value but the loss is not irretrievable and is, in fact, never incurred unless there is overpowering belief in the ability to recoup it out of savings affected by the particular invention. The enjoyment of the fruits of the invention is assured in one or more ways: (1) Patents, (2) secrecy, (3) inertia of competitors, (4) monopoly of the business, partial or complete. Where invention is not patentable, some sort of partial or complete monopoly of the business is usually the source of the protection needed to stimulate the effort to secure improvement. This holds also of all economic improvements whether or not they are entitled to be ranked as inventions.

Economic improvement from *within* an organization occurs only under the stimulus of some sort of protection in the enjoyment of its benefits, and in that case the depreciation that it causes is property amortized *subsequent* to the fact. But economic improvement from *without* an organization results in a depreciation that should be insured against, as far as possible, in *advance* of the fact.

Every industrial invention is a gain to society at large, but whether it is a gain to any particular group of men depends upon their partial or complete protection from the competition with the invention for a period of time. In the absence of such protection, an invention may cause great loss of property to some men.

When through the enjoyment of a franchise or of an established business, or both, a public utility company has gained the protection that a partial monopoly secures to it, the custom has been to amortize functional depreciation *after* its occurrence. This is entirely defensible, either as an economic or an ethical proposition. Where such a policy has existed, it is certainly not ethical for a government to change the policy by a sudden fiat, thus depriving a company of the opportunity to amortize its functionally retired plant units. And even were it ethical to do so, it would be uneconomic for a government thus to destroy a company policy by fiat, for the inevitable result would be to stop almost every effort to economize further. Certainly no company would initiate improvements under such conditions and it would be equally certain to put every obstacle in the way of improvements initiated by others.

DEPRECIATED PLANT VALUE ONLY A PART OF TOTAL VALUE.

Plant value is a function of the net earnings derivable from the operation of the plant. By assuming the gross earnings to be constant (that is, not affected by changing the plant), we have deduced a rational formula for ascertaining the depreciated value of a given plant unit. Observe, then, the absurdity of reducing rates of charge so as to yield only normal interest on depreciated value. A company devises a new plant unit of a given class for the purpose of reducing operating expenses. It thereby destroys most of the value of its old plant units of that class. But it does so because of the enhanced value given to its entire property by virtue of increased net earnings. Then comes a rate regulating commission and cuts rates so as to confiscate these increased profits, upon the theory that the commission is concerned with present conditions and present values of *plant only!*

It is asserted that to capitalize profits involves circular reasoning in fixing a rate making value. *But it is entirely overlooked that depreciation due to invention and inadequacy is itself a function of profits.* If there were to be no increased profits as a result of invention and better engineering design of plant, then economic progress would halt and functional depreciation would cease.

Functional depreciation caused by a company itself is irrevocably tied to appreciation of its prospective profits. Those who contend that profits cannot affect rate making value do not understand the full significance of the term value. That this ignorance exists may be shown in many ways. Thus, commissions have used "depreciated values" as a base for rates, although most of the depreciation is functional and caused by the company's own efforts; and functional depreciation is dependent on profits.

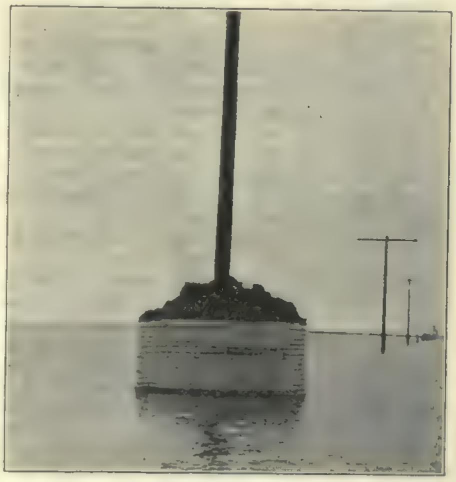
Most appraisers assert that they do not re-engineer the plant they are appraising. They estimate the cost of reproducing the "identical plant" and therefrom deduct accrued depreciation. But when they deduct depreciation, most of it is functional depreciation, and they seemingly fail to realize that they are thus re-engineering the plant.

From the foregoing discussion it should be evident that only *natural* depreciation should be deducted if the "identical plant" theory of appraisal is adopted. If functional depreciation is deducted, then assuredly functional appreciation should be given due consideration. If, for example, a railway has built a cut-off line and abandoned an old line, it has done so because the functional appreciation due to the cut-off is greater than the functional depreciation due to abandoning the old line. Hence, if the cost of the old line is to be deducted from the total property value, an even greater sum should be added to cover the appreciation in value consequent upon the building of a cut-off line that reduces operating expenses. In short, commercial values cannot be disregarded in an appraisal if there is to be a rational result.

Corrugated Iron Protectors for Transcontinental Telephone Line Poles in Lake Humboldt, Nev.

(Staff Article.)

The use of a corrugated iron protector, rock filled, in crossing Lake Humboldt, Nevada, with a line of telephone poles, was one of the measures adopted by the engineers of the Bell Telephone Co. to make possible the recent initial telephone conversation between New York City and San Francisco. The line construction problem thus solved is frequently encountered by those who have to do with the maintenance of transmission lines of any sort crossing bodies of water subject to the destructive action of running ice.



View of Rock-Filled Galvanized Iron Crib Around Telephone Pole in Lake Humboldt, Nev.

The waters of Lake Humboldt are shallow. Ice forms to a considerable thickness and poles set in the ordinary manner are often deflected or overthrown by ice floes. Ten of the poles in the lake were surrounded by protectors made from Armco corrugated culvert material 89 ins. in diameter and 4 ft. in height. Twelve gage material was used. The protectors are rock filled as shown in the accompanying view. This construction provides an effectual protection against the grinding and racking action of moving ice. The high purity iron is comparatively little affected by corrosion. In some places it might be advantageous to substitute a lean concrete for the rock filling here shown.

Carrying Suggestions Over Heads of Local Managers to General Managers.

To the Editor:—In a recent editorial you referred to a certain principle of management which you call "credit to whom credit is due." The statements made were prompted by the circular letter sent out to the salesmen of "The United Cigar Stores Co.," in which the management invited letters of suggestion and criticism referring to company business, to be sent direct to the general offices over the heads of salesmanagers.

The action of the president of the United Cigar Stores Co. seems so unusual that the results should be watched with interest. This plan has often proved a complete failure when tried out and a careful study of the situation fails to disclose a sufficiently convincing argument in its favor. The one point of advantage attained by this proposed wholesale co-operative management is the receipt of valuable suggestions from subordinates which might otherwise fail to obtain recognition from officials in direct charge.

The disadvantages resulting from the adoption of such a plan are too numerous to enumerate and discuss in one paragraph. In the first place what must we assign as the duties of the executive head of a large organization and the chiefs of various departments? Are they to be burdened with details, or should they direct only the general policies of the corporation? The judgment of these men is based on their experience and facts and figures presented to them by trusted and competent subordinates. In gathering this information the sub-chief may act in any one of three ways: First he may accept the suggestion of an employee, act on the suggestion and give due credit to the originator; second, he may act on the suggestion and accept credit himself; or third, he may turn down the suggestion altogether.

Suppose after an idea has been refused by a department head, the originator writes a letter to the general office stating his case, what is the result? The following four conditions then obtain:

First: The general officer becomes entangled in a mass of detail in order to pass judgment on the merits of the case. An executive who can justly glean the wheat from the chaff by investigating the correspondence of chronic kickers should be classed as a very industrious man of unusual judgment and patience.

Second: The general officer loses confidence in the sub-chief.

Third: The sub-chief knows although he may have acted in good faith that he has lost the confidence of the men under him.

Fourth: Every man in the organization knows he will be protected in trying to further his own ambition at the expense of others. Too many employees of deficient mental and productive powers are willing to hatch a new scheme to court the favor of those higher in authority. If these men know that scheming is encouraged, their efficiency is greatly impaired due to energy misdirected and alien to the work at hand. The spy system does not promote confidence and good feeling.

The case of The United Cigar Stores Co. is an exception. These salesmen are scattered, usually well educated and students of human nature. With such a loose organization and excellent personnel many pitfalls might be eliminated.

One of the most serious problems to be considered in connection with this subject is the question of responsibility. If the department head is held strictly responsible all his tools are taken away when his discipline and authority are destroyed. He is the man most thoroughly cognizant of local conditions, facts and temperaments, and his judgment should be trusted in matters of policy. If such a man is not competent replace him with all justice to the man and the firm.

We must remember that there are two kinds of criticism, constructive and destructive. The average worker capable of constructive criticism will be affable and diplomatic enough to have a perfect understanding with the man in charge and will not deem it necessary to write letters of suggestion to the general office.

There are many other angles to be considered in the problem of maintaining an efficient organization, such as the encouragement of invention, just compensation and the reward of merit. We fail to see, however, how the proposed scheme of The United Cigar Stores Co. can produce the desired results.

Yours very truly,
RALPH DARE BROWN,
Assistant General Superintendent, O'Gara Coal Co.
Harrisburg, Ill., June 25, 1915.

Bulk Cement for Small Repair Work.

(Contributed).

When the method of shipping cement in bulk was introduced, cement users felt that it was only feasible for large construction enterprises where expensive equipment for receiving, unloading and handling would be practicable, but experience shows the simple methods that have been used for storage of sand, gravel and lime would be applicable to cement with only slight changes. An instance is the use of bulk cement at the Donora plant of the American Steel & Wire Co.

Prior to receipt of the cement, Mr. J. P. Clark, superintendent of the plant, had erected a bin with the floor sloping towards a discharge gate and chute on one side and with a doorway on the track side through which the cement could be shoveled. Between one-half and three-quarters of the car was unloaded by shovels direct from the car into the bin, but that portion in the ends of the car was shoveled into buckets and carried to the car door where it was dumped into the bin.

For handling the cement from the bin to the work a double handled box carried by two men was found advantageous. This proved economical, as they could take the shortest possible course from the bin to the work regardless of railroad tracks or other obstacles. For large quantities hand carts or mule drawn buggies were used.

At the time of mixing, the cement was measured by volume in the same way as the other ingredients of the concrete. Accurate records of the expense of handling this material in this manner show the following advantages: 1. The sacks are not held for from one to three months at a considerable carrying expense. 2. With no sacks to return there are no freight charges to pay and no loss due to theft or carelessness. 3. Actual cash saving of 2 cts. per barrel on the invoice price over cement in sacks. 4. Total saving of between 7 cts. and 12 cts. per barrel in favor of handling the cement in bulk.

Concrete Tests: Outline of Work in Progress Under Direction of Committee of American Society for Testing Materials.

The procedure which is being used in most of its investigations by Committee C-9, on standard tests of concrete and concrete aggregates, of the American Society for Testing Materials, was outlined in the report of this committee at the annual meeting of the society at Atlantic City, N. J., June 22-26, 1915. The committee's practice is to distribute test series to various college and commercial laboratories, accompanied by complete instructions. The arrangement of tests is such that each series is duplicated a number of times. The tests are designed to separate the individual variables, to determine the specifications for each function.

At the first meeting of the committee it was voted that the work of Committee C-9 and that of the committee on specifications and methods of tests for concrete materials of the American Concrete Institute be coordinated; and preliminary use has been made of the results of investigations made by the latter committee.

SUB-DIVISIONS OF COMMITTEE C-9.

The work of Committee C-9 has been divided among nine sub-committees, the following data referring to these sub-committees and to the work of each:

Sub-committee 1 is in charge of the finances of the work.

Sub-committee 2 on Laboratory Tests for Concrete and Laws of Mechanical Mixtures.—This sub-committee has outlined certain tests on concrete and mortars with the object of establishing the best practice in making and testing concrete specimens in the laboratory, and to determine the effect of variations in the gradation of sizes of the aggregates on the strength and properties of concrete.

The following series of tests have been outlined as a part of the necessary investigations:

1. Comparison of metal and wood forms for standard laboratory tests of concrete.
2. Variations in strength and properties of concrete throughout the batch.
3. Effect of different methods of tamping and compacting.
4. Effect of condition of storage of specimens for standard compression test of concrete.
5. Method of capping test specimens preparatory to testing.
6. Effect of gradation of sand.
7. Effect of varying ratio of fine to coarse aggregates.
8. Effect of varying sizes of fine to coarse aggregates.
9. Strength of mortar as affected by the form of the test specimens.

Sub-committee 3 on Sampling and Testing Field Concrete.—In laying out the work of this sub-committee it was found that on a number of the larger concrete jobs field tests are being made, but there seems to be no uniformity of practice in making, storing, and testing the specimens. It was deemed wise, therefore, that this sub-committee select tentatively a method which seems to have the most merit, and recommend that wherever possible such tests be made.

The following tests have been outlined:

1. Comparison of four methods of storage during the first two days after molding.
2. Comparison of methods of storage subsequent to first two days.
3. Study of the cold weather effect on field specimens.
4. Comparison of prisms made in the field and in the laboratory with prisms cut from work.
5. It is considered within the realm of possibility that a portable core drill can be made to use in cutting test specimens from concrete already in place in the form of 6x12 or 8x16-in. cylinders.

Sub-committee 4 on Relative Values of Various Strength Tests.—In the field to be covered by this sub-committee there are certain fundamental problems which it is felt should be investigated as soon as possible. These may be stated as follows:

1. To establish the relative reliability of mortar strength tests for determining the suitability of sand for use in concrete.
2. A determination of the most desirable size and shape of mortar test specimens and the relation of tension to compression.
3. A determination of the most desirable size and shape of concrete test specimens.

Sub-committee 5 on Impurities Affecting Fine Aggregates.—The work of this sub-committee is as follows:

1. In securing samples of fine aggregates which have shown abnormal results when used for concrete.
2. To make tests on the samples secured with the view of determining the cause of the peculiar action noted.
3. To find, if possible, an economical corrective for such peculiarities.

In order to secure samples for this investigation, letters were addressed to a large number of persons throughout the United States and Canada, who it was thought might be able to assist in supplying samples of sand which would be of economic importance if the impurities could be removed. Considerable information has been collected concerning sands of this kind. Several samples have been received and are now being subjected to preliminary tests. The tensile and compressive strengths of mortars made from each of these sands will be compared with mortar from standard Ottawa sands, using various brands of Portland cement. Chemical analyses will be conducted on the foreign material in the sands, and an effort made to discover some method of treatment which will remove the defects. In searching for a corrective, the commercial aspect of the problem will be kept constantly in mind so that the method of correcting used for each sand will be practical and the most economical one available.

Owing to the extremely technical nature of the tests involved in this investigation, a chemist has been employed by the committee to carry out the chemical work under the direct supervision of one of the members of this sub-committee.

Sub-committee 6 on Methods of Tests for Voids, Weights, Density, Specific Gravity and Consistency.—In the standardization of certain of these tests the committee is co-operating with other committees of the society in order to arrive at specifications which will apply to all classes of work. The first series of tests laid out has been with reference to methods of determining weights and voids.

The variables to be standardized are: (*a*) size of measure; (*b*) method of filling; and (*c*) condition of sand.

(*a*) Four sizes of measures are being tried of the following capacities: 100 cu. cm., 1,000 cu. cm., ¼ cu. ft., and 1 cu. ft., in order to find out whether it is necessary to make weight determinations on a large sample, such as ¼ cu. ft. or more. If smaller measures, such as 100 cu. cm., or 1,000 cu. cm., give equally concordant results, they will be more easily used in the laboratory. The two larger sizes of measures are being tried in cylindrical and cubical shapes.

(*b*) Seven more or less different methods of filling the measures are being tried out. Each method as outlined has been in use by laboratories testing sand and each gives results differing more or less from the others.

(*c*) Two sets of determinations on condition of sand are being made; one with the sand dried at room temperature, the other with damp sand. Samples of two kinds of sand have been furnished by the committee to those performing these tests.

Sub-committee 7 on Methods of Tests of Coarse Aggregates.—The work of this sub-committee is the investigation of methods of tests to determine the suitability of coarse aggregates for concrete to be used under varying conditions.

Sub-committee 8 on Available Aggregates for Concrete.—The work of this sub-committee is the compilation of localities throughout the United States where concrete aggregates are available. The co-operation of geologists of the United States Government in the various states will be solicited and also the assistance of engineers.

Sub-committee 9 on Definitions.—The work of this sub-committee is as follows:

1. To collect as many of the definitions as it can secure which are pertinent to the work of Committee C-9.
2. To endeavor to secure the co-operation of all committees pertaining to concrete or correlated subjects of the various engineering societies in this country, with a view toward standardizing definitions pertaining to the testing of concrete and concrete aggregates.

Rifled Pipe.—Rifled pipe is used for conveying heavy oils, which, in some districts are so heavy that they are referred to as "liver" oil. In pumping the heavy oil a certain amount of water is added. The rifling of the pipe produces a centrifugal action of the oil and water, and the latter, being the heavier, is forced against the wall of the pipe and thus acts as a lubricating film, or carrier, for the heavy oil. As a consequence, the friction of the water enveloped oil is much less than would be the case with unmixed oil.

WATER WORKS

Locating Ground Water Supplies—Design, Construction and Cost of Works for Their Development.

(Staff Abstract.)

In all parts of the country there is a noticeable tendency to turn from surface to ground water supplies to escape the expense of filtration. In some parts of the country the location of ground supplies is comparatively easy, but generally it is a difficult task. The present article contains many valuable suggestions relative to the procedure used in New England in locating ground water supplies and on the design and construction of works for developing such supplies. There are also given some useful cost data on dug and tubular wells. This discussion and these data supplement the article entitled: Data on the Cost of Installing Small Water Works Systems in Massachusetts, published in this journal of May 26, 1915.

At the present time, of the 208 cities and towns in Massachusetts which are supplied with water from public works, about 100 are supplied either wholly or in part from ground water sources. In the main, it is the smaller places which are so supplied; but the city of Lowell, the fourth city in Massachusetts, is supplied entirely from ground water sources, as are the cities of Newton and Waltham, while in other parts of the country very large supplies have been developed.

When ground water supplies first began to come into general use our knowledge in regard to them was very meager. We were dependent upon the expert with the witch-hazel stick or upon the advice of the well driver, and usually the opinion of one was just as good as that of the other. The records of failures of ground water supplies have been numerous, but in Massachusetts they are nearly all those supplies which were installed before the investigations of the State Board of Health were begun. This work, started about 25 years ago, has been brought to an exact science under the direction of Mr. X. H. Goodnough. Chief Engineer of the Board, so that it is possible to predict almost with certainty the quantity and quality of the water which can be obtained from the ground; and the application of this knowledge has prevented many costly mistakes by municipalities introducing water supplies.

There is another expert, however, who perhaps has done as much harm as the man with the well-driving apparatus or the witch-hazel stick, and this is the theorist who figures out the coefficient of friction in the soil and velocity and hydraulic gradient of the ground water and determines with nicety just how much water can be obtained from a given source. For such soils as we have in New England, at least, such work is a waste of time and absolutely worthless. The soil varies so in every foot that to obtain results which are accurate to any reasonable degree would require investigation of the soil by means of test wells much more extensive and expensive than would be required to determine first hand, by actual experiment and without any figuring, what the ground will yield.

SPRINGS, DEEP AND SHALLOW WELLS AND FILTER GALLERIES.

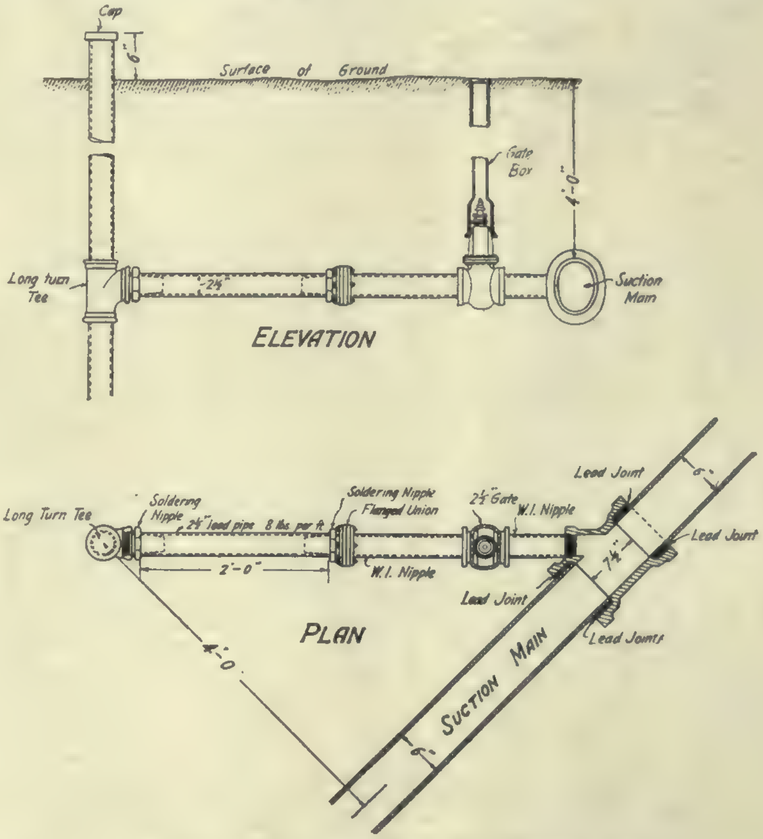
Ground water sources may be roughly divided into springs, deep wells (sometimes called artesian wells), shallow wells and filter galleries.

Deep Wells.—With the deep wells we have very little concern. It is sufficient to say that there are very few deep wells in New England which supply a sufficient quantity of good water to be of any assistance in connection with a public water supply system. In Massachusetts, probably hundreds of thousands of dollars have been spent in driving deep wells with a view to securing public water supplies, but there is not one really successful well to show for all of this money.

Springs.—Springs are ground waters which come naturally to the surface of the ground, and these generally furnish an excellent quality of water. There are few problems connected with the development of such a supply, as the quantity of water which the spring will yield can be seen and measured and there is no reason why its quality should change from time to time. If, however, the spring is developed by putting in a well or wells, the conditions may be very much changed and the supply would then be treated in the same manner as one which is secured from shallow wells.

Shallow Wells.—Shallow wells are those usually not more than 30 or 40 ft. in depth, obtaining most of the supply from rain water which has entered the ground in the immediate vicinity, although they are frequently supplemented by water which is obtained from some nearby stream. To obtain a satisfactory supply from shallow wells it is necessary that there should be an area with pervious soil near the surface which will absorb a considerable portion of the rain which falls upon it, and there should also be a stratum of pervious soil at a reasonable depth which will collect this water. If this deeper pervious stratum can be penetrated by wells, a supply of water will be secured.

Filter Galleries.—Filter galleries or filter basins are those which derive a considerable portion of their supply by filtration from some adjacent surface source, and they are usually not far beneath the surface of the ground. The proportion of the water obtained from the surface source varies greatly, in some cases being nearly the entire supply. In a few cases the yield of wells or filter basins has been increased by discharging water on the surface of the ground in the vicinity, thus creating what might be termed an artificial ground water. This was done recently in Greenfield, where a well was sunk in a small sandy area near Green River and a dam constructed across the river to divert river water to the sandy land around the well.



Details of Pipe Connections for a Driven Well.

TESTING FOR QUANTITY IN MASSACHUSETTS.

Cases have been found where one well yields as much water as many wells driven in the vicinity. Such a case has recently occurred in New York, where 10 wells were driven, each of which when tested alone gave a good yield. These wells were connected up and a pumping plant installed of sufficient capacity to pump as much water as was expected from the combined wells, but the result was that no more water was obtained from the group of wells than was obtained from the first test well driven.

While experience in these matters will give very much assistance, the only certain way to determine how much water may be obtained continuously at any particular place is by means of tests. The pumping test, as it has been developed by the engineers of the State Board of Health, consists in driving tubular wells and testing each individually until enough good wells are found to yield water at a rate at least as great as will be required for the completed works. These wells are then connected up with a pump, and water is drawn from them continuously for a period, the length of which depends upon the results which are obtained. Observation or witness wells are driven around the area from which the water is being drawn, and a record is kept of the height of water in the ground at frequent intervals. After the pumps are stopped, the observation of the height of water in the wells is continued until the original level is practically reached or the level of the water becomes nearly stationary.

With the results of such a test it is possible, allowing for the difference in yield in a dry season and a wet season, to predict with a considerable degree of certainty the quantity of water which can be obtained from the source.

The necessary duration of a pumping test is generally from one week to two weeks, although there are times when a test of a week is unnecessary and again there are times when a much longer test is desirable. The test usually ceases when the water in the ground reaches a state of equilibrium, or if, after pumping for one or two weeks, the ground water level still continues to go down at a rapid rate.

One of the serious disadvantages in selecting a ground water supply is that expensive tests must be made before it can be located, whereas with a surface water supply the source can be selected before going to any considerable expense. When a water supply is being considered in a town the money for tests is obtained with difficulty and it is next to impossible to convince a committee that a thousand dollars put into a test will be money well expended, admitting as one must that as a result of the expenditure there may be nothing to show except failure.

The preliminary investigations for a ground water supply cost from $500 upwards. Many times the first location tested proves satisfactory and the cost is comparatively small. Such was the case recently at Duxbury, where the first wells driven proved absolutely satisfactory. On the other hand, in cases like Bedford and Norton, very extensive tests were required before a suitable supply was secured. The cheapest complete test of which the author has record was at Ashland, where the driving of the wells and the conducting of a pumping test was done for about $225. This was possible, however, only by the use of a borrowed pump and the services of citizens who volunteered to operate the pump during the test without expense to the town, such was their enthusiasm in getting a water supply. The cost of the test, of course, varies with the size of the plant required, but for a test of from 200,000 to 400,000 gals per day the wells and the connections will cost in the vicinity of $500, and conducting the pumping test will cost about $30 per day of 24 hours, making the total cost of pumping test of a duration of 10 days a little less than $1,000. The wells used in the test can generally be made a part of the permanent works if the test is successful.

Sampling for Quality During Pumping Tests.—One of the most important functions of the pumping test is to determine the probable future quality of the water. It is possible to determine what the quality of the water is in its natural state as it flows through the ground by means of samples collected from test wells. This is the quality of the water which will be secured if the water should come to the surface of the ground in the form of springs. When, however, the water is pumped from the ground, the conditions are changed very materially. The surface of the ground water is lowered, which tends to draw toward the wells water from a different area from that which would flow to this point naturally. If there is a body of water in the vicinity, the lowering of the ground water level will tend to draw water from this surface source, and the rate of infiltration will increase as the ground water level is lowered, thus producing entirely different conditions from those which naturally exist This difference in conditions when water is pumped has been responsible for many of the troubles which have occurred with ground water supplies.

While the pumping test is in operation, samples for chemical analysis are collected at least once each 24 hours, and so delicate is the test that it is possible to foretell whether there is likely to be trouble with the water in the future. An increase in the iron or in the free ammonia, as the test progresses, is a sure indication of future trouble, although the trouble may not be serious for several years.

In certain soils it is almost impossible to get clear samples when pumping with a hand pump attached to a well, and the turbidity cannot be entirely removed by filtration in the laboratory. Turbid samples generally show iron, and this iron may not be present in the water itself and would disappear as soon as the water came perfectly clear. Cases have been known where this turbidity has remained for several days after water has been drawn continuously from the wells, and the iron content has been high; but eventually water free from iron has been obtained.

RELATIVE MERITS AND COSTS OF DUG AND DRIVEN WELLS.

As to the relative merits of driven wells, dug wells or filter galleries, there is no question but that the dug well is the most satisfactory, provided the conditions are favorable and if the expense is not too large. Where water is obtained from some neighboring water source and the depth of porous material is small, a filter gallery parallel to the shore of the surface source may be desirable. Where the water-bearing soil is at some considerable depth it is almost invariably much cheaper to obtain water by means of tubular wells.

TABLE I.—COST OF DUG WELLS.

Place.	Year built.	Depth in ft.	Diameter in ft.	Cost.
Bedford	1909	21.0	20.0	$3,981
Avon	1895	22.0	20.0	3,317
Canton	1889	29.0	40.0	8,555
Cohasset	1909	33.67	25.0	3,500
Greenfield	1913	31.0	40.0	7,850
Henniker, N. H.	1914	25.15	20.0	2,141
Manchester	1892	29.0	32.0	10,476
Marblehead	1912	31.0	25.0	6,100
Middleborough	....	22.0	26.0	4,964
Waltham	....	18.0	40.5	8,940
West Warren	1913	18.0	20.0	3,800
Winchendon	1911	35.0	40.0	7,815

Between these two extremes the best method to adopt must be determined by local considerations, One of the advantages of the dug well is that there is a large body of water in store from which to draw while the pumps are being run, and when this is exhausted the well has the time until the pumps are next operated to recover. This means that pumps of larger capacity can be used than with the driven well plant. Furthermore, under these conditions the average suction is likely to be less, as in the case of driven wells the ground water level at the wells goes down quickly when the pumps are started. Perhaps the chief advantage, however, of the large well is the avoidance of troubles from sand and air which are likely to occur in any driven well plant.

Another type of well, used considerably abroad, and to some extent in this country, is a large pipe 6 ins. or 8 ins. in diameter, which is driven into the ground and water is drawn from this well by means of a smaller pipe inserted in the larger one. This avoids the troubles with air and sand to a very large extent, but is, of course, somewhat more expensive.

TABLE II.—COST OF TUBULAR WELLS.

Place.	No. and size.	Depth, in ft.	Cost of wells.	Cost per well.	Cost, including suction to pumping station.
Ashland	12—2½ in.	25-32	$1,267	$105.50	$1,460
East Brookfield	9—2½ in.	20.7 av.	604	67.20	....
East Douglas	9—2½ in.	.....	....	....	629
Duxbury	22—2½ in.	27.8 av.	....	....	3,324
Littleton	10—2½ in.	22 av.	....	....	2,000
Merrimac	18—2½ in.	35 av.	....	....	3,100
North Chelmsford	20—2½-in.	30 av.	2,800	140.00	....
Oxford	15—2½ in.	24-28	....	....	800
Pepperell	34—2½ in.	19-28	2,704	79.50	3,200
Plainville	11—2½ in.	25-50	4,500	....	....
Uxbridge	16—2½ in.	26-35	1.800	112.50	....
Wrentham	9—2½ in.	29 av.	1,048	116.50	....
Wrentham State School	6—2½ in.	.....	680	113.20	....
Fairhaven	30—2½ in.	22½ av.	2,040	68.00	5,645
Wareham	12—2½ in.	39 av.	1,160	97.00	....

A modification of this type has been used with very good success in two or three installations in this vicinity, by the Hanscom Construction Co. Sections of cement pipe or of tile pipe 2 ft. in diameter are sunk by dredging on the inside of the pipes to the required depth. Water is drawn from these by means of small suction pipes connected up as in the case of tubular wells. These wells are comparatively inexpensive and have proved very successful, avoiding most of the troubles which occur with the ordinary driven well.

The cost of a system for collecting ground water varies greatly with the local conditions. Tables I and II give statistics in regard to the cost of dug wells and of recent installations of systems of tubular wells.

CONSTRUCTION OF WELLS.

The construction of tubular wells and the method of making connections with the suction pipe are of the greatest importance, as the leakage of a small quantity of air will cause endless trouble; and it is also desirable that it should be possible to cut out any particular well from the system.

The usual size of driven wells in New England is 2½ ins. The adoption of this size is simply the result of experience, as it is found that this is about as large a pipe as can well be driven under ordinary conditions, and it is, of course, desirable to have the pipe as large as is feasible. For the well, an extra heavy wrought-iron pipe should be used, as in the process of driving the pipe receives very hard treatment and it requires a heavy pipe to stand the strain. The pipes are driven with open ends except in the case of very fine sand, when strainers have to be resorted to. The bottom length of pipe is perforated with a large number of small holes about ¼ in. in diameter for a distance of perhaps 2 ft. from the end of the pipe.

The two methods of driving the pipes most commonly in vogue are the use of a tripod carrying a pulley block over which the rope carrying the driving weight passes to men standing on the ground, and the use of a platform, clamped to the well casing above the ground, upon which the men stand and lift the driving weight by hand. The use of the tripod is the simpler, but the platform has the advantage of carrying the weight of the men upon the pipe, which assists materially in sending the pipe down with each blow. It would seem that raising the weight by a rope would be much easier for the men than to stoop and lift the weight as is necessary with the platform. Men, however, incline toward the platform method.

After the pipe is driven and washed out, it is cut off at the level at which the suction is to be placed. A long-turn T is put on and then the pipe is continued up to somewhat above the surface of the ground, the object of the extension to the surface being to provide access to the well for cleaning out, as sand is likely to work into the pipe. The well is then connected to the suction with 2½-in. pipe and a lead gooseneck, each connection being provided with a gate so that it can be shut off in case it gives trouble. The object of the piece of lead is to give flexibility to the connection and prevent danger of leakage. A good design for pipe connections for a driven well is shown is plan and elevation in the accompanying cut. There is always a certain amount of sand finds its way into the water, and to prevent this from getting into the pumps a sand chamber is put on the suction. This sand chamber is simply a large chamber in which the velocity of the water is sufficiently checked to permit the sand to drop out of the water.

Air is one of the great troubles in a driven well system, and in some cases pumps are installed which operate automatically to remove the air either from the top of the sand chamber or from a special air chamber constructed for the purpose.

Ground water is likely to be of satisfactory quality if it does not contain iron or manganese and if it is not hard. If the water is hard, it is probably not feasible to use it for domestic purposes. If it contains iron or manganese, it is perfectly possible to remove these substances and make the water of satisfactory quality. The filtration of a ground water containing iron is likely to be a much more simple and less expensive process than the filtration of surface waters, although the iron occurs in so many forms or in combination with so many other substances that it is impossible to tell in advance how simple or how difficult the process of removal is likely to be. In the case of Marblehead, for example, the iron is very readily oxidized and precipitated by simple aeration, and then the iron can be readily strained out by passing it through sand filters at a rapid rate. At Reading, on the other hand, the iron occurs in connection with organic matter, which makes it very difficult to remove, and it must be treated chemically. In Germany, where ground water supplies are very largely used, a large majority of them are purified on account of the presence of manganese or iron.

The failure properly to purify a polluted surface water is a serious thing, but the failure of plant filtering a ground water does not mean a possible injury to the users of the water, for the iron or manganese is harmless, and the worst that can happen is to serve water which causes rust spots in the laundry and has an objectionable appearance and taste.

PUMPING PLANTS.

Ground water supplies are usually found in locations where it is necessary to pump the water, and the pumping plant is an essential part of the development of a ground water supply. There are a few cases, like Monson, West Warren and Deerfield, where good ground water supplies are obtained by gravity; but such cases are very rare.

The development of the oil engine in connection with public water supplies is responsible in a very large measure for the increase of ground water supplies in recent years. The cost of construction and operation of a steam pumping plant is so great as to discourage a small town from installing a supply where these are necessary. The oil engine, however, is so much cheaper in first cost, and the cost of maintaining it is so small, that it is more economical to put in a pumping system and pump water from some nearby ground water source than to go to any considerable distance for a gravity supply. An article giving data on the cost of small pumping stations and the pumping machinery in these stations was published in ENGINEERING AND CONTRACTING of Sept. 30, 1914.

There are in many small towns, ground waters which can be developed to supply a considerable quantity of water which are so located that the water can be obtained by gravity, although the yield of these sources may be insufficient to supply all the requirements of the town. These ground water supplies may oftentimes be developed economically to supply a portion of the water required, and a small pumping unit can be installed to supplement the supply when necessary. Such installations have been put in recently in the Deerfield Water District and in Henniker, N. H. The gravity supply in these places is sufficient to meet all the requirements during wet seasons, and an inexpensive pumping unit supplies the deficiencies during dry times. The saving to the town in such cases over the cost of installing either a complete gravity supply or a complete pumping supply is very considerable, especially during the first years of the operation of the plant.

Ground water when exposed to light deteriorates very rapidly on account of the growth of microscopical organisms, and, in order to keep a ground water supply satisfactory, it is necessary to keep it from exposure to the light. Consequently covered reservoirs are absolutely essential. These reservoirs may be either standpipes or masonry structures, the latter being preferable on account of preserving the low temperature of the water.

ACKNOWLEDGMENT.

The foregoing data and discussion are taken from a paper before the Boston Society of Civil Engineers by Mr. William S. Johnson, Consulting Engineer, Boston, Mass. The full paper is published in the Journal of the Society for May, 1915.

Another Method of Constructing Logarithmic Charts for Hydraulic Formulas.

Contributed by Leo G. Hall, Seattle, Wash.

In Engineering and Contracting of March 17, 1915, an article was published entitled "Procedure in Logarithmic Diagram Plotting of Hydraulic Formulas," by Mr. Warren A. Lyon, in which Mr. Lyon describes a short method of plotting a certain kind of chart. It is the purpose of this article to show another type of logarithmic chart, and to describe the method of constructing it.

Williams' formula, which reduces to $Q = 1.29\,D^{2.668}\,H^{0.535}$, is plotted in the accompanying chart. In this case Q is the discharge in second-feet, D is the diameter of the pipe in feet, H is the loss of head in 1,000 ft. of pipe, expressed in feet.

The diagram is plotted on logarithmic cross-section paper, and much time will be saved if this can be purchased. But if not available in convenient form, a sheet can be ruled with the aid of a slide-rule, or a table of logarithms. If ruled on tracing cloth, and printed on Van Dyke paper, as many white prints as are needed can be printed from the Van Dyke print, and used without the trouble of ruling extra sheets. If these white prints are printed on Van Dyke paper, blueprints can be taken from them after the completion of the chart, as from a tracing.

Having the logarithmic paper, the next step is to compute and plot curves for the desired sizes of pipe. These curves are all parallel straight lines. Two points only need be computed, when the line can be drawn. After the first curve has been drawn, the others can

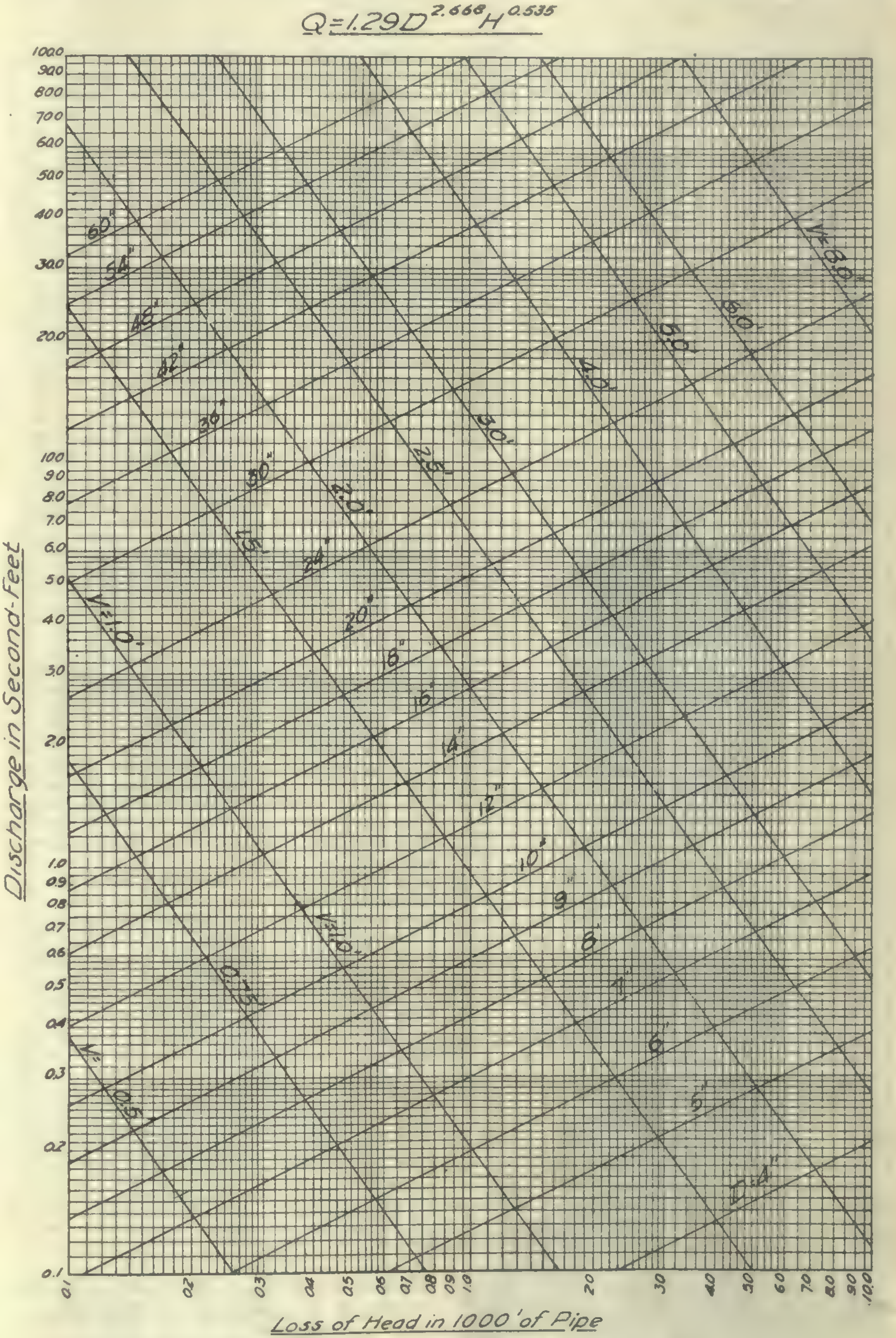


Chart of Hydraulic Properties of Wooden Stave Pipe of 4 to 60 ins. in Diameter.
(Shown to illustrate method of constructing logarithmic chart.)

be drawn from it with a parallel ruler, one point on each, only, being located.

In locating these points, it is well to choose points on the line, $H=1$. This does away with the handling of one fractional exponent in each equation, as any power of one, is one.

Handling the fractional exponents can be simply done by the use of logarithms. For instance, to find the value of $2^{2.668}$, look up the log. of 2, which is .30103. Multiply this by the exponent, and the product is .803148. Look up the number which corresponds to this logarithm, and you have 6.355, the required result. The multiplication may be done on the slide rule accurately enough for practical purposes.

When the 12-in. and 24-in. curves have been located, the 6-in. and 48-in. curves may be immediately located without solving the equation. This is by virtue of the fact that the distances of these curves apart form another logarithmic scale similar to the horizontal and vertical scales. For instance, the distance from the 12-in. curve to the 24-in. curve is equal to the distances between the 24-in. and 48-in. curves, or between the 12-in. and the 6-in. curves, measured along any ordinate. And when the 5-in. curve has been computed, the distances between the 5-in., 10-in., 20-in. and 40-in. curves will be the same as that from the 12-in. to the 24-in. curves. From this, after the 5, 7, 8, 12 and 24-in. curves are drawn, the entire series can be laid out graphically, without further solutions of the equation.

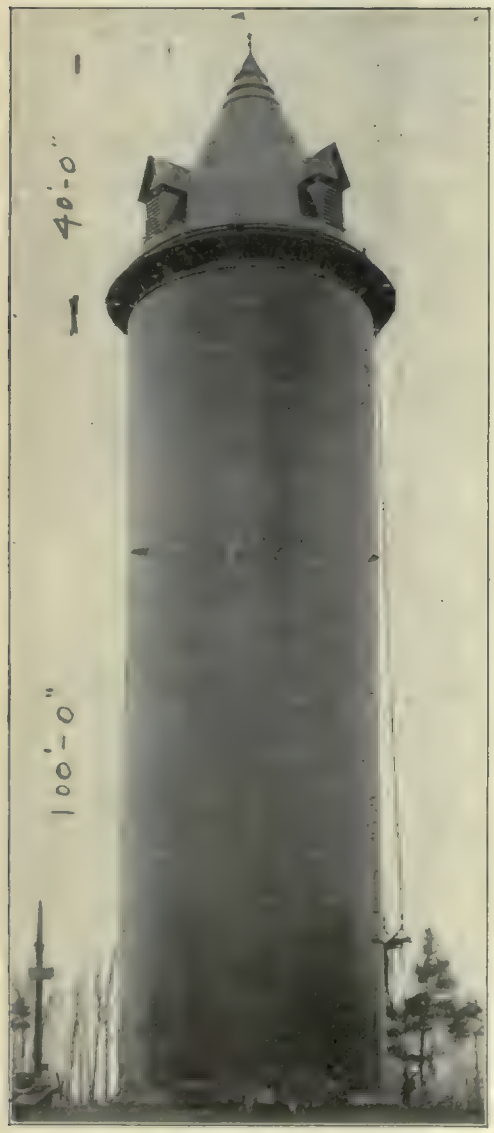


Fig. 1. View of Reading, Mass., Standpipe, Coated with Bitumastic Enamel.

The velocity curves are next drawn. These, too, are parallel straight lines, and can be drawn in the same manner as the first set from the formula, $Q=\frac{V\pi D}{4}$, using the diameter curves, and the discharge ordinates as reference lines. Points on the lines for constant velocity can be located by taking the velocity and assuming a constant value for D, then solving for Q.

When completed, the chart presents four series of ordinates. When values are given for any two of the ordinates, the point thus located immediately shows the values of the other two. When logarithmic paper is at hand, the entire chart can be drawn in about an hour's time.

Coating of Standpipes at Reading, Mass., and Baltimore, Md.

Contributed by Frank C. Perkins, Buffalo, N. Y.

Figure 1 is a view of the water works standpipe at Reading, Mass. This structure was coated with the special waterproofing materials manufactured by the Bitumastic Enamels Co. of 17 Battery Place, New York City. The internal surface from the base to the bottom of the peak received one coat of Bitumastic solution, applied cold, and one coat of Bitumastic enamel, applied hot. The inside surface of the peak received two coats of Bitumastic solution applied cold. The external surface from the base to the top of the peak received two coats of Bitumastic solution, applied cold. This standpipe has a diameter of 30 ft. and a total height of 140 ft.

Bitumastic enamel is coming to be recognized in this country as a very serviceable material by water works engineers. Its use abroad and in marine work is old—its use in American water works engineering practice is still comparatively new. The Board of Water Supply of the City of New York has used Bitumastic for protecting both the outside and inside of the Narrows Siphon of the Catskill Aqueduct under New York Harbor. This is a 3-ft. cast iron pipe line 10,000 ft. in length.

Bitumastic enamel is highly resistant to attacks by corrosive agencies. It has been tested in solutions of sulphuric acid, chloride solution and alkaline sulphate solution for 14 days at room temperature and was found to be unaffected. In using it no field coat of bituminous paint is needed at the joints or abraded points in the structure. Bitumastic is applied after riveting and is applied to sections of pipe lines before they are lowered into the trench, thereby avoiding the abrasion sustained in transporting shop-coated pipe. In cases of very large conduits the enamel is applied after laying.

Figure 2 is a view of the Roland Park water tower at Baltimore, Md. It is coated with Dixon's Silica-Graphite paint. It is claimed that on this structure the durability of this protective coating in the presence of moisture, gases and sea air has been proven.

In the manufacture of this paint the pigment of silica and graphite is not mechanically mixed. It is used just as it comes from the mines, after being properly ground, and pure boiled linseed oil only is used as the vehicle. The lubricating quality of graphite causes the silica-graphite to be easily applied, which saves in labor and brushes. The paint will not crack or blister and it is said to be suited to all climates, readily covers other paints and is one of the most durable protective coatings known.

Comparative Cost Estimate of Water Waste Prevention by Individual Meters and District Meters.

(Staff Abstract.)

There are many cases in which it would be difficult to make an equitable charge for water consumed unless the quantity were measured: these are industries, institutions, premises requiring water in very small quantities for sanitary purposes, and large consumers. But the large majority of consumers do not actually need much water, although it is well known that an inordinate quantity is used or misused. This has arisen in some instances from the fact that it was considered more economical to supply water than to check its consumption. In other cases it is due to indifferent management and neglect on the part of some of the water authorities until the waste has created serious disabilities.

There is now a general movement for the conservation of water, and the means usually taken is to install individual meters on all water connections. The object of this article is to discuss the question whether the general installation of individual meters or the provision of district meters and inspection is to be advocated as a means for waste curtailment.

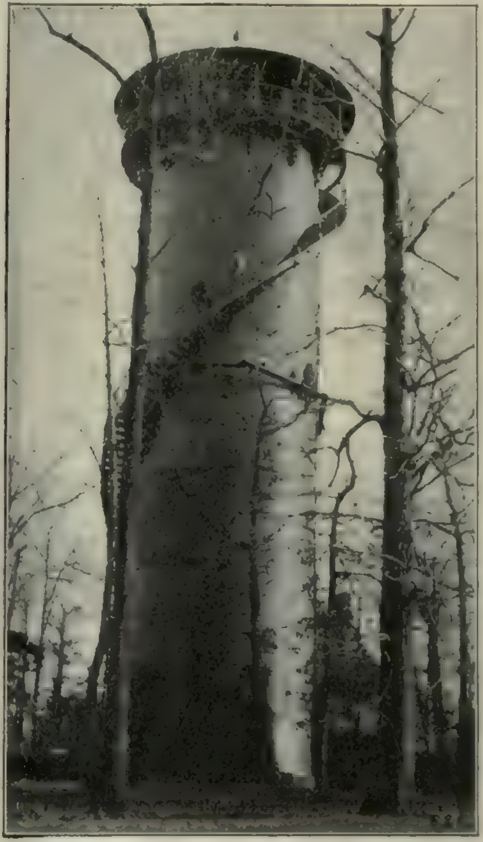


Fig. 2. View of Roland Park Water Tower at Baltimore, Md., Coated with Dixon's Silica-Graphite Paint.

Waste of water must be eliminated as far as is practicable and economical, for the keynote of successful management of all businesses is to stop leakages of all kinds.

Most cities are comparatively small and if it be assumed that the average size is about 20,000 population it will doubtless represent a large number of towns. The unrestricted total consumption is, say, 150 gals. per head daily. In such a city there would be about 3,500 water connections, and if all are metered there would be that number to fix and maintain. The water authority, to secure full control over the meters, would buy the meters and rent them out.

Adopting the careful analysis of costs made by the Wisconsin Railroad Commission and mentioned in their report of 1911, the average annual cost is as follows:

Labor, moving and resetting meters		$0.18
Labor, meter and fittings department		0.34
Supplies, meter and fittings department		0.12
Maintenance of meter		0.35
Reading meters and delivering bills		1.35
		$2.34
To these must be added		
Depreciation, say	$0.50	
Interest	0.36	$0.86
Per meter per year		$3.20

The cost of metering will fall on the consumers, and in this case it would amount to $11,900 per annum.

The cost of filtered water at the works will be about $3.50 per 1,000,000 gals.

Individual meters measure the water entering the premises and consequently constitute good waste detectors. The saving in the quantity of water used before and after installing meters varies greatly, but in all cities metering has effected a tangible reduction in the quantity of water pumped. Published figures are often misleading because the diminution in the quantity consumed by the people is often small compared to the losses from the mains. When the total quantity of water registered by individual meters is ascertained, the unaccounted-for losses amount to from 20 to 66 per cent of the total quantity pumped. It will be fair to expect 33 per cent reduction in the pumpage by universal metering. Supposing the head on the pumps is 100 ft. and the price of coal is $4 per ton, then the saving in fuel due to diminished pumpage will be about $1,200 per annum. The cost of labor will remain practically the same.

District meters could be installed in this city for about $3,000; a small number of individual meters would be required as explained in the commencement, and inspectors would be employed to make a systematic and frequent survey of the whole water works. The annual expenditure in this case would be as follows:

Interest on $3,000	$ 150	
Depreciation	150	
		$ 300
2 inspectors	$2,500	
Clerks, etc.	1,500	
		4,000
250 meters at $3.40		850
Miscellaneous		250
Total		$5,400

By careful and diligent inspection the pumpage should be gradually reduced to one-half, and the saving in fuel on the same basis as before would be $1,800.

The above estimate is a liberal one. The writer once had control of a water works and by the adoption of this method was able to supply the public on less than 30 gals. per head daily for all purposes. The railroad companies were large consumers. The London Water Board use from 1,300 to 1,400 Deacon meters to detect waste, and by discovering and localizing leaks the average supply is under 45 gals. per head daily. By means of a pitometer survey at Ottawa, Ont., leakages amounting to 5,300,000 gals., per day were remedied in a short time. Washington has in seven years detected leakages aggregating 40,000,000 gals. daily. Three permanent self-recording district meters have been installed in Regina, but systematic inspections have not yet been started. The records obtained from the district meters enable the officials to detect leaks and to localize them and by this means to keep the consumption at a reasonable figure. Such meters and records are a check on the pumps and on the daily occurrences in the district controlled.

The reduction of waste is equivalent to increasing the capacity of the water works to meet growing demands, and at a reduced cost or with an increased revenue.

Even in cities where the rate is fixed by the Public Utility Commissions and where individual meters are compulsory, district meters are essential to provide an efficient and economical system. With both individual meters and self-recording district meters the quantity of water necessary to satisfy all requirements should not exceed 50 gals. per head per day, except in special cases where the industrial consumption is abnormally high.

The financial situation as estimated in the foregoing illustrations will be as follows:

Individual Meters.

Cost of operation, $11,900.

Saving in fuel	$1,200
Value of water savel	1,277
	$2,477

District Meters.

Cost of operation, $5,400.

Saving in fuel	$1,800
Value of water saved	1,914
	$3,714

The differences between the estimated cost of operating the two methods and the savings effected by them are $9,423 and $1,786 respectively. The extra cost per water-paying consumer per annum is $2.70 and 52 cents.

ACKNOWLEDGMENT.

The preceding cost analysis is from a paper by R. O. Wynne-Roberts, consulting engineer, before the annual convention of the Illinois Section of the American Water Works Association.

Comparative Cost of Collecting Water Bills by Mail and By Collectors at Seattle, Wash.

(Staff Abstract.)

The suggestion is sometimes made that water departments could save money by using collectors instead of collecting water bills by a combination of the mails and receipts over the counter. Thus at Seattle one suggestion made by the citizens, with a view to the improvement of methods in handling the business of the department, was that the employment of collectors to go from house to house and render bills would be cheaper than the present method of mailing bills and receiving payment through the mails. Since this and other similar suggestions were made in a constructive spirit it merited and received careful consideration from the water department, of which Mr. L. B. Youngs is superintendent. The following cost analysis of the two methods of collecting was made:

As to employing collectors it is certain that the expense would be greater than collecting by mail, even when one takes into account the postage paid on remittances to the department by water users. An estimate of the cost of the present method was made in October, 1911, and the result was as follows:

COST OF MAILING 29,014 WATER BILLS AND RETURNING 4,536 RECEIPTS IN AUGUST, 1911.

29,014 accounts @ 2c each would be	$580.28
By grouping the bills payable by each firm the number of stamps required is reduced to 24,290 @ 2c each	485.80
Putting accounts in envelopes and assorting 5 days	16.35
Cost of 24,290 envelopes @ $2.00 per 1,000	48.58
Sealing envelopes with machine	2.00
Putting stamps on envelopes with machine, 15,000 per day	5.30
Postage on 4,536 receipts for checks received by mail	90.72
Putting receipts in envelopes, ¾ day	2.46
Cost of 4,536 envelopes @ $2.00 per M	9.07
Sealing envelopes	.37
Putting stamps on envelopes, 3-10 days	.98
Cost to consumer for mailing, if we assume that the cost to consumer for envelopes and time in sealing and putting on stamps is double that of the city, we would have:	
Stamps	90.72
Time and envelopes	25.62
Making a total monthly cost of	$777.97

An inspection of the above statement will show that the actual cost to the city per month of mailing the 29,014 accounts and returning the receipts is $661.63. The actual cost to the consumers for postage in mailing checks, plus cost of envelopes and time is $116.34.

It will be noticed that the number of users who pay by mail remittance is small as compared with the number of those who pay at the counter, so that users would save far less in postage and envelopes by having collectors call at their houses than might be supposed.

The number of accounts that one man could collect is estimated as follows:

Allowing a man 15 minutes to go from the office to his work, and three-fourths of an hour to come from his work to the office and check up his cash each evening, which he would have to do before the treasurer's office closed at five p. m., his working time would be seven hours a day. This is doubtless a high estimate of the hours that he could spend in the field. Taking into account the time lost in ringing door bells and waiting for admission, the time lost when people were not at home, the time lost in hunting them up at their offices and elsewhere, and the inevitable discussions and arguments about the amount of the bills, Mr. Youngs estimated that six minutes would on the average be consumed for each bill collected. This would be ten collections per hour or 70 per day or 1,820 per month per man, requiring the time of 16 men at $75 per month, or a total of $1,200. Add car fare $2.50 per month, and cost of bonds say $1.50 per month, and we have a total of $1,264 against a present cost of $777.97, a difference in favor of the present system of $486.03 per month or $5,832.36 per year.

If, under the personal collection system, only a few accounts were paid at the office the cashier might handle the work now done by the receipt clerk, thus saving the salary of one man. This would reduce the cost $1,080 per year, still leaving a balance in favor of the present system of $4,752.36 per annum.

ACKNOWLEDGMENT.

This information is taken from a historical, descriptive and statistical report on the Seattle Municipal Water Plant.

Types and Properties of Deep Well Pumps.

(Staff Abstract.)

The simple steam-driven pump is the simplest form of deep well pump. It consists of a submerged cylinder, hung from the well head by a drop pipe or expanded into the casing, fitted with foot-valve and screen, and containing the plunger and lift-valve. The plunger hangs by a string of rods, usually of wood, from the piston rod of a vertical double acting steam cylinder using steam non-expansively. Where the plunger rod passes through the well head there is usually a differential plunger to equalize the flow of water. This type of pump is "single stroke" or single acting, and its capacity for a given diameter of plunger depends on the speed and length of stroke. The stroke is usually 24 or 36 ins. The speed is limited to 15 to 30 strokes per minute, depending upon the depth and the delivery pressure, which affect the life of the valves and rods and the water ram in the distributing system.

The steam economy of this simple steam-driven deep well pump is very poor owing to non-expansive use of the steam. This is frequently a minor consideration because the total steam consumption is inconsiderable, but this consideration gives the "power-head" a title to favor.

The power-head drives the pump rods and plunger by a crank, connecting-head and cross-head with power received through belting or gearing from a gas, electric, or other motor more economical or convenient than the steam-head. The plunger stroke is not often greater than 24 ins., and the speed may be somewhat greater than that of the steam head by reason of the reduced plunger speed at the ends of the stroke. It is doubtful if there is much difference in capacity for the two types, all other things being equal.

Capacity is usually the most important single consideration. The two-stroke or double plunger and the three-stroke or triple plunger deep well pumps enable double or triple capacity, respectively, as compared with the single stroke pump, for the same permissible diameter of cylinder and plunger. In the multiple plunger deep-well pumps the several plungers work in the same cylinder, which is long enough to permit this, the plungers working one above the other. The rod for the lowest plunger is enclosed by, and works within, that for the next higher. Foot-valves may be dispensed with since each of the plungers serve in turn as the foot-valve of the other or others. The differential plunger at the well-head is not used.

The direct acting steam-head has been adapted to two-stroke pumps, as in the Downey pump. The power-head has been adapted to both types of multiple stroke pumps. Besides increased capacity, the multiple stroke gives a more uniform flow of water in the distributing system, and the strains on the operating head are less than in the one-stroke pumps, at the expense, however, of greater complication of the parts below ground.

Of the underground parts—drop-pipe, cylinder, foot-valve plungers and valves, and rods—all may, and sometimes do, contribute to the trouble score, but the rods are the worst offenders. Rod trouble is a minimum in single-stroke pumps where the rods are of wood with iron couplings, where the well is straight, and the speed low enough to let the rod and plunger fall freely.

In the two-stroke pump, the wear of the rods, both of which are metal, on each other, is bound to be considerable and usually is serious, particularly if the well is not straight, when the rods break frequently and must be withdrawn for repairs. The situation in this respect would be worse with the three-stroke pump.

All of the plunger-type deep-well pumps have to some degree the following disadvantages: 1. Limited capacity. 2. High maintenance of underground parts.

Where certain conditions, to be mentioned shortly, can be met, the air-lift pump will greatly increase the pumpage from a given well, provided the water is there, as compared with any plunger pump, and the underground maintenance cost is practically *nil*. The conditions to be met by the employment of the air-lift are: (1) That the well shall be drilled deep enough so that the air-pipe can be submerged below the pumping level of the water, a distance of 1½ to 2 times the height from the pumping level to the outlet of the delivery pipe, and (2) that secondary pumping is necessary for distribution in all but a very few exceptional cases.

The fuel cost of air-lift operation of deep-wells is high as compared with economically operated power-head plunger pumps, but the extreme simplicity of the well-parts of the former is worth much, particularly where the dependence is on a single well.

The elimination of secondary pumping, together with reasonable simplicity and durability of underground parts and relatively economical fuel cost, if the well or drop pipe is straight, can be obtained with the centrifugal type of deep-well pump. For surface delivery, as in irrigation, the pump may be of the impellor or of the turbine type. In either case the pumping element rotates on a vertical shaft suspended from the well-head. In the impellor type, the pumping element is much like a short section of a screw conveyor, and several of these elements are keyed to the shaft at intervals from below the pumping level to near the well-head. In some designs guide vanes are placed in the drop-pipe below each element.

In the turbine type the turbine to the necessary number of stages is hung to the bottom of the drop-pipe, and its rotor is driven by the shaft. In either type the shaft may be supported laterally by suitable guides with wood or other bushings.

For direct pressure service, a multiple stage centrifugal pump forms the well-head and "boosts" the water for distribution. The driving power may be belt, gears or direct connected motor.

The centrifugal deep-well pump can be designed for any reasonable pressure and can be run without special pressure control on direct pressure service.

ACKNOWLEDGMENT.

The foregoing discussion is from a paper before the Michigan Engineering Society by George W. Bissell, Dean of the Engineering Department of the Michigan Agricultural College, East Lansing, Mich., as published in the Proceedings for 1915.

BUILDINGS

Design, Construction and Detailed Costs of a Car Storage House in Council Bluffs, Iowa.

Contributed by W. L. Fulton, Chief Draftsman, Omaha, Neb.

The building which is described and on which cost data are given in this article was constructed by the Omaha & Council Bluffs Street Railway Co., at Council Bluffs, Iowa.

DESIGN FEATURES.

As shown in Fig. 1 the structure is in reality an extension of the existing car house, and was built to provide additional storage space required by the Council Bluffs lines. The outside dimensions of the building are 101 ft. 5 ins. by 250 ft. As it was an extension of an existing building its size and location, as well as the details of the track layout, were already determined. The design was further simplified since the offices, lobbies, club rooms, repair pit, etc., had been provided for in the original building.

The roof construction, trusses and columns of the car house were designed for a live load of 25 lbs. per square foot and a snow load of 15 lbs. per square foot, in addition to the weight of the structure. The allowable pressure on the soil was 2,500 lbs. per square foot. The allowable stresses in the steel reinforcement were: Columns, with reinforcement up to 1 per cent, 7,500 lbs. per square inch; main tensile reinforcement, 18,000 lbs. per square inch; and stirrups, 16,000 lbs. per square inch. The allowable compression in the concrete was 600 lbs. per square inch.

Brick and reinforced concrete were adopted as materials of construction. As the building was to be used only for the storage of cars, and therefore the usual clear space between cars not required, a row of columns was placed in each space between tracks, the resulting short spans effecting a considerable saving in cost. Figure 2 (a) is a floor plan of the structure, Fig. 2 (b) is a half cross section, and Fig. 2 (c) is a half south elevation. These drawings give the general dimensions and indicate the type of construction used.

The wall footings and the walls up to the grade line are of plain concrete. Above the grade line the walls are of brick and carry reinforced concrete beams which support the half span of the roof slab adjacent to the wall.

The column footings and columns are of concrete reinforced with straight rods. The columns were reinforced with four rods each, hooped every 12 ins. with ⅜-in. round rods bent and wired to place.

The concrete roof slab has a total thickness of 4 ins. The slab is supported by reinforced concrete beams extending from column to column lengthwise of the building and by reinforced concrete lintel beams extending along the edge of the slab entirely around the building. These lintel beams are supported by the brick walls, as noted above.

The roof is divided into three equal parts by expansion joints extending entirely across the building.

All reinforcing steel used was in the form of round corrugated bars.

CONSTRUCTION METHODS AND DETAILED COSTS.

Excavation.—The earth excavated from the footing trenches and pits was either back-filled or was distributed over the surface of the ground; no earth was hauled away. The total amount excavated was 233 cu. yds., and the total cost was $51.70, or 22.2 cts. per cubic yard. Laborers were paid 20 cts. per hour.

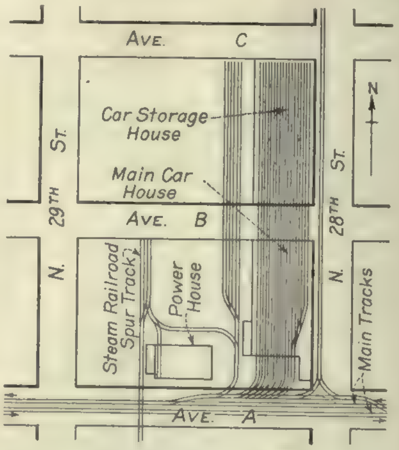


Fig. 1. Layout of Plant of Omaha & Council Bluffs Street Railway Co., Council Bluffs, Iowa.

Hauling Materials.—The cars of building materials were set on a steam railway siding about ¼ mile from the building site. Materials were hauled to the site in flat-bottom wagons of about 1-cu. yd. capacity. The teams stood idle while wagons were being loaded and unloaded, and the drivers helped in loading and unloading. At the building, the sand and stone were dumped on the ground, the brick was piled, and the cement was carried by hand into the storage shed. Table I gives the total and unit costs of hauling, the quantities of materials being as follows: Stone, 393 cu. yds.; sand, 124 cu. yds.; brick, 36,000, and cement, 470 bbls.

Laying Brick.—The walls were 13 ins. thick. The pilasters, which were 9x26 ins., were built as indicated on the floor plan (see Fig. 2). Common brick, laid in mortar composed of "Carney's" bricklayers' cement and sand (mixed 1:2), was used. The mortar was mixed by machine, and the brick and mortar were conveyed to the masons in wheelbarrows. The costs given in Table II cover the laying of 42,700 bricks.

TABLE I.—TOTAL AND UNIT COSTS OF HAULING MATERIALS.

Item.	Rate per hour.	Stone.	Sand.	Brick.	Cement.
	Total Costs.				
Driver and team..	$0.40	$70.60	$24.40	$22.00	$15.20
Labor	.20	18.10	4.00	12.00	9.60
Totals		$88.70	$28.40	$34.00	$24.80
	Unit Costs.				
Driver and team..	$0.40	$0.18	$0.20	$0.61	$0.03
Labor	0.20	0.05	0.03	0.33	0.02
Totals		$0.23	$0.23	$0.94	$0.05

Form Building and Demolition.—(a) *Forms for Walls Below Grade.*—The total length of these walls was 600 ft. and their height 4 ft. 6 ins. Pilasters 9x26 ins. were built, as indicated in Fig. 1 (a).

The forms were built in sections and were used three times. They contained 5,000 ft. B. M. of lumber. The forms for the pilasters were made of 1-in. lumber, and the remainder of these forms was built of 2-in. lumber, cleated together into sections.

TABLE II.—TOTAL AND UNIT COSTS OF LAYING BRICK.

Item.	Rate per hour.	Total cost.	Cost per M.
Foreman	$0.75	$ 41.25	$0.97
Building scaffolds......	0.25	15.50	0.36
Masons	0.675	182.90	4.28
Masons' tenders	0.225	39.10	0.92
Mortar mixer	0.225	11.25	0.26
Totals		$290.00	$6.79

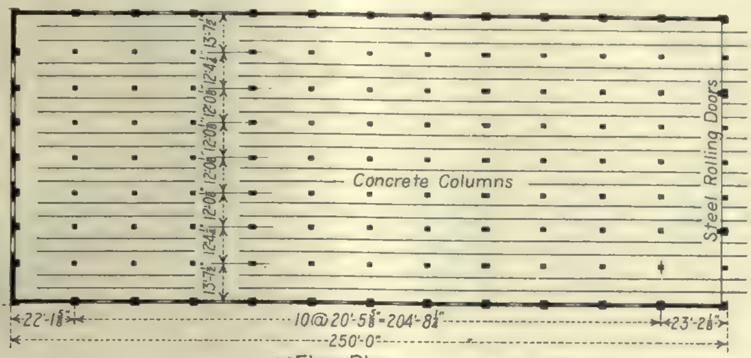
The total and unit costs of the forms for walls below grade are given in Table III.

Form Building and Demolition.—(b) *Forms for Columns, Beams and Roof Slab.*—The

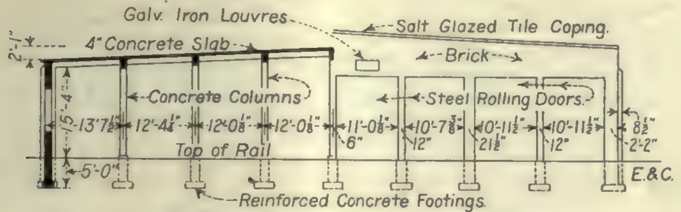
TABLE III.—COST DATA ON BUILDING AND MOVING FORMS FOR WALLS BELOW GRADE.

Item.	Ft. B. M.	Total cost.	Cost per M ft. B. M.	Cost per cu. yd. of concrete.
Form building...	5,000	$ 31.00	$ 6.20	$0.25
Moving forms ..	15,000	121.50	8.10	0.98
Totals		$152.50	$14.30	$1.23

column boxes were built of 2-in. planks, set vertically and clamped together. In the beam boxes the bottoms were of 2-in. planks, and the sides were of 1-in. shiplap. The floor of the slab forms was also of 1x8-in. shiplap. The forms were supported by the column boxes and by 4x4-in. shores set below the beam boxes and about 5 ft. apart. The joists under the slab forms were 2x6 ins., 16 ins. center to center, and they extended from beam box to beam box. The ends of these joists were supported by 2x4-in. cleats extending down the sides of the beam boxes to the bottom of the same, from whence the load was carried directly to the shores.



(a) Floor Plan



(b) Half Cross Section (c) Half South Elevation

Fig. 2. Floor Plan, Half Cross Section and Half South Elevation of Car Storage House of Omaha & Council Bluffs Street Railway Co.

The forms were used twice, and they contained 50,000 ft. B. M. of lumber. The parts were framed (cut and shaped) on the ground. The forms were built in place, and were put together in sections. Each section was about 6 ft. long, including the floor of the slab forms between the two-beam boxes, together with the adjoining sides of these boxes. A batter of ½ in. was given to the sides of the beam boxes. It was the intention of the contractor to remove the forms in sections by lowering them from between the concrete beams, on the assumption that the batter given to the sides of the beam boxes would be sufficient to allow for their removal in this manner. When is was attempted to take down the forms, however, it was found that it was impossible to remove them in sections. It was therefore necessary to tear them to pieces, and to erect them again in their new location.

TABLE IV.—COST DATA ON FRAMING, ERECTING AND DEMOLISHING FORMS OF COLUMNS, BEAMS AND ROOF SLAB.

Item.	Carpenters.	Helpers.	Total.
Framing 50,000 Ft. B. M.			
Total cost	$ 347.72	$ 12.00	$ 359.72
Per M ft. B. M.	6.95	0.24	7.19
Per cu. yd. of concrete	0.65	0.02	0.67
Erecting 100,000 Ft. B. M.			
Total cost	$1,043.04	$107.20	$1,150.24
Per M ft. B. M.	10.43	1.07	11.50
Per cu. yd. of concrete	1.96	0.20	2.16
Demolishing 100,000 Ft. B. M.			
Total cost	$ 335.20	$278.00	$ 613.20
Per M ft. B. M.	3.35	2.78	6.13
Per cu. yd. of concrete	0.63	0.52	1.15

The only labor cost saved, therefore, was the cost of framing the parts a second time.

The costs for this work are given in Table IV. There were 533 cu. yds. of concrete enclosed by these forms. Carpenters were paid $0.45 and helpers $0.25 per hour.

Assembling and Placing Steel Reinforcement.—All of the steel reinforcement was shipped to the job already bent and cut to length. Beam reinforcement was assembled into units, one per beam, before shipping Column reinforcement was assembled on the job. All reinforcement, except the top reinforcing bars in the roof slab, was put in place and wired before any concrete was placed. The top reinforcing bars in the roof slab and the reinforcing bars in the column footings were placed by the concrete workers, and the cost of same is included in the cost of the concrete work.

TABLE V.—COSTS OF ASSEMBLING AND PLACING STEEL REINFORCEMENT.

	Rate per hour.	Total cost.	Cost per 100 lbs.	Cost per cu. yd. of concrete.
Foreman	$0.45	$ 88.20	$0.096	$0.166
Laborers	0.25	125.20	0.137	0.235
Totals	....	$213.40	$0.233	$0.401

The quantity of reinforcing steel in the various portions of the building is as follows:

	Lbs.
In column footings	3,000
In columns	12,500
In roof slab, main reinforcement	52,000
In roof slab, top reinforcement	26,000
In beams	27,000

The costs of assembling and placing the steel reinforcement (except as noted above) are given in Table V, these costs covering 91,500 lbs. of steel and 533 cu. yds. of concrete:

Mixing and Placing Concrete.—The concrete in the floors and walls up to the floor level (including footings) was wheeled from the mixer to the forms in wheelbarrows and poured at the floor level. The concrete in the roof and in the portion of the columns above the floor level was discharged from the mixer into wheelbarrows, which were hoisted to the roof level in a double-cage building elevator and wheeled to place over runways laid on the roof forms. All concrete was mixed in mixers of the batch type. All stone and sand were wheeled to the mixer in wheelbarrows loaded by hand. The costs of this work are given in Table VI.

TABLE VI.—COST DATA ON MIXING AND PLACING CONCRETE IN VARIOUS PARTS OF STRUCTURE.

Item.	Rate per hour.	Total cost.	Cost per cu. yd.
Walls and Footings; 163 Cu. Yds.; Av. Dist. Wheeled, 75 Ft.			
Foreman	$0.40	$ 7.00	$0.04
Wheeling sand, stone, concrete	0.20	101.75	0.63
Placing concrete	0.25	10.25	0.06
Attending mixer	0.25	13.25	0.08
Totals	....	$132.25	$0.81
Column Footings and Columns Up to Floor Level; 66 Cu. Yds.; Av. Dist. Wheeled, 85 Ft.			
Foreman	$0.40	$ 14.50	$0.22
Wheeling sand, stone, concrete	0.20	46.40	0.70
Placing concrete	0.35	13.65	0.21
Attending mixer	0.25	13.50	0.20
Totals	....	$ 88.05	$1.33
Columns Above Floor Level, Beams and Roof Slab; 467 Cu. Yds.; Av. Dist. Wheeled, 90 Ft.			
Foreman	$0.40	$ 97.60	$0.21
Wheeling sand, stone, concrete	0.20	315.95	0.67
Placing concrete	0.35	79.25	0.17
Attending mixer	0.25	55.25	0.12
Operating elevator	0.20	45.70	0.10
Totals	....	$593.75	$1.27

Results of Some Tests of I-Beam Connections.

(Staff Abstract.)

The following data give the results of a series of tests the purpose of which was primarily to determine whether or not satisfactory I-beam connections could be made with fewer web rivets than are required by the standard connections:

TEST PIECES.

The test pieces, 18 in number, were 15-in., 12-in., 10-in., 8-in. and 6-in. I-beams 4 ft. long, with clip angles shop riveted to the webs. The clip angles attached to two of the beams of each size were standard connection angles (American Bridge Co.'s old standards); while two beams of each size, except the 6-in. beams, were fitted with special connection angles having simpler symmetrical web connections and fewer web rivets. The outstanding legs of the standard and special angles were, in all cases, the same for each size of beam. (Some of the special connections have since been adopted as standard by the American Bridge Co.) All web connections were made with ¾-in. shop rivets in 13/16-in. punched holes. The outstanding legs were connected to the supports by machined bolts turned to make what was practically a driven fit in the holes.

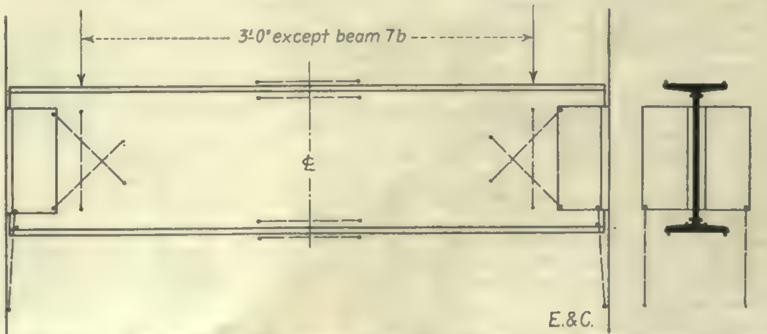


Fig. 1. Diagram Showing Gage Points on Test Beams and Application Points of Loading.

The latter were punched 11/16 in., and reamed to 13/16 in.

MANNER OF MAKING TESTS.

Numerous observations of deformations were made with an 8-in. "Berry" strain gage at various points, and the deflection of the beam itself was measured in order to determine both the slip of the connection angles relative to the beam web and support, and the effect of the deformation of the beam on the strength of the connection.

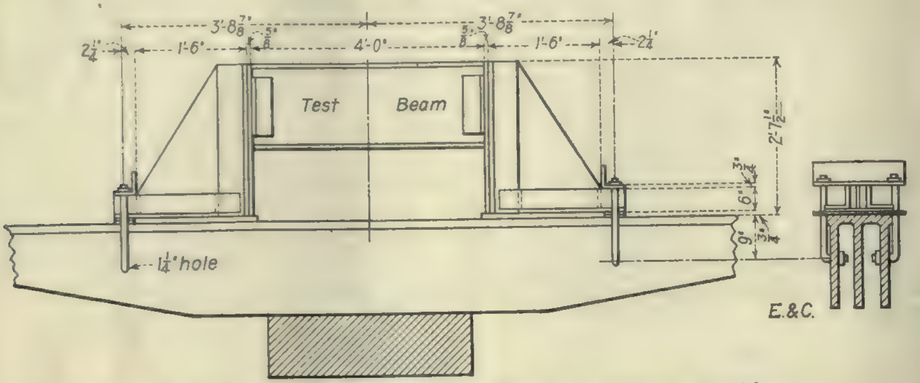


Fig. 2. Manner of Supporting Test Beam in Testing Machine.

Twenty-four 8-in. gage lines were laid out on each beam, as shown in Fig. 1, and the deflection apparatus was suspended from points at each end of the lower flange. A complete set of readings was taken each time the load was changed. A large number of data was obtained from these deformation readings, which have not been completely analyzed and therefore are not included in this report.

The beam supports were made of steel plates and angles riveted together to provide two rigid vertical faces between which the beam to be tested was bolted (see Fig. 2). These two supports were bolted securely to the cross beam of the 400,000-lb. "Riehlé" testing machine.

The load was applied to the upper flanges of the beams through 1½-in. steel rollers. In the majority of cases steel bearing plates 6 ins. long were placed under the rollers to distribute the load on the beam flange, and where they were not used the beam was badly buckled. Beam *7b* was loaded at the quarter points, but it buckled under the load points without causing the connections to fail. All the other beams were loaded at points 3 ft. apart, 6 ins. from the ends. The load was applied in increments of about 1/20th of the total estimated ultimate strength of the two-end connections.

RESULTS OF TESTS.

The action of clip-angle beam connections is so complicated and indeterminate that a close calculation of the stresses is impossible. For this reason an artificial average stress, computed by considering all forces vertical and neglecting eccentricity, is used as a measure of the strength of the connections.

The values of the average rivet shear, bolt shear and web bearing for each beam tested, computed from the ultimate load, are given in Table I.

The values in Table I show the great importance of eccentricity, as the more eccentric joints fail at lower average unit stresses.

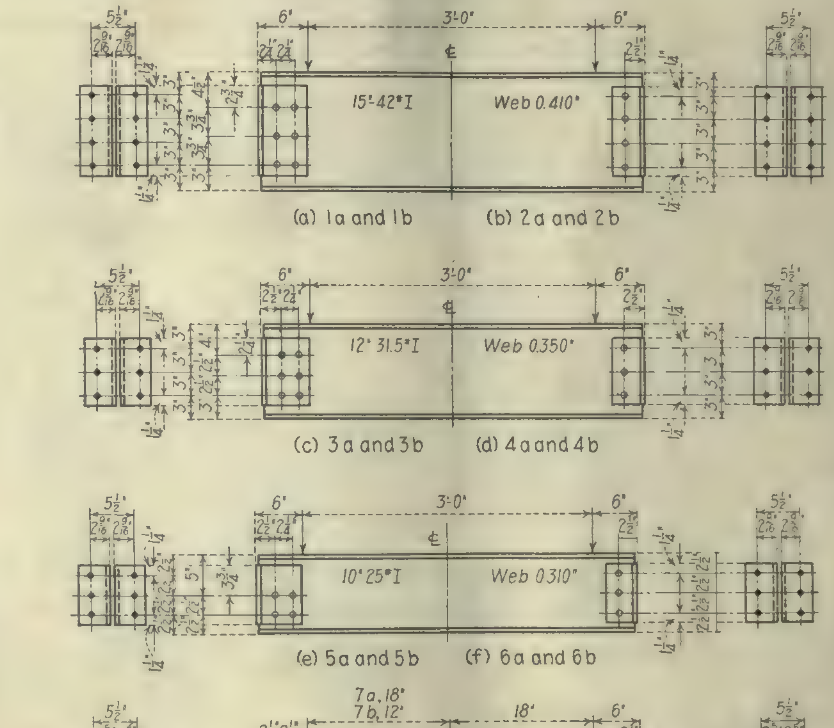
The final failure of the connections of beams *1a* to *6b* was due to shearing of the bolts. Special connections show nearly as much strength as the standard, the ultimate strength bearing no direct relation to the number of rivets in the web.

The connections of beams *7a* and *8a* failed in the web bearing, the strength of *8a* being considerably less than that of *7a*, but not in proportion to the number of web rivets, because the eccentricity of *7a* was greater. In every case, the decreased effect of eccentricity of the special connections tended to offset the decreas in the number of rivets.

The special connections on the 15-in., 12-in. and 10-in. beams gave very satisfactory results. They are more economical than the corresponding standard connections, as they are symmetrical and require fewer rivets. Their strength should be sufficient for all ordinary cases (for which a standard connection must be designed), as they are capable of developing the full flexural capacity of I-beams except for spans so short that the beam web is in danger of buckling.

The 8-in. beam tests indicate the advisability of decreasing the number of web rivets in the light connections, as the web is the weak point and the connection must be made as stiff as possible to decrease the very high stresses due to eccentricity.

The following data supplement those given in Table I, and indicate the effect of the loading and the manner of failure:



(a) 1a and 1b (b) 2a and 2b

(c) 3a and 3b (d) 4a and 4b

(e) 5a and 5b (f) 6a and 6b

(g) 7a and 7b (h) 8a and 8b

(i) 9a (j) 9b

Fig. 3. Details of I-Beams and Connection Angles Tested.

End shear, lbs.	Effect of loading and manner of failure.
	Beam 1a (see Fig. 3, a).
110,000	Southwest connection angle showed slight deformation.
60,000	South connection angles slightly distorted; northwest angle also distorted.
65,000	Northeast connection angle started.
87,500	Distortion suddenly increased.
97,500	Slight distortion of top flange at north end.
142,500	Bolts in north connection angle distorted.
180,000	Flange at north and south end showed slight deformation, and bolts at south end sheared off.
	Beam 1b (see Fig. 3, a).
105,000	Slight deformation of bolts on south end.
112,500	Slight deformation of bolts on north end.
120,000	Slight distortion of flange on south end.
135,000	Connection angles on south end pulled away from plate.
142,500	Connection angles on north end pulled away from plate.
157,500	Web at south end buckled about ⅛ in.
184,125	All bolts on south end sheared off.
	Beam 2a (see Fig. 3, b).
170,500	All eight bolts at south end sheared suddenly.
	Beam 2b (see Fig. 3, b).
177,110	Beam web under south loading point buckled; no failure, but connection bolts were badly deformed and would soon have failed.
	Beam 3a (see Fig. 3, c).
132,500	All bolts at one end sheared suddenly.
	Beam 3b (see Fig. 3, c).
138,800	All six bolts at north and sheared suddenly.
	Beam 4a (see Fig. 3, d).
96,000	Slight distortion in south connection angle.
127,000	Five bolts in north end sheared.
	Beam 4b (see Fig. 3, d).
50,000	South connection angles started to bend.
70,000	North connection angles started to bend.
128,850	Five bolts at south end sheared; center in southwest connection angle not sheared.
	Beam 5a (see Fig. 3, e).
128,585	Five bolts at south end sheared.
	Beam 5b (see Fig. 3, e).
118,350	Five bolts at south end sheared.
	Beam 6a (see Fig. 3, f).
122,500	Five bolts in connection angle sheared.
	Beam 6b (see Fig. 3, f).

TABLE I.—SUMMARY OF RESULTS OF TESTS OF I-BEAM CONNECTIONS.

Ref. No.	Beam.	Connection angles.	No. of web rivets.	No. of flange bolts.	Total area (both ends). Web bearing, sq. ins.	Rivet shear, sq. ins.	Bolt shear, sq. ins.	Safe design load,[3] lbs.	Total max. load, lbs.	Maximum average stress Web bearing, lbs. per sq. in.	Rivet shear, lbs. per sq. in.	Bolt shear, lbs. per sq. in.
1a	15-in., 42-lb.	6 × 4 × ½	6	8	3.69	10.60	7.08	70,800	360,000	97,500	34,000	50,900[1]
1b	15-in., 42-lb.	6 × 4 × ½	6	8	3.69	10.60	7.08	70,800	368,250	99,800	34,700	52,000[1]
2a	15-in., 42-lb.	4 × 4 × ½	4	8	2.46	7.08	7.08	70,800	341,000	138,700	48,200	48,200[1]
2b	15-in., 42-lb.	4 × 4 × ½	4	8	2.46	7.08	7.08	70,800	354,220	144,000	50,000	50,000[1]
3a	12-in., 31.5-lb.	6 × 4 × ½	6	6	3.15	10.60	5.30	53,000	265,000	84,100	25,000	50,000[1]
3b	12-in., 31.5-lb.	6 × 4 × ½	6	6	3.15	10.60	5.30	53,000	277,600	88,100	26,200	52,400[1]
4a	12-in., 31.5-lb.	4 × 4 × ½	3	6	1.575	5.30	5.30	47,250	254,000	161,200	47,900	47,900[1]
4b	12-in., 31.5-lb.	4 × 4 × ½	3	6	1.575	5.30	5.30	47,250	257,000	163,200	48,500	48,500[1]
5a	10-in., 25-lb.	6 × 4 × 7/16	4	6	1.86	7.08	5.30	53,000	257,170	138,200	36,300	48,500[1]
5b	10-in., 25-lb.	6 × 4 × 7/16	4	6	1.86	7.08	5.30	53,000	236,700	127,400	33,400	44,700[1]
6a	10-in., 25-lb.	4 × 4 × 7/16	3	6	1.395	5.30	5.30	41,850	245,000	175,600	46,300	46,300[1]
6b	10-in., 25-lb.	4 × 4 × 7/16	3	6	1.395	5.30	5.30	41,850	246,850	177,000	46,600[1]	46,600[1]
7a	8-in., 18-lb.	6 × 4 × 7/16	4	4	1.62	7.08	3.54	35,400	132,000	81,500[1]	18,650	37,300
7b	8-in., 18-lb.	6 × 4 × 7/16	4	4	1.62	7.08	3.54	35,400	85,000[2]	52,500	12,000	24,000
8a	8-in., 18-lb.	4 × 4 × 7/16	2	4	.81	3.54	3.54	24,300	117,000	144,400[1]	33,100	33,100
8b	8-in., 18-lb.	4 × 4 × 7/16	2	4	.81	3.54	3.54	24,300	111,300	137,500[4]	31,450	31,450
9a	6-in. 12.25-lb.	6 × 4 × 7/16	2	2	.69	3.54	1.768	17,680	44,000	63,800[4]	12,430	24,900
9b	6-in. 12.25-lb.	6 × 4 × 7/16	2	2	.69	3.54	1.768	17,680	48,400	70,200[4]	13,690	27,400

[1] Manner of final failure. [2] No failure of connections. [3] Computed from safe web bearing of 30,000 lbs. sq. in. and safe bolt shear of 10,000 lbs. per sq. in. [4] No bearing plate under load.

123,425	Bottom bolt in southwest angle sheared; then middle bolt sheared; then rivets in web at south end sheared.
	Beam 7a (See Fig. 3, g).
40,000	Slight deformation of southeast flange.
42,500	Slight deformation of south connection angles, bearing in web.
66,000	Web torn out by rivets; southeast top bolt sheared and southwest connection angles torn.
	Beam 7b (see Fig. 3, g).
42,500	Beam flange and web buckled under loading points; no failure of connection.
	Beam 8a (see Fig. 3, h).
39,000	Slight deformation of south angles.
40,500	Slight deformation of northeast flange
59,000	Lower south rivet in web tore through web.
	Beam 8b (see Fig. 3, h).
55,650	Final failure by buckling of flange; no failure of connections.
	Beam 9a (see Fig. 3, i).
22,000	Connection angles twisted apart; flange was buckled, but no rivets or bolts sheared.
	Beam 9b (see Fig. 3, j).
24,200	Connection angles twisted apart; no rivets or bolts sheared.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by C. S. Whitney in The Cornell Civil Engineer. The tests were made in the College of Civil Engineering of Cornell University, in co-operation with the American Bridge Co. and at the instigation of James H. Edwards, assistant chief engineer. The test pieces were fabricated by the Elmira Bridge Co.

Some Data on Wood Frame and Reinforced Concrete Ice Storage Houses.

(Staff Abstract.)

In our issue of Dec. 16, 1915, we published an article treating of the principles which govern the design, construction and operation of railway ice storage houses. The following data apply to the design, construction, operation and cost of ice houses of wood frame and of reinforced concrete construction.

WOOD FRAME ICE STORAGE HOUSES.

The New York Central & Hudson River R. R. has 73 ice houses on its lines east of Buffalo (except the Boston & Albany R. R.). These ice houses have a combined storage capacity of 240,000 tons and are all of wood frame construction. Fifteen of the houses are equipped with platforms and ice handling devices, while the other 58 are small storage houses for use in local territory.

Large Ice Storage Houses.—The three best equipped houses of this company are fairly uniform in construction but vary in size. These houses are 60 ft. wide and 120 to 240 ft. long. They are located so that additional rooms can be added in the future. The inside dimensions of these rooms are 38 ft. 9 ins. x 57 ft. 6 ins. x 36 ft. high, with a capacity of 1,700 tons each.

The foundations under the walls are of concrete, while the foundations under the floors consist of 12 ins. of cinders, well tamped. The partition foundations are of concrete.

The floors are of 2-in. plank spiked to sleepers, for which old 8x10-in. bridge ties, old car sills or other timbers may be used. There has never been used any insulation other than the foundation of cinders, and it is not thought essential if proper foundation walls are used.

Beginning at the outside the walls and partitions consist of: siding, sheathing paper, 2-in. live air space, sheathing paper, 1-in. hemlock, 10-in. air space, 1-in. hemlock, sheathing paper, 2-in. air space, sheathing paper and 1-in. hemlock. The standard construction up to 1913 called for sawdust or shavings to be used in the exterior walls of houses, but during the last two or three years nothing has been used between studding in the 10-in. space. The 2-in. outside air space has an opening back of the water table, which extends the entire height to about 8 ft. up the rafters and opens into the attic. Interior partitions are of 1-in. sheathing on each side of the studding, giving a 10-in. air space. No paper is used.

The ceiling is entirely floored over, and 18 to 24 ins. of shavings are placed on the top. Experience seems to question the advisability of this plan for several reasons: (1) Floor joists and flooring rot out in about six years, and renewals are very expensive: (2) much space is lost because workmen can not pack ice within 3 ft. of the ceiling, thus necessitating a house 3 ft. higher than would otherwise be the case for a given tonnage; and (3) ice would really keep better if the ceiling were omitted and the roof insulated instead, and the ice covered with 12 ins. of swamp hay. Under this plan it is believed the shrinkage would be much less.

The attic and roof are well aired by large ventilators set on the ridge of the roof, and by a door at each end of the house. The gable roof is ceiled on the under side of the rafters to a point where the distance from the attic floor to the roof is 2 ft. In case the ceiling of the houses is omitted the under side of the rafters should be entirely ceiled and the space filled with shavings. A ventilator should be placed over each bay.

The doors are 9 ins. thick, with a clear width of 3 ft. 6 ins.; they contain one air space and one space filled with shavings.

A platform is suspended against one or both sides of the house carrying an endless chain conveyor, which is lowered or raised according to the height of the ice in the rooms being worked. The long platform, which is 14 ft. 6 ins. above the base of rail, is for icing cars, and the short platform below is for filling the house.

The "Gifford-Wood" conveyors are used, the motive power being electricity. The conveyor on a suspended gallery is reversible to fill or empty the house. Where the conveyor of the suspended gallery joins the icing platform men are stationed to push the cakes to conveyors running each way along the platform from that point.

From 5 cakes per minute for the oldest house of this type to 12 cakes for the newest can be handled. From 25 to 30 cars per day can be stowed with a force of 45 men. The ice averages 25 to 28 tons per car. All ice comes by railroad and is packed as closely as possible. The standard size of cakes is 22 x 32 ins. x 12 to 24 ins. thick. A thickness of 12 ins. is preferred, as handling 24-in. ice costs more in the end. The ice comes out better and with less breakage when stored on edge, but it can be more easily and quickly packed when laid flat. The practice in this respect is not uniform. The cakes are placed in contact as solidly as possible. No space between the ice and the wall is necessary with houses of this design.

The space between the ice and the ceiling is 3 to 4 ft., because it is impossible to work in less space. The ceiling may well be omitted to avoid this. No insulation for the ice is provided. No wood is used between layers for natural ice, but this is necessary for artificial ice to prevent freezing together.

No sawdust is placed between layers. At railroad houses ice is not well cleaned when removed, and the sawdust makes a bad mess. In refrigerator cars it causes trouble by clogging the drip pipes. Cork is too expensive, in addition to its being a nuisance like sawdust. If the construction of the house requires a covering, swamp hay is the best material as it can be used several times. The top layer of ice is always covered and it is not as dirty as sawdust and shavings. There is no difference in methods of handling for a short busy season and a long slow one for conditions which vary from a few cars per day in the spring and summer to 200 cars per day in the fruit season.

The sub-grade and floor of each room are sloped ½ in. per foot to the center. A 6-in. tile drain is provided for each room, extending from the catch basin at the bottom of the cinders. In a good percolating soil, however, a drain is not necessary. There must be a trap in the drain to prevent the entrance of air.

For houses kept closed the shrinkage will average 15 per cent; with doors open more or less of the time this will amount to 25 per cent; doors open most of the time will result in a loss of 50 per cent or more. With doors carefully supervised and good swamp hay covering, shrinkage should not exceed 10 or 15 per cent. Ice is drawn before or after arrival of trains depending on operating conditions. In busy times conveyors are constantly at work.

The cost of the 60x240-ft. house, with six rows and a capacity of 10,000 tons, including platforms and machinery (but not the tracks), at Rochester, built in 1913, was $60.000, or $6 per ton. The house at Oswego, built in 1913, 60x120 ft., with three rooms and a capacity of 5,000 tons, cost $25,177, or $5.05 per ton. The former has very long platforms, with a total length of 1,800 ft., extending beyond the end of the house on each side. The latter house has shorter platforms, with a total length of 1,500 ft. on one side only, thus having only half the outfit of motor and hoisting machinery, and a little more than one-fourth of the conveyor chain.

Medium Size Houses.—The ice houses at North Rose and Model City represent houses of small capacity and with less elaborate equipment, these houses being built recently. The size of rooms is 48 x 28 ft. x 24 ft. high, with a capacity of 735 tons. Some of the houses are 33 x 32 ft. x 24 ft. high, with a capacity of 500 tons.

The foundations are posts, or they may be old bridge ties, but concrete is sometimes used and is preferable. The floors are of 2-in. hemlock plank on 18 ins. of cinders. Plank should be spiked to the sleepers for which old bridge stringers or old car sills may be used.

The walls are similar to those in larger houses, viz., beginning at the outside: siding, sheathing paper, a 2-in. air space, sheathing paper, 1-in. hemlock, an 8-in. air space, 1-in. hemlock, sheathing paper, a 2-in. air space, sheathing paper and 1-in. hemlock. In some cases the larger air space is empty and in others it is filled with shavings. The outside 2-in. air space is ventilated. The partitions consist of studding sheathed with 1-in. hemlock, leaving a 10-in. space, which is filled with shavings or sawdust if desired. The ceiling is built with rafters ceiled on the under side, or ceiling joists ceiled on top. In some cases the latter is covered with 14 ins. of shavings or sawdust, and in other cases not. In the Pennsylvania division houses no ceiling was placed, but the roof was insulated by one-ply tar paper and ceiling on the under side of the rafters, while the space to the top of rafters was filled with shavings and then tongue-and-groove roof sheeting, finished with some type of prepared felt roofing. The space under the roof in all houses is well ventilated, in the cheaper houses by louvres in each end, and in the better houses by 6x8-ft. ventilators along the roof, and by doors or louvres in each end of the house.

The doors are the same as previously described for the larger houses.

On the latest houses the platforms are 6 ft. wide, and are supported by brackets on the side of the house. On the Pennsylvania division houses the platforms are 4 ft. 8 ins. wide, and are supported by piers. No conveyors are used on the smaller houses. Elevators operated by steam or electricity are used. The gig used on the St. Lawrence division will handle four cakes per minute; most of the installations will handle about two cakes per minute. Natural ice exclusively is handled and stored. The standard size of cakes is 22 x 32 ins. x 10 to 24 ins. thick. No standard is adopted, but ice is stored flat in most houses and as compact as possible. A cavity of 6 or 8 ins. is left between the ice and the wall, while the space between the ice and the ceiling is 2 to 3 ft. A heavy covering of sawdust is placed on top of the ice and sometimes between the ice and the wall. Swamp hay is preferable to sawdust. Nothing of any kind is used between layers.

No standard method is adopted in removing the ice. In some cases it is lowered in all rooms uniformly, and in others one room is emptied before working another.

In some cases seepage is found to be entirely sufficient to provide drainage. In others blind drains or tile drains are provided, but they are arranged so that air currents cannot enter the house. In some cases the floor is placed a little higher than the adjacent ground. The sub-grade of the floor should be sloped ½ in. in 1 ft. to carry the water to the center.

The shrinkage is estimated at about 10 to 12 per cent. At some houses where cars are iced daily with ice brought to the platforms some time in advance, the loss may reach as high as 40 per cent.

Two houses, built in 1910 and 1912 for North Rose and Model City, cost as follows:

2,200 tons capacity; total cost, $5,538, or $2.51 per ton.

2,200 tons capacity; total cost, $4,730, or $2.14 per ton.

The following data apply to two houses built on the St. Lawrence division in 1912 and 1913:

1,500 tons capacity; total cost, $5,742, or $3.83 per ton.

1,500 tons capacity; total cost, $5,092, or $3.39 per ton.

Other houses, built from 1903 to 1911 according to the plan for the house at Newberry Junction, cost on the average $2.75 per ton, as follows:

Capacity, tons.	Cost.
500	$1,440
500	1,266
500	1,280
800	1,455
800	2,042
800	2,742
1,000	3,275
2,000	5,843

Recommendations.—For a sensible and fairly cheap ice storage house the following is recommended by W. A. Pettis, general superintendent of buildings of the railway company:

The structure to consist of concrete foundation walls, with 2x10-in. studding, the interior and exterior being sheathed horizontally with sheathing not over 6 ins. wide. Place good saturated building paper over the entire exterior. Over each stud place 2x2-in. furring strips with paper on the strips, and then cover with drop siding or novelty siding. This 2-in. air chamber is to be open at the top and bottom, thereby forming a live circulating air space. The space between the studs is to be filled with planer shavings, if desired. The under side of the rafters should be ceiled with 1⅛-in. narrow ceiling strips, well nailed, and the space between the roof boards and the ceiling should be filled with planer shavings. Louvres should be provided on the roof not over 40 ft. apart, with openings covered with wire netting. Ventilating doors should be placed in each end and the openings covered with netting. It is believed that a house built in this way will keep ice in first-class condition and that it is less expensive than some of the modern houses built by this railway company.

REINFORCED CONCRETE ICE STORAGE HOUSE.

The following data apply to the reinforced concrete ice storage house built for the Northern Pacific Ry. at Pasco, Wash., the data being published originally in the Railway Age Gazette of Jan. 23, 1914:

The new ice house is 483 ft. long, 94 ft. 6 ins. wide, and 41 ft. 10 ins. high to the roof at the center line of the side walls, and has a storage capacity of 30,000 tons of ice. It is divided into twelve compartments by walls of the same construction as the exterior walls. These walls consist of two 4-in. concrete walls reinforced vertically and horizontally, and cast with a 10-in. space between them, which is filled with fine regranulated cork for insulation.

The walls are made rigid by building columns, which are spaced from 9 ft. to 13 ft. 4 ins. and are cast monolithic with the walls. Insulation around the exterior columns is provided by building U-shaped concrete pilasters and filling the space formed by the U with granulated cork. These pilasters were cast monolithic with the outside walls. The walls are given additional stiffness between columns, and are made to act together, by inserting two 2x10-in fir planks spaced equidistant and extending the full height of the wall. Bolts, spaced 4 ft. apart and running through both walls on the same vertical line as the 2x10-in. timbers, hold the two walls solidly together and give considerable additional stiffness to the structure as a whole. These bolts are long enough to hold in place the lagging on the inside of the building, which will be described later.

The floor is made of a 4-in. concrete slab reinforced in both directions, and laid on 16 ins. of cinders, well tamped for insulation. To provide drainage, and to give the ice a tendency to tip away from the walls, the floor is sloped from all four sides to the center in each compartment.

The ceiling is of the beam-and-slab type of reinforced concrete. The slab is 4 ins. thick, reinforced two ways. The beams running lengthwise of the building are framed around the bottom chords of the trusses which support the roof and ceiling. The beams framing into the longitudinal beams are spaced so as to give panels 13 ft. 4 ins. x 10 ft. 2 ins. On top of the ceiling slab 2x6-in. timbers are placed 3 ft. between centers, and fine regranulated cork is tamped between them giving a 6-in. thickness of insulation. Boards ⅞-in. thick are nailed to the 2x6-in. timbers and are covered with two layers of oiled paper. On top of this is placed 1½ ins. of cement mortar reinforced with "McMillan's" wire netting. This construction gives a solid ceiling and provides excellent insulation.

The reinforced concrete roof is supported on 40-ft. Warren steel trusses with sub-verticals supported on the end and transverse walls. The roof slab is divided into panels of the same size as the ceiling and is covered with a tar-and-gravel roof laid under the Northern Pacific specifications. The slope of the roof is about 4 ins. in 10 ft. This double construction of ceiling and roof is designed to give additional insulation and to provide room for ice chutes leading from elevators to the outside of the building. Ventilation of the space between the ceiling and the roof is provided by galvanized iron ventilators fastened to the concrete by means of expansion bolts.

The cupolas or pent houses built along the center line of the building are provided for ice chutes and elevator machinery. The frame is of structural steel supported by two middle rows of trusses, and the wall is made of hard burned tile laid in cement mortar, except in those parts which carry the slabs supporting the elevator machinery, where they are of hard brick laid in cement mortar. The roof on the cupolas is of reinforced concrete covered with a composition roofing of tar and gravel similar to that on the main roof.

Each compartment is provided with an elevator operated by an electric hoist. After considerable investigation it was decided to use a direct-connected worm-gear type manufactured by Lee & Hoff Mfg. Co., St. Paul, Minn., with all machinery placed on top of the hatchway. These elevators are equipped with all possible safety devices, and are driven by 11-hp. slip-ring induction motors, 3-phase, 60 cycles, 220 volts, using external grid resistance in starting, allowing a starting current of 150 per cent of full load running current. The capacity is 2,000 lbs. at a speed of 75 ft. per minute. The cars are constructed of steel and are designed to unload the ice automatically into the chute at the top of the building. The elevator shaft is made of structural steel and is designed to resist any lateral displacement of the ice that may take place. It also carries the guides for the elevator cars. No equipment is furnished for filling the ice house, as this is all done by the contractor who supplies the ice. One steel ladder is provided for each compartment. These ladders are attached to the division walls by means of angles which run horizontally through the walls and project about 1 ft. beyond and to the ends of which the ladders are bolted.

Ice chutes run from each elevator to openings in the side walls just above the ceiling slab where the ice is delivered to special conveying machinery and transferred to the icing platform. The ice chutes are made of wood supported on wooden bents placed from 10 to 14 ft. apart and having a minimum fall of 1 in 20. The 2x2-in. oak strips forming the bottom of the chutes are protected from wear by ¼x1-in. half oval steel strips.

On the west side of the building, one door is provided for each compartment for filling purposes, and to give easy access from one compartment to another each division wall has a door 3 ft. wide by 20 ft. high located near the center line of the building. The outside doors are double and are constructed of four thicknesses of ¾-in. boards—two on the inside and two on the outside—with a 2½-in. air space between. Two layers of waterproof paper were laid between the ¾-in. boards. The doors are hung on heavy strap iron combination hasps and hinges in sections alternating 4 ft. 4 ins. and 2 ft. long. All edges closing against jambs or each other are covered with rubber canvas 1/16-in. thick on a cushion of hair. The outside of the doors is covered with No. 22 gage galvanized steel for fireproofing. To provide additional insulation at the outside doors where leakage is bound to occur two vertical rows of 3-in. channels, 9 ins. apart, were bolted to the column on each side of the door and 1½x10-in. planks were fitted into the grooves of the channels—the space between the plank being filled with regranulated cork. The doors in the division walls are constructed of two thicknesses of 1½ x 10-in. plank, each thickness fitted into channels as explained for the outside doors except that the insulation space is somewhat greater. The trap doors in the ceiling are of wood, with cork insulation, and are covered with galvanized steel. On the inside of all walls 2x4-in. timbers spaced 2 ft. 6 ins. on centers were bolted in a vertical position, and 1x4-in. drip boards with beveled edges were nailed to these horizontally to keep the ice and drippings away from the walls.

The question of insulation was given considerable thought. Fine regranulated cork is an insulating material of high efficiency, it is moisture repellent, and can be bought at a very reasonable price. For these reasons it was decided to use fine regranulated cork for insulation. After the walls were built to their full height the regranulated cork was poured into place and compacted as much as possible by tamping or rather stirring wtih long poles.

All forms were constructed of wood. Those for the walls and columns were made in sections 4 ft. high, a sufficient number being built to extend the full length of all walls. After the concrete had hardened sufficiently, these forms were raised into a new position and used over again. With but slight repairs they lasted for the entire job and were raised on an average of twice a week. The outside forms for the pilasters were built up in 8-ft. sections, and were left in place for the full height of the walls; but those used to form the insulating space were made in 4-ft. sections, and were raised at the same time as the wall forms.

Ceiling forms were hung from the trusses and the roof forms were supported on the lower chords of the trusses by means of vertical posts.

A 1:2:4 concrete mixture was used throughout. Bank sand was obtained within a short distance of the site, and a very fine grade of gravel was shipped in from a distance of 25 miles. The gravel was run through a ¾-in. screen. "Trident" Portland cement was used.

The contractor's plant consisted of two "Smith" mixers of ½-yd. capacity, located one on each side of the building about 120 ft. from opposite ends. A platform long enough to serve seven gondola cars was constructed for each mixer, and the cement, sand and gravel were fed into the mixers direct from the cars by means of wheelbarrows. The mixers discharged into steel bucket hoists, which in turn dumped into a forebay from which it was taken to the forms by two wheel push carts. A substantial staging 6 ft. wide, of 4x4-in. timbers and 4x6-in. timbers for urights, with 2-in. planking, was built along all walls.

Construction commenced in the early part of December, 1912, but considerable delay was experienced on account of difficulty in getting materials, and some time was also lost on account of bad snow storms. Good progress was not attained till the first of February, but from then on the work went on rapidly and the building was delivered to the Northern Pacific about the first of June.

Considerable freezing weather necessitated the installation of steam pipes between the 4-in. walls, and the water used for mixing the concrete was heated to almost the boiling point and the proper amount run into the mixer. The correct proportions of sand and gravel were then added to the water and thoroughly mixed, after which the cement was dumped in and mixed sufficiently to insure its proper distribution. By using this method concrete was delivered from the mixer at about 90° F. By taking the precautions noted above, no trouble was experienced with frozen concrete. The performance of the plant in preventing loss by melting of the stored ice has been so satisfactory that the owners consider that the economy thus secured pays good interest on the total investment made.

ACKNOWLEDGMENT.

The foregoing data were abstracted from the report of a committee of the American Railway Bridge and Building Association.

ROADS AND STREETS

Road Construction in Reading Township, Livingston County, With Convict Labor.

Contributed by B. H. Piepmeier, Engineer in Charge of Maintenance and Township Road Construction, Illinois.

Reading Township, Livingston County, is a rich agricultural township, lying just south of Streator, Ill. There are but two small villages in the township, which together have a total population of about 400 people. The township, which is six miles square, has an assessed valuation of $1,275,000.

For the past few years a great many arguments have been presented to the tax-payers in favor of hard roads. The township officials and a number of interested farmers became enthusiastic for better roads and proceeded to draw up a petition to vote bonds in the township to the extent of $63,500 ($1 on the $100 assessed valuation for five years) for constructing some 15 to 20 miles of crushed stone roads 9 ft. wide. The petition was presented before the taxpayers at the April election last spring and it carried by a large majority.

After the bond issue had carried, the commissioners communicated with the State Highway Commission for its assistance. The State Highway Commission agreed to furnish them with an engineer to superintend the construction, three macadam road outfits and the necessary crushed stone from the penitentiary, providing convict labor could be used in constructing the road.

The writer made a very careful study of the system of proposed roads in the township and decided that it was entirely practical to construct a majority of the roads during this season, and to handle all the work from one central point, where a convict camp might be established.

Surveys were ordered and all detailed arrangements made for starting the work within 30 days after the bonds were voted. On April 7, Mr. Floyd Little of the State Highway Department was placed in direct charge of all the improvement. On May 13, 46 convicts were sent out to Reading and a camp was established. During the months of April and May, there was very little work done on account of delays in disposing of bonds and on account of the general condition of the weather. However, by the first of June, all preliminary arrangements had been made and actual construction started.

Superintendence.—Mr. Floyd Little, Superintendent, is in direct charge of all work. He is supplied with a small auto truck that is used in shifting men to and from different points on the job. The car also enables him to keep in close touch with all divisions of work namely, the unloading plant, the hauling system, the excavation, subgrade work, the spreading and the finishing. The work is scattered over some twenty miles of road and even with the car, it keeps the superintendent very busy.

Equipment.—To build the number of miles desired in one season and in the most economical manner with convict labor, it was decided that all the crushed stone should be hauled with an industrial railroad outfit. The commissioners accordingly arranged to rent a complete outfit, which consists of one 30-hp. locomotive, 65 one and one-half yard dump cars, 5½ miles of 24-in. gage, 20-lb. steel rail, and accessories, from the Orenstein, Arthur Koppel Co. of Chicago. The railroad equipment was delivered on the ground and ready to work May 20.

The industrial railroad was decided upon for hauling the material for several reasons, namely: The material could be delivered rapidly and by one unit, which could be easily supervised and depended upon. It could haul a load over the black earth roads even when water soaked, or in a condition that no other practical method of hauling could be used. It could be easily handled by convict labor and it could be worked overtime when desired.

The principal grading on the proposed system of roads was to prepare a subgrade or roadbed for the crushed stone. An elevating grader and heavy road grader was therefore purchased by the township and put in use preparing the roads for the hard surfacing material. Three 10-ton steam rollers were furnished by the State Highway Department together with the necessary accessories such as sprinkling wagons, plows, harrows, tool boxes, etc. A 30-hp. steam tractor pulling engine for the graders was furnished by the State Highway Department, also six large wheel scrapers.

Because of the difficulty in securing teams in a farming community of this kind, team work was reduced to a minimum. A gasoline engine and pump and two miles of pipe line were installed for pumping water onto the road for supplying the boilers of the three 10-ton steam rollers and for flushing the screenings into the macadam surface in preference to hauling the water by teams. Small creeks are so located over the township that two miles of pipe line will deliver water to any portion of the roads to be improved.

Unloading Device.—On account of the quantity of stone that has to be handled from one central plant and the necessity of having some device that would load the industrial train rapidly, it was decided to construct an unloading bin, as shown by Fig. 1, and to use a belt and bucket elevator for carrying the material from the pit beneath the track, to the bin. The Santa Fe railroad agreed to furnish Rogers center dump cars on all shipments to this point.

The bin has a capacity of about 80 cu. yds., and is so constructed as to permit the dinky cars to pass under the center of the bin for loading. There are four trap doors in the bottom of the bin, and the 1½-cu. yd. cars can be filled in about five seconds. With the unloader, a minimum number of men are used at the unloading plant. The train of material is always made up quickly so there are no unnecessary delays for the locomotive, which insures efficiency in hauling. A second-hand 16-hp. traction engine was purchased for driving the belt and for working the drum that spots the railroad cars over the pit.

With the device shown, ten to fifteen cars of stone may be unloaded daily, which will readily supply the one hauling outfit on the 2½-mile average haul. The locomotive hauls about 40 dump cars or 60 cu. yds. per trip, and makes from six to ten trips per day.

Yards.—The industrial tracks in the yards, Fig. 2, are laid so that there is but one move for the locomotive in the yards, and that one is to uncouple the empty train and to couple up with the loaded cars. On the first stop, the engine is supplied with water, coal, and is oiled, which takes about five minutes.

The switching in the yards is done with a horse. The empty cars are spotted and the loaded cars made up into a train for the locomotive. This arrangement saves time for the locomotive to the extent of an extra trip or two each day. The horse was purchased by the township so the cost of switching will be small.

Excavation.—The excavation is handled by a large traction engine, elevating grader, an ordinary engine grader and six wheel scrapers. All of this equipment is placed in charge of one man, who reports direct to the superintendent. The grading is completed as far in advance of the improvement as possible.

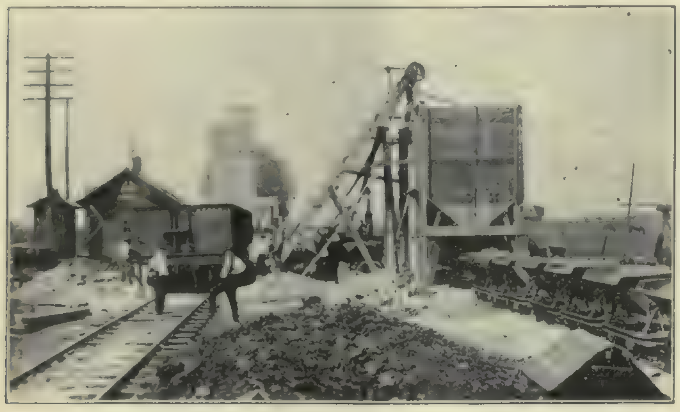


Fig. 1. Unloading Plant; Materials in Cars Are Dumped Into Pit Under Track and Elevated to Bin by Belt and Euckets.

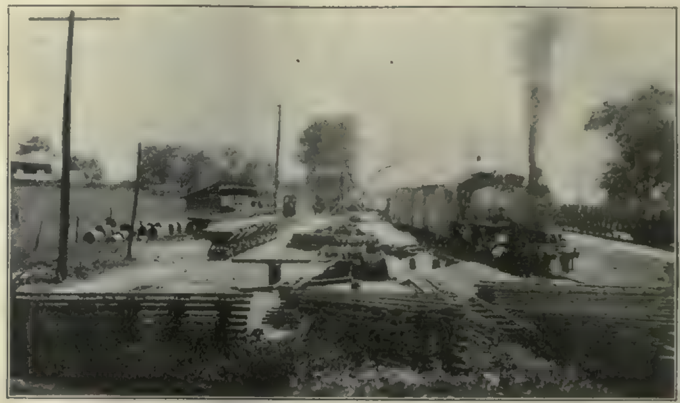


Fig. 2. Material Yards and Unloading Plant.

Subgrade.—The subgrade work, Fig. 3, is handled by one man, who has use of the tractor, grader and team leveller. He also has a squad of men for doing the necessary hand-work.

Hauling.—All hauling is done with the locomotive and dump cars as shown in Figs. 4 and 5. The train crew consists of an engineer, and front and rear flagman. The track is first placed a little to one side of the center of the subgrade, and as soon as one dumping of stone has been made, the track is shifted to the edge of the subgrade where another dump is made to make up the required amount of material. The track is then shifted to the earth shoulder, and the necessary screenings and bonding materials dumped on the earth shoulder. When all material is dumped for about a mile of road, the track is picked up and extended on another route. Two or three men, known as track walkers, are required to patrol the track and keep it lined up so that a maximum speed may be obtained by the locomotive.

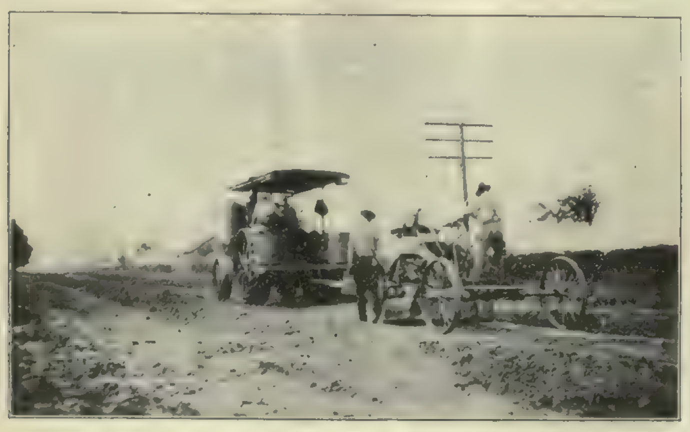


Fig. 3. Preparing Subgrade for Crushed Stone.

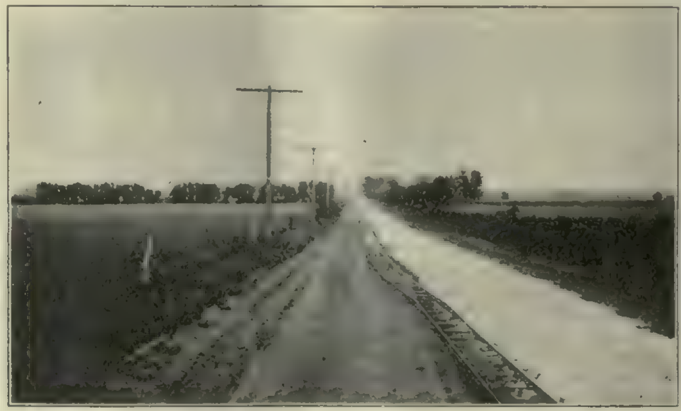


Fig. 4. All Stone is Delivered by Industrial Railroad Equipment.

Spreading and Finishing.—All spreading, shaping and finishing of the macadam is under the direct charge of one man who reports to the superintendent. The stone that has been dumped onto the subgrade is first spread by means of a team grader. After the material is evenly distributed over the subgrade, a heavy harrow is driven over the road, to distribute the material more uniformly, and to shift the dirt and fine particles of stone to the bottom of the crushed material. After this is done, the earth shoulders are drawn up properly to the stone road and the finishing touches are made by men with stone forks and shovels. The road is rolled with the 10-ton rollers and if any depressions are found, they are immediately filled with additional stone. The road is then thoroughly rolled until no depressions are formed by the roller wheels and the stone is thoroughly compacted and keyed. The screenings are then whipped over the road from shovels and broomed and rolled in dry until all voids between the stones are filled, after which it is flushed with water, and puddled with the roller.

Bridgework.—All bridge and culvert work on this system of roads is handled by a contractor, under the county superintendent of highways and superintendent in charge.

Convict Camp.—The prison camp is officially known as "Camp Dunne." Mr. T. G. Keegan is directly in charge of all prison camps. He is assisted at the camp at Reading by Wm. Mahony, who looks after the men during the day and Lewis Falkie, who acts as watchman at night. The law permitting convicts to work upon the public highways has been in effect since 1913. "Camp Dunne" is recognized as the sixth road camp that has been established since that time.

Location.—The camp is located on a two-acre lot within one block of the postoffice at Reading, Ill., and within three blocks of Moon Station on the Santa Fe Railroad. The camp ground is adjacent to a small creek which affords good drainage.

Equipment.—The camp consists of the following: One plain building 18x60 ft. as shown in Fig. 6. This building is partitioned off for a kitchen, dining room, Fig. 7, and officer's dining room. Adjacent to the kitchen is a good well, which is equipped with a small gasoline pump which supplies the wash-house and kitchen with abundance of water. An old building on the ground was utilized for a combination wash-room and laundry. The wash-room is supplied at all times with hot and cold water. Two convicts work in the laundry. Everything washable is washed each week. There is a barber chair adjacent to the wash-house where the convicts may receive the necessary haircut and shave as desired. Two large tents 14x14 ft. are located near the entrance to the camp ground. One is used by the officers and the other for a commissary.

On the highest portion of the grounds there are located thirty 9x9-ft. sleeping tents, Fig. 8, each tent accommodating two men. All the tents are floored with lumber. Each man has his own bed and bedding, consisting of an iron bed-stead, wire springs, mattress, a pillow, blanket and linen. During cold weather the tents are supplied with small coal stoves so the camp may remain in use during severe weather, if needed.

Sanitation.—The entire camp is kept clean. No convict is permitted to commit any act which may cause filth. All garbage is carted away from the camp. The kitchen, dining room and outhouses are all screened to prevent insects. Precautions are taken against the breeding of flies and mosquitoes. Each convict is required to take a bath at least once each week. He is permitted to take as many other baths as he chooses. The camp, as a whole, looks much better than the ordinary construction camp, in fact, it compares favorably with the best kept home with respect to sanitation.

Clothing.—An expert tailor, having a good equipment, is kept constantly at work repairing, altering and making garments. All garments are inspected at least once each week, and buttonholes, tears and weak spots are repaired without delay. The convicts are permitted to wear ordinary citizen's clothes, so it is very hard to distinguish prison labor from free labor. Most of the convicts dress up on Sunday in made over second-hand clothing, which has been given to them by their friends or donated to the camp. Donations are always welcomed by the prisoners.

Rules and Privileges.—The camp rules are simple, but strict obedience to them is required. No convict is permitted to indulge in any form of disorderly conduct. Gambling and drinking are barred from the camp. The men must be either in the camp or on their work and are not permitted to loitre about the community. They are required to arise at 5:30 a. m., be ready for breakfast at 6 a. m., and on their work at 6:45 a. m. Their dinner hour is from 11:45 to 12:45. Quitting time is 5 p. m. Supper is served at 6 and all lights out at 9:30 p. m.

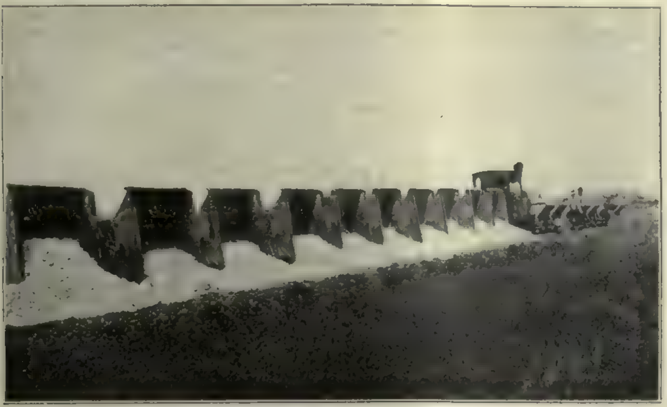


Fig. 5. Industrial Hauling Outfit Dumping Material in Subgrade.

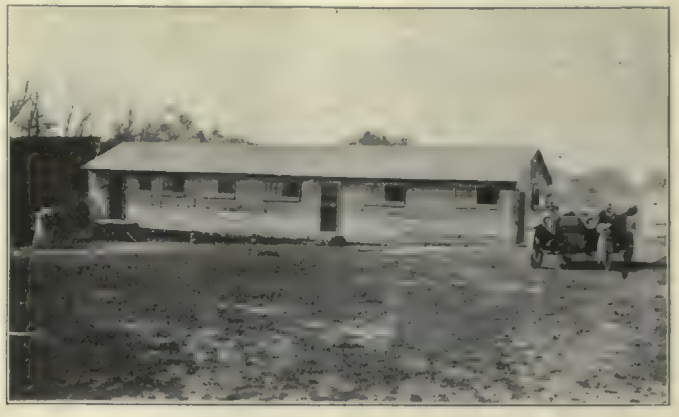


Fig. 6. Building Erected for Dining Room and Kitchen for Convict Labor Camp.

No road work is required of the men on Saturday afternoon, Sundays and holidays. During leisure hours they are permitted to enter into any beneficial form of recreation. Each person is permitted to write only one letter per day and to receive visitors every Saturday afternoon. There is no limit on the mail the convicts may receive.

The convicts are permitted to earn money when there is an occasion to work overtime on the road. They also make small amounts selling souvenirs to visitors. They are not permitted to have any money in their possession. Each convict is furnished with a passbook in which credit and debit are entered as fast as money is earned or expended. His balance is turned over to him on the completion of his sentence.

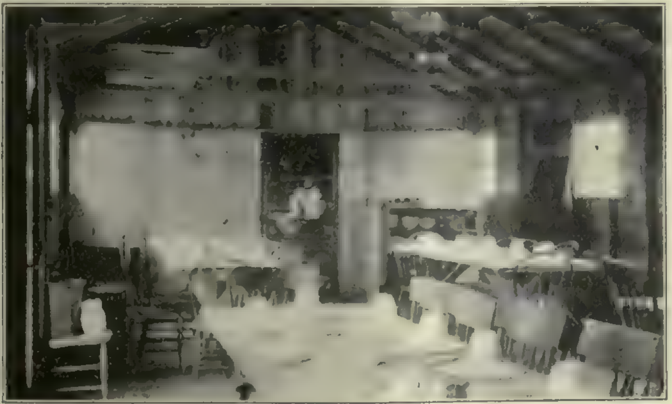


Fig. 7. View of Dining Room in Convict Labor Camp.

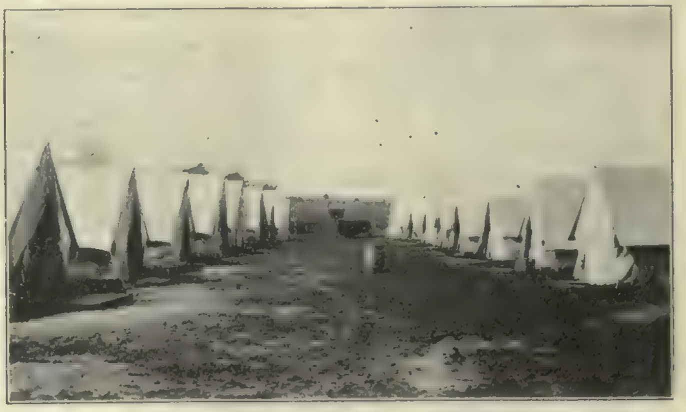


Fig. 8. Sleeping Tents for Men at Convict Labor Camp.

Supplies.—The convicts are supplied with three good meals each day. Practically all their food is prepared at the camp. The State furnishes the convicts with all the chewing and smoking tobacco they care to use. Those who prefer not to use tobacco furnished by the State are permitted to purchase tobacco and cigars at cost from the commissary.

Convict Work.—The road camps that are sent out from the penitentiary have selected men for the various divisions of work in the road camps. They are assigned to various divisions of work and kept at that one thing as much as possible, which always insures the best results. In the camp at Reading there are 46 convicts. Ten are assigned to camp duties and 36 to actual work on the road.

The ten men at the camp are assigned as follows:—there being first and second cook in the kitchen and four assistants, who look after the dining room, the delivery of field dinners, and many other small details about the camp. There are two men in charge of the laundry, one in charge of the tailoring department and one general clerk.

Of the 36 men that are on the road, eight are assigned to the unloading plant, about six to the hauling gang, four to sub-grade work and the balance to spreading and shaping stone and screenings. The men on road work are not definitely assigned but are shifted from one division of work to another as the superintendent may see they are needed.

The men are at their work nine hours each day and any part of rainy days that it is possible to work. Where the men are working several miles from camp, meals are carted to them by one of the dining room assistants, so there is no loss of time in reporting back to camp for meals.

There are two crews for the industrial railroad hauling system. One crew goes on at daylight and works until noon. The other crew runs the equipment until dark. The crews relieve one another at meal time so there is no loss of time hauling material during meal hours or when it is light enough to handle the equipment.

There are no guards over the men at any time. They are merely counted twice a day to make sure they are all on the job. The men are permitted to work with free labor, by themselves, or in groups, as the superintendent may see fit. So far the road camps have been handled in such a way that it would be difficult for an outsider to determine a prison camp from the ordinary free labor camp.

Any township or county officials in Illinois that are particularly interested in convict labor on the public highways, will undoubtedly be benefited by visiting the camp at Moon, the first station south of Streator on the Santa Fe Railroad. The State Highway Commission will be glad to meet any party at Moon and go over the work with them or explain more in detail concerning convict labor camps upon receipt of inquiry.

Maintaining Roads in San Joaquin County, Calif.

(Staff Article.)

All improved roads in San Joaquin County, Calif., are maintained under county engineer Frank E. Quail. This county's organization for road maintenance is unique in California—it is the first county in the state to do away with the system whereby the road money of the county is set aside into various road district funds and its expenditure left to the supervisor or commissioner of the district with little attempt to systematize the work or to keep cost data on it.

In San Joaquin County the highway maintenance department is under the jurisdiction of the county engineer, as stated. It is in direct charge of an assistant engineer, Mr. W. B. Hogan, who devotes his full time to the work. Mr. Hogan has an assistant who is also an engineer. The system of about 300 miles of improved roads of bituminous macadam is maintained as a unit. The roads are patrolled daily and repairs are made as soon as their need is indicated. The annual cost of maintenance is about $70,000.

ORGANIZATION AND PROCEDURE IN MAINTENANCE.

Patrolmen.—There are 13 district patrolmen in the maintenance department. Each man works eight hours a day and has a certain length of road to look after. He is paid $90 a month and furnishes his own horse and wagon. Besides the county engineer and the two assistant engineers there is also an accountant in the organization. All patrolmen report directly to the second assistant engineer. The patrolmen are selected with care. Responsible men who live near the centers of their districts are chosen. The patrolmen are continually alert for they do not know when one of the assistant engineers will come along on an inspection trip.

Patching.—When a patrolman sees a spot in the road at which the wearing coat has been worn off, leaving the stone below exposed, he cleans the spot thoroughly of all dust and dirt by means of a stable broom. He then paints it with a thin coat of heavy, hot, asphaltic oil, and then deposits on the asphalt stone screenings or pea gravel in sufficient quantity to absorb the oil. This forms a patch which unites readily with the older portions of the road surface, so that a few days after the patch is made it cannot be distinguished from the remainder of the roadway.

Daily Reports.—All patrolmen are required to report daily to the office the road or roads upon which they have been working and the amount of oil used.

A patrolman is not expected to maintain the mileage of road given to him, exclusive of other assistance. When the condition of the section of the road is such that it would be impracticable or impossible for him to maintain the same, a large outfit is employed for the work.

Use of County Prisoners.—There is a construction gang which consists of from 12 to 16 hired men, according to the season. This gang is free to work in any part of the county where its services are needed to help out a patrolman. The county prisoners are also worked in a chain gang. In the winter the chain gang averages from 20 to 32 men; during the harvest season the jails are less crowded and the chain gang isn't so large. About a dozen prisoners were working on July 1st of this year. Almost as good work is got out of the prisoners as from the hired men.

Plant.—The plant consists of five auto trucks, steam rollers, portable steam boilers, dump wagons, graders, water wagons, etc. A blacksmith keeps all the equipment in good condition.

Motor Patrol.—The motor patrol gang outfits handle work in which the entire wearing coat of the roadway is in need of replacement or where the surface has become so rough or uneven that it is necessary to rebuild it.

Records of Rail Wear From Vehicle Traffic.

(Staff Abstract.)

It is the general impression that vehicle traffic causes but very slight wear on a railway track structure properly built; but recent observations made up idle track of standard concrete base construction located in Franklin St., Chicago, are of extreme interest. While this track was laid for normal operation, the refusal of frontage consents before mentioned has prohibited its use for street railway traffic. Measurements made by vernier instrument after 40 months in the street showed that approximately 2/64-in. reduction in section of the rail head had taken place, measured on the center line of the tread. This represents 5 per cent of the wearing life of the rail's original section. As the tread was perceptibly coned, the maximum wear was even greater than above indicated.

These results are in a general way corroborated by the fact that the lip of old girder rail has been worn down and bent over by team traffic, and in some cases the flange-way of standard 129-lb. rail has been considerably enlarged by the wear of wagon wheels, materially reducing the wearing width of the rail tread.

In order to determine to what degree this vehicle traffic is responsible for deterioration of the track structure, a large number of observations, by a micrometer instrument, were made at various points on the system; selected with reference to both car and vehicle traffic.

The results, which were fairly consistent, are presented in Fig. 1, in which the relative portions of wear from cars and vehicles are shown for varying average headway of cars along the street. This diagram indicates the startling result that, even with as heavy a trunk line as Cottage Grove Ave. or Madison St. (around 40 cars per hour average for a 20-hour day), the vehicle wear may amount to as much as half of the total wear on the rail head and thus reduces the life of the rail by a corresponding amount. On a short section of track, carrying heavy car but no vehicular traffic—Clark St. between Wisconsin and Center Sts.—the rate of wear was found to be no greater than that on Cottage Grove Ave. and on Madison St., with only half the car traffic but with heavv team traffic. This results from the fact that the Clark St. line, at this point, runs along the edge of Lincoln Park, leaving a wide roadway to the west so that this stretch of track is practically unencumbered by heavy vehicles and thus escapes the rapid wear which is found on the heavy arteries where vehicles also use the tracks.

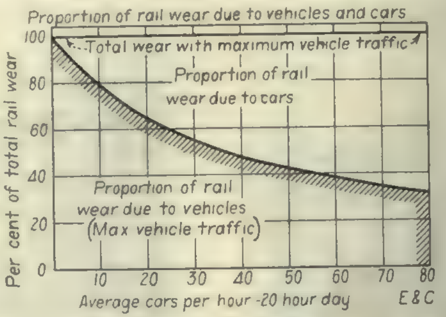


Diagram Showing Rail Wear Under Varying Traffic Conditions.

The preceding data are extracted from the Annual Report of the Board of Supervising Engineers, Chicago Traction.

New Michigan Law on Highway Crossings of Railways.

(Staff Article.)

An important change in the general highway law of Michigan was made by the last legislature. Now, before laying out any highway crossing over a steam or electric railway track, application must be made to the state railroad commission to approve such crossing.

The railroad commission is required, after application has been made for a crossing, to make a strict examination and ascertain whether such a crossing at grade would be reasonably safe. If the commission is satisfied that the proposed location of the crossing is hazardous, the railroad commissioners so notify the state highway commission. Acting jointly the railroad commissioners and state highway commissioner examine the proposed crossing in company with the parties interested, and if in their judgment it is necessary they order a relocation of the proposed highway.

If the railroad commissioners and state highway commissioner after making the examination decide that it is impracticable to secure a reasonably safe crossing by locating it in another place, they may order a separation of the grades, or may deny the application for a crossing. If a separation of grades is ordered the separation must be constructed according to plans which shall be submitted to the railroad commission and state highway commissioner for their joint consideration and approval.

The law now provides that the railroad company furnish a competent man to superintend the work, to be paid by the township, good roads district or county, as the case may be, a per diem compensation not to exceed $3. Where grades are separated the costs are apportioned between the several parties at interest, the state's apportionment being 25 per cent or under.

It is thought that this law will lead to changes in location or construction of the hundreds of dangerous crossings now existing in the state, authority to remedy existing conditions being granted by the law.

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Use of Split Granite Blocks on Cincinnati Streets.—During the year 1914 Mr. F. S. Krug, city engineer of Cincinnati, made a service test of split granite blocks on a section of roadway 100 ft. in length. The results of this experiment were so satisfactory that Mr. Krug intends to resort to this plan whenever it becomes necessary to relay a granite block pavement. Briefly, the plan consists of splitting the old granite blocks into two equal parts which are relaid with the new surface exposed to traffic. The blocks are readily split, to form the new paving stones, by the use of hand tools. Besides possessing obvious economic advantages this plan makes a solid pavement and one less noisy than the one replaced. The surface formed is as smooth as is required for the heavy traffic common to granite paved streets.

Pennsylvania Regulates Traction Engines.—Traction engines drawing trailers and damaging state highways thereby will no longer be permitted to operate with impunity in the State of Pennsylvania. State Highway Commissioner Cunningham has served notice that the license fee for tractors and trailers will be exacted in each case and that each application will be scrutinized to see whether or not all the provisions of the law are observed. Owners of traction engines, operated for other than agricultural needs, will be compelled to refrain from damaging state highways and will be held to a strict accountability for whatever damage may be done.

CURRENT NEWS

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The Doings of the Week.

Developmnets of the past week indicate that the business and finances of the country were approaching normal. Business is not only keeping up, but the volume is steadily increasing. Bank clearings for the month of June totaled $14,006,172,676, an increase of 1 per cent over the figures of a year ago and a gain of 2.7 per cent over the total of two years ago. The export business continues to show an increase. The United States Steel Corporation's unfilled orders on June 30 totaled 4,678,196 tons, according to the monthly statement issued last Saturday. This is an increase of 413,598 tons over the amount of the corporation's business at the end of May. Considerable activity has been shown in the railroad field, at least in regards to the construction end. New York City and Philadelphia have asked bids on subway work. In practically every construction field marked improvement has been made. The states of New York and Ohio are seeking bids on highway work, the latter on 41 new improvement and 5 repair contracts. In the municipal line street paving and waterworks and sewerage construction are offering many opportunities. Perhaps the best building news of the week is the continuation of work in the Chicago district, where permits for $16,000,000 worth of construction have been awaiting the settlement of the strike. The Federal government is calling for bids on a considerable amount of rivers and harbors work. Several small ditch iobs have reached the call for bids stage. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending July 7 were as follows:

Finished Iron and Steel: Per lb. to large buyers:	July 7. Cts.	June 30. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.22½	1.22½
Iron bars, Pittsburgh........	1.25	1.25
Iron bars, Chicago...........	1.20	1.20
Steel bars, Pittsburgh.......	1.25	1.25
Steel bars, New York........	1.419	1.419
Tank plates, Pittsburgh.....	1.20	1.20
Tank plates, New York......	1.369	1.369
Beams, etc., Pittsburgh......	1.25	1.20
Beams, etc., New York......	1.419	1.369
Skelp, grooved steel, p'gh....	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh......	1.30	1.30
Sheets, Nails and Wire. Per lb. to large buyers:		
Sheets, black, No. 28, P'gh..	1.75	1.75
Galv. sheets, No. 28, P'gh...	4.50	4.50
Wire nails, Pittsburgh.......	1.60	1.55
Cut nails, Pittsburgh........	1.55	1.55
Fence wire, base, Pittsburgh	1.40	1.35
Barb wire, galv., Pittsburgh.	2,50	2.40

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.25 cts.

Railways.—The most notable happening in this field was the placing of advertisements on Friday by the Public Service Commission for the First District of New York City for the construction of three sections of subways, one in Manhattan and two in Brooklyn. Philadelphia requests bids on a section of the Frankford elevated, extending from Callowhill to Unity Streets, this in addition to the first section of the Broad Street subway, advertisement for which was placed a few weeks ago. The Alaska Engineering Commission, Seattle, Wash., has asked bids on material estimated to be sufficient to construct 42 miles of the Alaska Railway. In the contract let line the best job appears to be that let by the Ozark Ry., for 15 miles of its line in Arkansas. This was secured by the Blodgett Construction Co. of Kansas City.

Roads and Streets.—In both the highway and municipal fields a considerable amount of work made its appearance last week. The state of Ohio has asked bids on 41 improvement and 5 repair contracts. Maine wants bids on four sections of state highway and New York on over 5 miles of road for Orange County. In the municipal field a number of cities are asking bids on street paving improvements of all classes, while several large contracts have been let by states and cities. Some worthy of mention are: State of California, for about 36 miles of roads, the contract prices aggregating $266,949; city of Trenton, N. J., for asphalt paving on six streets, to cost $45,000; Alleghany County, Pennsylvania, for the construction of six county roads, the awards being made on July 12; city of Milwaukee, for about $50,000 worth of asphalt pavements; Boston, Mass., for street paving to cost $70,526; Port Angeles, Wash., for a $94,533 job calling for 12 miles of street grading; North Wales, Pa., for resurfacing a turnpike, the low bid for which is $60,000, and Edmonton, Alberta, a $125,000 paving job secured by the Crown Paving Co.

Bridges.—A fair amount of bridge work is up for bids and several large jobs have about reached the stage of calls for bids. Worcester, Mass., has voted a 20-year loan of $250,000 and appropriated the money for a bridge over Lake Quinsigamond at the present causeway. Some of the contracts let were: L. E. Sturm, Columbus, O., for concrete viaduct and approaches over the Norfolk and Western and Baltimore and Ohio Southwestern tracks in Portsmouth for $120,356; Missouri Valley Bridge Co., for the Northern Electric Ry. Co.'s bridge across the Sacramento River at Meridian, to cost about $80,000; Wm. F. Cogley, for 3-span concrete and steel bridge over new channel of Mohawk River for city, to cost $59,158; Luten Bridge Co., for $50,600 bridge over the Tygarts River at Grafton, W. Va., and the Oregonia Bridge Co., Lebanon, Ind., for bridge over Whitewater River, Lawrenceburg.

Drainage and Irrigation.—No particularly large undertakings in either the drainage or irrigation fields appear to have been advertised during the past week. Several small drains are up for bids in Indiana. It is probable the U. S. Reclamation Service will have additional work to let shortly on its projects. In the construction line there has been 142 miles of drainage ditches and levee work let at Bartow, Fla., for the Peace Creek Drainage District. This contract calls for 2,432,743 cu. yds. of excavation and was secured by A. V. Wills & Sons of Pittsfield, Ill.

Waterworks and Sewerage.—Some fair-sized jobs are now being advertised in this line. Ocean City, Md., wants bids on intercepting sewers and other sewer work, while Toronto, Ont., has asked competitive bids on several large sewers. Sioux Falls, S. Dak., will build a 1,200,000-gal. reservoir; a 350,000-gal. elevated tank, etc., the bids to be in by July 26. The Pittsburgh Filter Mfg. Co. has taken a contract to built a 5,000,000-gal. filter plant at Cheyenne, Wyo., while Jersey City, N. J., plans to construct a pipe line from Brookdale to Jersey City at a probable cost of $1,500,000.

Rivers and Harbors.—Bids have been asked by the government on a number of dredging jobs—at the Navy Yards, Puget Sound, Washington; in Tuckerton Creek and Absecon Creek, New Jersey; in St. Johns River, Florida, etc. It was announced during the week that Governor Dunne of Illinois had presented to Secretary of War Garrison plans to deepen the Illinois River from Joliet to the Mississippi River, for which $20,000,000 has been appropriated.

Buildings.—One of the largest building jobs up for bids is the new East high school at Cincinnati, O., which has been estimated to cost $1,000,000. Bids are also wanted at Akron, O., for the new Armory building to cost $165,000. Contracts let were: Syracuse, N. Y., to Phalen Engineering & Construction Co., for Vocational high school to cost $290,778; Washington, D. C., to P. F. Gormley Co. for colored high school to cost $260,767; Louisville, Ky., $150,000 building for Y. M. C. A., and at Baltimore, $100,000 garage for Baltimore City Garage Co.

$500,000,000 for Irrigation Reservoirs.

Mr. J. B. Case of Abilene, Kans., president of the International Irrigation Congress, is confident that the Newlands bill appropriating $500,000,000 for the construction of large irrigation reservoirs in Colorado, Montana and one or two other western states, will be passed at the next session of Congress. He predicts that there will be more progress in irrigation and colonization in this country in the next 10 years than during the last 40 years. The Newlands act proposes the appropriation of $500,000,000 in 10 annual installments of $50,000,000 for the construction of large reservoirs in the intermountain country, containing headwaters of large streams, for the purpose of supplying water and power to these and adjacent states.

Mr. Case states that there is a widespread and genuine interest in the Newlands act throughout the territory affected. A systematic campaign is to be made in the interests of the passage of this act at the next session of Congress. Mr. Case feels that sufficient sentiment has already been crystallized to insure its passage. Meetings will be held in every state affected by the measure, and every effort will be made to bring out an irresistable demand for its passage.

Mr. Case anticipates that at the close of the European war there will be thousands attracted to this country by the wish to escape the taxes that will burden the countries of Europe for years as a result of the war. He feels that with the numerous irrigation projects now under way and in process of creation, there will be plenty of available land for the farmers of this country and those who may come from abroad.

Power Canal in Missouri.

The construction of a power canal is provided for in a bill now pending before the Missouri legislature. This project has been branded impracticable by the report of a committee of the Associated Engineering Societies of St. Louis, appointed to look into its feasibility. The project is to develop hydro-electric power by constructing a canal between the Missouri and the Meramec rivers, the electric current generated to be used in the city of St. Louis. Those who introduced the bill based their claims favorable to its passage upon the belief that there is a natural fall from the Missouri to the Meramec sufficient to develop 200,000 HP. The committee report mentioned, points out that there is no fixed difference in elevation between the two rivers which could be utilized to develop power; in fact, the flow between the rivers would be reversed several times during the year owing to variations in water stage.

Outside Competition.

Some cities carry the principle of keeping the money at home beyond the stipulation that preference shall be given to local labor to the actual or virtual exclusion of bids from outside contractors. Philadelphia was formerly in this class of cities. During the past three or four years bids have been asked not only from Philadelphians, but from those outside the city, and even outside the state of Pennsylvania. Director M. L. Cooke of the Department of Public Works, says this outside competition "has destroyed the hold of powerful political contractors on local construction work." He shows that the aggregate saving to the city on four contracts awarded to outside bidders was $100,734.

The Lighter Side of Engineering and Contracting

Senegambian Affluence.

FURTHER insight into the labor problem of the southern contractor may be gained from the following story. A contractor was overseeing a trenching job through joint clay which caved badly. A section of the trench wall was obviously about to fall in and all hands were exceedingly busy trying to hold it up with improvised shoring. The contractor turned to call for help, but the rest of his gang were out of earshot. A large colored gentleman of the leisure class hove into sight at this moment. "Here you, Sambo," said the contractor, "give us a hand a minute and I'll give you a quarter." "White man," said Sambo, "yo' doan interes' me. I'se got a quatah."

Those Inevitable Dry Streaks.

THE reader who is disturbed because every article in an engineering journal is not immediately and directly helpful or interesting to him will do well to reflect on the viewpoint of the man concerning whom Dudley Field Malone, Collector of the Port of New York, tells the following story:

A man was hunting up in Pike County, and up around Porter's Lake he visited a settler's house. He noticed a volume of a good enclyclopaedia on a shelf above the gun, and said: "It must be a handy thing, away off here, to have an encyclopaedia." "Yep," said the mountaineer. "Yep, she's handy. I ony got the first book." "Why haven't you got the others?" "I ain't finished this one yet, so I ain't ready for another. I bought this one offen an agent about eight years ago. He come around six months, afterwards and says, says he, 'Here's yer second volume, mister.' "What! say I. "Why I aint' near finished the first volume yet. You jest dig out! He dug, too. Nine years ago it was. I ain't more'n half through her yet. The wife, she's about quarter through. It took a lot o' brains to write this book, but it's my opinion all the same, and I don't mind tellin' ye, that I think she's got her dry streaks, like most everything else."

IN AN Indiana city a brick pavement was being laid on a concrete base. The specifications called for 5 ins. of concrete, but the thrifty contractor was putting down only 2 ins. One night at quitting time the gang did not show up at field headquarters. The contractor waited until 9 p. m., when the brick foreman finally showed up. "Where you been, Bill?" asked the boss. "I wanted to get them bricks on that concrete base before some night prowlin' varmit run over it and busted it in," said Bill.

A PLACARD on the wall of the boiler room of the Danville, Ill., water works pumping station reads: Put your trust in God but always carry two gages of water.

J. Caesar, Road Builder.

WHEN Caesar built the Roman roads and furnished appropriate subject matter for the introductory chapters of modern works on road building, he also laid himself liable to commemoration odes such as the one here quoted. This one is attributed to the Town Report of Stockbridge, Mass.:

When Caesar took an eastward ride and
grabbed the Gauls of Rome,
What was the first thing that he did to
make them feel at home?
Did he increase the people's loads and
liberty forbid?
No; he dug in and built good roads—that's
what old Caesar did.

Did Caesar put the iron heel upon the foeman's breast.
Or did he try to make them feel that
Roman rule was best?
What did he do, to make them glad he
came their lands amid?
He built good roads in place of bad—
that's what old Caesar did.

He built good roads from hill to hill, good
roads from vale to vale;
He ran a good roads' movement 'till old
Rome got all the kale.
He told the folks to buy a home, build
roads their ruts to rid.
Until all roads led up to Rome—that's
what old Caesar did.

If any town would make itself the center
of the map,
Where folks will come and settle down
and live in Plenty's lap,
If any town its own abodes of poverty
would rid,
Let it go out and build good roads—just
as old Caesar did.

A YOUNG St. Louis contractor was desirous of going up into Michigan to bid on a sewer job. He could figure everything out if he could just make good with the certified check. This seemed almost hopeless, but he called on an old friend of his family, a banker, and pleaded his case. The banker finally agreed to furnish the check, but the figure to be filled in was then unknown to them and for a time it seemed that this would spoil the young man's plans. At length the banker certified a blank check, at the same time exacting a verbal promise from the contractor not to fill it in with a figure exceeding a certain sum. This was agreed to and the contractor went and made his bid and it turned out that he was low bidder. The question of his financial responsibility was then raised and he flashed on the city officials the certified blank check, drawn in his name on the biggest bank in St. Louis. "There," he said, "is how I stand with this bank." This flattened out the last obstacle and he got the job.

The Pinnacle of Recklessness.

The Reclamation Record extends a cordial invitation to all eligible bachelor readers to write their candid opinion about starting a matrimonial department in that publication. The Record says: "We're willing to try anything once." That may be a precarious venture for the Record, but what may we appropriately call the position of the bachelors who are clamoring for such a department?

A SEWAGE treatment plant was being built at an insane asylum. Many of the patients were nearly enough sane to help on the work which was done by day labor. The broken stone for the contact beds was wheeled in barrows from a nearby railroad siding and dumped in place. Several men were wheeling, pursuit fashion, and one man was going along solemnly with his wheelbarrow turned upside down. "Here, you," said the foreman, "that isn't the way to do. Turn your barrow over." "Not much," said the man, "I did that yesterday and a man shoveled some of this rock into it."

A VERY large Swede and a small Frenchman, members of a bridge gang, were sawing up 12x12 timbers for the pile caps on a trestle job with a crosscut saw. As they pulled the saw back and forth a green Irishman, just over and that morning engaged as a helper on the gang, came along. He watched the men sawing for a minute and then stepped over and delivered a terrific straight-arm punch to the point of the Swede's jaw. "Gwan," he said to the Swede, "give the little man the saw if he wants it."

A Definition of Efficiency Engineer.

THE following definition of an efficiency engineer is attributed to Alderman Frank Dowling of New York City. "The title of efficiency engineer," said the alderman, "doesn't necessarily imply that the man is either efficient or that he is an engineer. It's a good deal like a welsh rabbit—which is neither Welsh nor rabbit—it's just a piece of cheese."

Skinner Mulvey says: Jest t' show that I'm nootral I didn't know whether t' be glad er sorry when I heered about them fourteen-hundred odd mules goin' down when th' Armenian was torpedoed.

Two Double-Leaf Bascule Bridges to Be Constructed at Seattle, Wash.

Bids to Be Received Until July 23, 1915.

Structures to Span Salmon Bay Waterway and Lake Washington Canal.

Bids will be received until 10 a. m., July 23, 1915, by C. B. Bagley, secretary, Board of Public Works, Seattle, Wash., for the construction of two bridges consisting of double-leaf steel bascule superstructures, reinforced concrete substructures, and appurtenant works. One bridge will span the Salmon Bay Waterway at Fifteenth ave. N. W., and the other will cross the Lake Washington Canal at Fremont ave., Seattle, Wash.

Fremont Ave. Bridge.—The bridge at Fremont ave. will cross the canal at an angle of 56° 58′ 58″ and will provide a clear channel of 150 ft. It will consist of two leaves, each 121 ft. long from center of trunnion to end of leaf. The bridge will provide a 40-ft. clear roadway and two 6-ft. sidewalks, the latter being cantilevered beyond the main riveted trusses which are spaced 44 ft. on centers. The main trunnions are 18½ ins. in diameter. The floor system consists of built-up floorbeams, spaced 17 ft. 10 ins. on centers; longitudinal I-beam stringers, spaced about 2 ft. 6 ins. on centers; and a wood block pavement supported on 1¾-in. planking laid on 3¾x12-in. subplanks. The center part of the roadway will carry two lines of street railway tracks. The sidewalk surfacing consists of 2x8-in. planks. The sidewalks are equipped with a fence consisting of 2-in. square mesh fencing of No. 12 wire supported by double angle posts. Each leaf will be raised and lowered by two electric motors geared to a pinion, which in turn engages a rack attached to each truss. All control of the bridge will be automatic, and the operations of withdrawing the center lock pin and raising the leaves will be interlocked. The roadway will be protected by electrically operated safety gates. Each leaf is to be equipped so as to control separately, and in addition both leaves are to be controlled from the south side of the canal.

The substructure will be constructed of concrete, reinforced in parts, and will consist of four units, two on each side of the axis of the waterway. Each unit will consist of a footing course, placed lengthwise of the bridge. Two shafts will be built on each footing, one at the channel end and one at the anchorage end. These shafts will be connected transversely and longitudinally by concrete and steel girders and braces. A light curtain wall will be built on the outsides of the piers completely enclosing the space between the shafts. The footings will rest on a natural foundation of sand and gravel.

Each anchor span will have a length of 36 ft. 6 ins. from its outer end to the center of the trunnion. These spans consist of longitudinal girders which frame into an end floorbeam and carry a floor system consisting of a wood block pavement supported on a concrete base, the latter resting on buckle-plates riveted to the longitudinal girders.

Fifteenth Ave. N. W. Bridge.—The bridge at Fifteenth ave. N. W. will cross the Salmon Bay Waterway at an angle of 66° 21′ 33″. It is a trunnion bascule span of two leaves, each 109 ft. long from center of trunnion to end of leaf. This bridge will also provide a 40-ft. clear roadway and two 6-ft. sidewalks, the latter being cantilevered from the riveted trusses which are spaced 44 ft. on centers. The main trunnions are 16½ ins. in diameter. The center part of the roadway will carry two lines of street railway tracks.

The details of the floor system, operating mechanism, and substructure are similar to those described for the Fremont ave. bridge.

DIVISION OF CONTRACT AND QUANTITIES OF MATERIALS.

In bidding for the construction of these two bridges, bidders may make proposals for any one or more of the following seven propositions, with the exception of Proposition No. 1.

Proposition No. 1.—This work includes the construction of timber approaches and appurtenant works at both ends of the bascule bridge over the Salmon Bay Waterway at Fifteenth ave. N. W. This work has been taken out of competition.

Proposition No. 2.—This work includes the construction of the substructure of the bascule bridge over the Salmon Bay Waterway at Fifteenth ave. N. W. The following are the approximate quantities of materials required for this part of the work. Elevation —35 referred to in this bill of materials is the elevation of the bottom of the footings as shown on the plans.

1.	Excavation, cu. yds.	5,200
2.	Class "A" concrete deposited under water by tremie, 1:2:4 mixture, cu. yds.	2,700
3.	Class "C" concrete in piers above water, 1:3:5 mixture, cu. yds.	4,600
4.	Alternate tc items 2 and 3 concrete placed in unwatered foundations and piers Class "C" concrete 1:3:5 mixture, cu. yds.	7,300
5.	Class "B" concrete 1:2:4 mixture, cu. yds.	850
6.	Reinforcing steel, lbs.	127,000
7.	Placing and painting structural steel, grillages, and anchor bolts, including grouting, lbs.	300,000
8.	Fir bumping logs	2
9.	Peeled piles in protection works, lin. ft.	4,200
10.	Timber in protection works, M. ft., B. M.	8.0
11.	Chains on Dolphins, lin. ft.	325
12.	Surface treatment of panels, sq. ft.	560
13.	Brick pattern work, sq. ft.	400
14.	Pendants of 1 part cement to 3 parts sand	16
15.	Test piles	4
16.	Eye bolts in shafts of anchor piers.	8
17.	Extra excavation below elevation —35, cu. yds.	750
18.	Extra Class "A" concrete below elevation —35, cu. yds.	750
19.	Alternate to item No. 18 in case foundations are unwatered. Extra Class "C" concrete below elevation —35, cu. yds.	750

Proposition No. 3.—The work included in this contract consists of the construction and erection of the superstructure of the bascule bridge over the Salmon Bay Waterway at Fifteenth ave. N. W. The following are the approximate quantities of materials required to complete this work:

1.	Furnishing and erecting machinery, lbs.	230,000
2.	Furnishing and erecting structural steel, lbs.	1,900,000
3.	Furnishing structural steel, erected by contractor for substructure, lbs.	300,000
4.	Furnishing, placing and adjusting gravel, concrete counterweight, cu. yds.	390
5.	Furnishing, placing and adjusting cinder concrete counterweight, cu. yds.	280
6.	Furnishing and weighing gravel concrete test blocks, cu. yd.	1.0
7.	Furnishing and weighing cinder concrete test blocks, cu yd.	1.0
8.	Roadway floor on movable leaves, sq. yds.	890
9.	Roadway floor including reinforcement on fixed portion, sq. yds.	410
10.	Sidewalk floor on movable leaves, sq. yds.	265
11.	Sidewalk floor on fixed portion, sq. yds.	130
12.	Concrete floor including reinforcement, on machinery platforms, sq. yds.	90
13.	Reinforcing bars in concrete counterweight, lbs.	10,000
14.	Electric equipment complete in place	lump sum
15.	4 operators' houses and 2 toilet rooms complete	lump sum
16.	Meneely fog bell in place	lump sum
17.	Copper ball vessel signals in place.	2
18.	Iron pipe hand rails below deck of bridge, lin. ft.	80
19.	All wooden steps and railings, providing access to machinery platforms	lump sum
20.	Double arm roadway gates complete in place	4
21.	Oak buffer blocks	14

Proposition No. 4.—This work consists both of constructing the substructure and constructing and erecting the superstructure of the bascule bridge over the Salmon Bay Waterway at Fifteenth ave. N. W. The approximate quantities of materials required are as given under Proposition Nos. 2 and 3.

Proposition No. 5.—The work included in this contract consists of constructing the substructure of the bascule bridge over the Lake Washington Canal at Fremont ave. The approximate quantities of materials required are as follows. Elevation —32 referred to in this bill of materials is the elevation of the bottom of the footings as shown on the plans.

1.	Removing existing structures and debris	lump sum
2.	Excavation, cu. yds.	15,000
3.	Class "A" concrete deposited under water by tremie 1:2:4 mixture, cu. yds.	3,500
4.	Class "C" concrete in piers above water 1:3:5 mixture, cu. yds.	3,200
5.	Alternate to items 3 and 4 concrete placed in unwatered foundations and piers Class "C" concrete 1:3:5 mixture, cu. yds.	6,700
6.	Class "B" concrete 1:2:4 mixture, cu. yds.	1,100
7.	Class "D" mortar, 1:2 mixture, cu. yds.	300
8.	Reinforcing steel, lbs.	155,000
9.	Placing and painting structural steel, grillages, and anchor bolts, including grouting, lbs.	305,000
10.	Fir bumping logs	2
11.	Peeled piles in protection works, lin. ft.	7,000
12.	Timber in protection works, M ft. B. M.	9.0
13.	Chains on Dolphins, lin. ft.	570
14.	Test piles	4
15.	Extra excavation below elevation —32, cu. yds.	1,200
16.	Extra Class "A" concrete below elevation —32, cu. yds.	1,200
17.	Alternate to item 16 in case foundations are unwatered Extra Class "C" concrete below elevation —32, cu. yds.	1,200
18.	Eye bolts in shafts of anchor piers.	8

Proposition No. 6.—This work includes the construction and erection of the superstructure of the bascule bridge over the Lake Washington Canal at Fremont ave. The approximate quantities of materials required are as follows:

1.	Furnishing and erecting machinery, lbs.	260,000
2.	Furnishing and erecting structural steel, lbs.	2,050,000
3.	Furnishing structural steel, erected by contractor for substructure, lbs.	305,000
4.	Furnishing, placing and adjusting gravel concrete counterweight, cu. yds.	700
5.	Furnishing, placing and adjusting cinder concrete counterweight, cu. yds.	10
6.	Furnishing and weighing gravel concrete test blocks, cu. yds.	1
7.	Furnishing and weighing cinder concrete test blocks, cu. yds.	1
8.	Roadway floor on movable leaves, sq. yds.	1,010
9.	Roadway floor including reinforcement, on fixed portion, sq. yds.	400
10.	Sidewalk floor on movable leaves, sq. yds.	490
11.	Sidewalk floor on fixed portion, sq. yds.	172
12.	Reinforcing bars in concrete counterweight, lbs.	20,000
13.	Electrical equipment complete in place	lump sum
14.	4 operators' houses and 2 toilet rooms complete	lump sum
15.	Meneely fog bell in place	lump sum
16.	Copper ball vessel signals in place.	2
17.	Double arm roadway gates complete in place	4
18.	Wooden steps and railings and angle iron bracket supports providing access to machinery at sides of trusses	lump sum
19.	Steel ladders providing access to counterweight pit sumps, pairs.	2
20.	Pit pumps complete	2
21.	Iron gratings over counterweight pit sumps	2
22.	Black iron pipe railings on stairways and platforms below deck, lin. ft.	60
23.	Machinery houses complete	2
24.	Galvanized iron pipe railings at sides and rear of anchor piers, lin. ft.	130
25.	Oak buffer blocks	14

Proposition No. 7.—This work includes both the construction of the substructure and the construction and erection of the superstructure of the bascule bridge over the Lake Washington Canal at Fremont ave. The approximate quantities of materials are as given under Propositions Nos. 5 and 6.

The American Association of Engineers.

A new engineering society, or association, called the American Association of Engineers, has recently been organized in Chicago. It is officially known as the American Association of Engineers and has headquarters at 29 S. La Salle St., Chicago. The objects of the association are to raise the standard of ethics of the engineering profession, and to promote the economic and social welfare of engineers. It is hoped that these objects will be accomplished, (1) by affording means for the interchange of information beneficial to engineers, (2) by maintaining a Service Clearing House for the benefit of members, (3) by affording patent and legal advice pertaining to matters of interest common to engineers, (4) by supervision of legislation affecting engineering, and (5) by proper publicity of the association's ideas. The watchword of the association is "Co-operation." The officers and directors of the association are: W. D. Wilcox, gas engineer, president; T. B. Lamber, power engineer, vice president; J. C. Kelsey, financial editor of "Telephony," treasurer; Arthur Kneisel, patent attorney, secretary; Garrison Babcock, telephone engineer, and A. H. Krom, electrical engineer, directors. The membership includes engineers, technical educators, chemists and draughtsmen who have had a technical education and two years' practical experience, or five years' practical experience.

CINCINNATI RAPID TRANSIT REPORT.

Loop Scheme Contemplates Rapid Transit for All Sections of City.

Bond Election November 2, 1915.

On July 2, Mayor Spiegel's Rapid Transit Commission made its report. The report calls for building the system known as Modification H of Plan 4. The estimated cost of the recommended project is $5,717,849. This figure is exclusive of power house, equipment and damages to property. The projected line runs from a point in Norwood through the Duck Creek ravine, under Owl's Nest Park, skirting the bluff and Mt. Adams to a point near the Pennsylvania Railroad Station, thence over Pearl to Walnut, then as a subway under Walnut to the canal, thence in the canal to St. Bernard and through the open country from St. Bernard to Norwood.

The projected line should be built, in the opinion of the Commission, with a view to affording an adequate entrance for interurbans into the city, and at the same time providing facilities for the operation of such local and suburban service as could be handled profitably. It is recommended that the system be built by the city and leased to an operating company for operation.

The question of issuing bonds to defray the cost of construction will probably be submitted to the voters at the election to be held Nov. 2, 1915.

PERSONALS

Mr. E. J. Holland has resigned his position as city engineer of Guelph, Ont., and the city clerk has been instructed to advertise for a new city engineer.

Mr. Howard R. Klepinger has been appointed as assistant superintendent of public works for the state of Ohio, and is in charge of rivers, dams, locks and all improvements to artificial lakes and also of canal systems. This position has been recently created and Mr. Klepinger will take the place of two division engineers. Mr. Klepinger was chief engineer for the J. A. Kauffman Co. from 1902 to 1906. For the two years following he was county engineer of Montgomery County, Ohio. Following that he was assistant city engineer of Dayton, Ohio.

Professor Charles M. Spofford of Fay, Spofford & Thorndike, Consulting Engineers, Boston, and head of the Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, has been appointed by Governor Walsh of Massachusetts, as one of the commissioners "to investigate the subject of terminal facilities and the improvement of facilities for the transportation of freight in the metropolitan district." This commission is authorized to investigate the entire question of the development and improvement of facilities for the transportation of freight in and from and with relation to the city of Boston; to determine the proportion of cost which should be borne by the commonwealth, by the city of Boston, and by public service corporations, respectively.

Mr. John F. Trumbull has been appointed chief engineer to the Connecticut Public Utilities Commission, succeeding Mr. C. C. Elwell, who resigns to become a member of the commission. Mr. Trumbull is a graduate of the Sheffield Scientific School at Yale, class of 1902. For one year following he was engaged on mountain location work for the International Railroad of Mexico. Since that time he has been in the employ of the Connecticut Company and the New York, New Haven & Hartford in the construction and maintenance of way departments. He has served in those departments as rodman, draftsman, assistant engineer and finally as chief clerk to the chief engineer. It is interesting to note that Mr. Trumbull gained his appointment after passing a civil service examination for the place with a grade of 97.5 per cent, a mark 5 per cent higher than any reached by his fourteen competitors.

Mr. Thomas L. Fountain of the Fountain-Shaw Engineering Co., Dallas, Tex., has been appointed engineer of sewers for the city of Dallas. The city is now building intercepting sewers and a disposal plant from plans by James H. Fuertes costing about $550,000, and Mr. Fountain will have charge of this and all other sewer work under the supervision of the city engineer. Mr. Fountain is a graduate of Cornell University with the civil engineering class of 1905. He is an associate member of the American Society of Civil Engineers. After leaving the university Mr. Fountain was employed for four years as assistant engineer on the staff of Alexander Potter, civil engineer of New York City, on the design and construction of sewers, sewage disposal and water supply plants. From 1909 to 1915 he has maintained a civil and sanitary engineering practice in Houston and Dallas, Tex., and is a partner in the Fountain-Shaw Engineering Co. He has designed and built many sewers, disposal plants and waterworks for various towns in Texas.

Mr. Daniel B. Sayer, formerly of the firm of Major & Sayer, civil and contracting engineers of Wellsville, N. Y., announces that he has opened an office in Wellsville, where he will continue the practice of civil and contracting engineering. Mr. Sayer will specialize in design and construction of buildings for residential, industrial, garage and livery purposes; also concrete "self-sentering" silos and steel and reinforced concrete bridges, water supply, paving, sewers, etc. Mr. Sayer is an associate member of the American Society of Civil Engineers and has been in active engineering work since 1904, when he was general draftsman for Marvin & Davis, architects, of New York City. After serving as chainman, instrumentman and assistant engineer for various railroads and engineering companies, in 1909 he was appointed assistant engineer for the Burlington, in charge of location and construction of twenty miles of line, consisting of heavy rock excavation and timber trestle bridges, and also division engineer in charge of double track work. For several years following he was employed in maintenance of way and construction work for the New York, Ontario & Western and the Delaware, Lackawanna & Western. From July, 1912, to April, 1914, he was with the New York State Engineering Department as assistant engineer, Bureau of Bridges of Barge Canal. For the past year he has been a member of the firm of Major & Sayer.

OBITUARIES

Arthur D. Osborn, paving contractor of Binghamton, N. Y., died at his home in that city, June 29, aged 58.

Richard F. Egan, general contractor of Springfield, Ill., died in that city July 4. Mr. Egan had been in business in Springfield for many years and had done a great deal of municipal work for that city. He also constructed a number of the county roads and at the time of his death was engaged on state highway work between Springfield and Rochester.

NEW CATALOGUES

Trailers.—Paper, folder. The Troy Wagon Works Co., Troy, Ohio.

Shows a number of Troy trailer outfits on various kinds of work. Gives specifications for special motor truck trailers.

Air Compressors.—Paper, 4x8½ ins.; 6 pp. folder. Gardner Governor Co., Quincy, Ill.

Describes the Gardner-Rix vertical air compressor. Gives tables of capacity, speed, dimensions, power required, etc., and cuts showing the various types.

Grouter for Brick Paving.—Paper, 6x9 ins.; 8 pp. Marsh-Capron Mfg. Co., 467 Old Colony Building, Chicago.

Book No. 32 describing the Marsh-Capron Grouter for brick pavement construction. This is a new machine, a mechanical grout mixer and distributor, light in weight with distributing spout to cover a radius of 6 ft. Construction details are described and a number of views of the machine in operation are included.

Good Roads.—6x9 ins.; 16 pp. The Garford Motor Truck Co., Lima, Ohio.

The above company has issued this little book entitled "Roads; Their Influence Upon Economic and Social Conditions," for the purpose of interesting the public in the subject of better roads. Illustrations show the effects of good roads upon the school and social conditions of the community, and the commercial value of the increased transportation facilities are set forth with statistics of costs and capacities.

CATALOGUE REVIEWS

Sand and Gravel Washing Plants.—Paper, 6½x10 ins.; 80 pp. The Raymond W. Dull Co., 111 W. Washington St., Chicago.

An attractive and well-illustrated catalogue recently issued describes the various Dull devices and equipment for the modern sand and gravel plant. The list includes conical washing screens, and screens of other types, scrubbers, water pans, sand separators of various kinds, loading spouts and gates, drag-line excavators, buckets, trolleys, hoists, conveyors, elevators, tubular washers, etc. Numerous diagrams and views supplement the text and explanations of application and operation are given where necessary. The latter half of the book consists of illustrations of Dull plants, showing a wide variety of designs and equipment.

INDUSTRIAL NOTES

The general office of the Sandusky Portland Cement Co., which has been located in Sandusky, O., since the organization of this company, will be moved to Cleveland, O., on August 1, 1915. The Cleveland office is already the headquarters of the treasurer, secretary, assistant manager and directors, and will now be combined with the offices of the president and general superintendent, and the sales, publicity and accounting departments. All will be located in the Engineers Bldg.

Mr. Albert Russel Erskine has been elected president of the Studebaker Corporation at a meeting of the Board of Directors held in New York City, July 7. Mr. Erskine has been treasurer of the corporation since 1911 and first vice-president since 1913. Mr. Fish, who relinquishes the presidency, becomes chairman of the board, the executive and finance committees. Mr. C. C. Hanch, formerly of the Nordyke & Marmon Co., of Indianapolis, and prominent in the National Automobile Chamber of Commerce, who has been connected with the Studebaker Corporation since last March, is now chosen as treasurer.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Something Different in Engineering Society Publications.

The June issue of the Journal of the Cleveland Engineering Society is termed the "Good Will Number." It is unique among the publications of engineering societies in that it contains nothing which technically may be called engineering; yet an understanding of its contents is as essential to broad engineering success as it is to success in any other kind of work. Its seventy pages are filled with poetry, prose, and truisms, collected from numerous sources. Undoubtedly a part of its contents will appear somewhat familiar to the reader; even so, a review of the issue at this time may have a new meaning. In any event, a better understanding of what the issue stands for will make a better engineer of one —and a better citizen. Such an understanding will quicken the appreciation of the engineer by those about him, and thus will help to secure the more general recognition of the true worth of the engineering profession.

The Preparation and Reading of Advertising Circulars.

There is ample evidence warranting the statement that the bad habit of throwing away unexamined all circulars has taken root in many business offices. It is less expensive to state a fact in a circular than by word of mouth. Therefore, we believe that the habit mentioned, by increasing selling costs, is bad economy. A few illustrations will be given to prove the truth of our premises and we shall offer some suggestions to those who prepare and receive circular matter.

The editors received a circular a few days ago issued by a manufacturer of water works appliances. On the face of the circular bearing the address this note appeared: "Note to Water Works Clerk—This is a fact story in which the Superintendent will be keenly interested. Kindly see that it gets to him." Back of that note lies some years of experience in circularizing the water works field. The manufacturer evidently had noticed the fact that clerks in water departments often take the responsibility of throwing away circulars addressed to water superintendents. It is often a serious blunder to refuse to listen to a salesman. Similarly, it is often an economic blunder to throw away, unread, a circular pertaining to some labor-saving or other form of money-saving material or device. In the case mentioned we do not hesitate to say that the device announced in the circular merits the careful consideration of every water superintendent. That being true, how ridiculous it is to take the attitude that any superintendent is too busy to spare the two or three minutes necessary to read the circular.

Two illustrations will be drawn from our own experience to show the lack of warmth in the welcome commonly extended to irregularly received second-class mail matter. It is our invariable custom to send a marked copy of this journal to every person mentioned in the technical article section. Despite this custom we are frequently taken to task for failing to send a copy of a certain number to an individual who has furnished something for publication in that number. The explanation of this is simply that the clerk who opens the mail in our contributor's office failed to bring the marked copy to the attention of the person addressed. Again, we frequently get as many subscribers on a repeat offer as on the original offer. In such cases it is not an uncommon experience for a subscriber secured on the repeat offer to write us saying the original offer was not brought to his attention.

There must, of course, be a cause for the tendency to scorn circular matter. What is it? We believe it to be due in part to the wordiness, bombast and exaggeration so characteristic of circulars a few years ago. Some circulars of the present day are faulty in these same particulars, but among engineering circulars instances of this kind are growing comparatively rare. The average engineering circular is, and all should be, prepared with great care to secure brevity and clearness and simplicity of expression. Every effort is made to economize the reader's time. Moreover, the modern circular usually possesses an attribute which was not so common some years ago. Advertising men have rediscovered one of the age-old truths, namely, it pays to tell the truth. "Truth in advertising" is the slogan of advertising men today. Exaggeration is largely absent from present-day engineering circulars, and the great majority of them are worthy of a careful reading.

In view of the facts stated in the preceding paragraph we believe engineers, contractors and municipal employes will do well to revise their attitude towards the circular. It should be regarded as a salesman and given a chance to state its proposition. From purely economic considerations one cannot afford to take, continually, an unreceptive attitude toward all circular matter.

Reorganization of the Illinois Free Employment Bureau.

An important step has just been taken in the solution of the problem of employment by the perfecting of plans for reorganizing the State Employment Bureau in accordance with the bill of the late Charles Richmond Henderson, passed at the last session of the Illinois Legislature. A central Chicago office will take the place of the three free employment offices in different parts of that city which have been closed since July 1. This office will be opened in the downtown district of Chicago by Charles J. Boyd, who was recently appointed as its head by Gov. Dunne. Temporary branch offices will be opened in different parts of the city, as required, to care for unskilled and foreign labor. The main office will give attention mainly to professional workers and to skilled labor, especial attention being given to those professions over which the state has supervising examining boards. The following six classes of employment will be handled, separate branches being maintained for men and for women:

1. Barbers, embalmers, nurses and other professions.
2. Skilled labor.
3. Hotel and restaurant help.
4. Clerical employes.
5. Factory and store workers.
6. Juvenile help.

The departments of the main office will be operated by the superintendents and assistants formerly in charge of the old free employment offices, all of whom have been reappointed. The new law requires that card index records and other identification be kept of every applicant and of every position filled

The success of the employment bureau will depend largely upon the co-operation which it is able to secure from employers of labor, and considerable educational work will be required to accomplish this. It will be necessary for employers to furnish information freely if they are to receive the full benefits from the bureau. The opportunity here afforded to assist both the employer and the unemployed should inspire those in charge of the bureau to their best efforts, and it is hoped that all will co-operate to make the work of the bureau effective to the highest degree.

The Cost of Gold.

The term "a regular gold mine" has come to indicate the ultimate peak in profitableness. Very few civil engineers have "a regular gold mine," either actually or figuratively, so their personal knowledge of the fact is negligible, but there are none, we imagine, who are disregardful of the truth that gold costs something always and may sometimes cost almost as much as it sells for even at mines worth working. What does gold cost? Most of us know that the United States mint pays about $20 an ounce for gold and also we know that this cannot be all cost or all profit, but who knows what gold costs, actually, as he knows, say, what copper costs? Well, a writer, Mr. Percy E. Barbour, in the "Engineering and Mining Journal" tells us and we publish his figures much condensed below:

Location.	Name of mine.	Cost of gold per ounce.
Alaska	Alaska Treadwell	$11.85
Arizona	Yuma	9.67
California	North Star	11.08
	Melones	18.30
	Oroville	9.62
	Yuba	6.26
Colorado	Vindicator	9.89
	Portland	15.94
	El Paso	16.78
	Camp Bird	7.65
	Butterfly Terrible	19.33
	Tomboy	11.31
	Colorado	6.82
Nevada	Round Mountain	16.15
	Goldfield Cons., 1912	7.21
	Goldfield Cons., 1914	11.93
So. Dakota	Homestake	13.72
Bri. Col.	Hedley	10.05
Costa Rica	Abanagarez, 1912	25.01
	Abanagarez, 1910	13.61
Nicaragua	Lone Star	18.91
Rhodesia	Gaika	14.53
Transvaal	Witwatersrand	13.58
	East Rand Proprietary	13.41
India	Mysore	8.39
	Ooregum	11.22
Australia	Sons of Gwalia	14.34
New Zealand	Waihi	12.20
Yukon	Yukon Gold—	
	Dawson Dredging	9.76
	Dawson Hydraulicking	9.13
	Iditarod Dredging	7.69

None of these costs, says Mr. Barbour, includes plant amortization or interest on investment. He also draws many, to the gold miner, very interesting distinctions as to the relations between costs and amount of production, richness of ore, method of mining, etc. These are for the edification of the specialist in gold; the engineer is concerned only in the main part that gold costs about as much as it is worth in most instances and that never is the profit of gold mining much greater than is the profit of a good manufacturing business. About its only advantage is that there is always a market. Mr. Barbour says: "These figures dispel many illusions." They do. And we must find a new figure of speech to designate ultraprofitable occupations.

Values of N for Irrigation Channels.

Values of n, the coefficient of retardation in Kutter's formula, especially determined for irrigation water conduits are given in another column. These values have mostly been computed from special tests but where data from other experiments helped to bridge gaps in these tests those data have been also employed. The values given are unusual in two respects. They apply to several forms of conduits peculiar to recent years as for example corrugated iron flumes; they differentiate more precisely than is common between conditions of surface of channel. A brief explanation makes these statements evident.

The tests from which the values of n that are being considered were computed were made on channels in a dozen widely separated states. They were made on channels with inner surfaces of earth, concrete, wood, iron, stone masonry and rubble stone paving. The ditches varied in size from 1 sec. ft. capacity to 2,600 sec. ft. capacity and the velocities of flow extended up to 10 ft. per second. Altogether the range in locality, containing material, size and velocity of flow was comprehensive. The more notable feature is, however, as indicated above, that differences in construction and in repair conditions of containing material were given particular consideration and values of n computed for each of these differences.

Referring to the article in another column it will be found that seven values of n are given for concrete channels, four values for wood channels, seven values for earth channels, etc. Each of the values for any containing material applies to a separate set of conditions of quality of workmanship or character of up-keep or alinement of channel or other physical element influencing retardation of flow. In respect to concrete channels in particular one does not recall any place in which so wide a differentiation of values of n can be found.

Peace in the Building Field: Chicago Remains an Open Market.

For the first time in many years it is reasonably certain that unrestricted building operations will be able to be carried to completion in Chicago. The unsatisfactory labor conditions which have long existed in that city have constantly operated to discourage every kind of construction work. Even during periods of general business depression there have been few inducements offered to capital as no contractor was able to give assurance to the owner that a structure would be completed at a definite time. The likelihood of a strike at any time on the part of any one of the numerous trade unions, accompanied by a sympathetic strike by allied trades, finally resulted in conditions which seriously affected every line of business. With the recent agreement of the painters and metal workers to arbitrate their grievances there is nothing to prevent the quick resumption of work in every branch of the building industry. And this has been brought about mainly by the acceptance of arbitration as a basis for the settlement of disputes.

The present tie-up of building operations started in April when the 16,000 union carpenters struck to force an increase from 65 cts. to 70 cts. per hour, and to prevent the use of outside materials and of materials made in non-union plants. Other unions followed the lead of the carpenters' union, and construction work was soon almost completely stopped. The differences between the Carpenter Contractors' Association and the striking carpenters promised such a slight chance for settlement that the Material Men's Association, about two weeks ago, gave orders that deliveries no longer would be made from material yards controlled by it. This brought matters to a crisis, which resulted in the agreement of the striking carpenters and the Carpenter Contractors' Association to arbitrate their differences. A working agreement has been signed which insures peace for at least three years, the life of the present contract. By this agreement the carpenters are to receive 70 cts. per hour. The differences between the material men, contractors and carpenters have also been adjusted, the open market provision, insisted upon by the building contractors, being retained. This provision is that "there shall be no restriction on any manufactured material except prison made."

The settlement of all differences by arbitration, and without violence, is a notable step toward the maintenance of peace in the building construction field. It will do more to insure the investment of capital in Chicago than any action brought about in years. Owners can now feel reasonably certain that building work undertaken by them will be carried to completion without undue interference from strikes. The material men and the carpenters have wisely retained the open market provision, for had they insisted on boycotting all except Chicago manufactured material the cost of constructing buildings in Chicago would have been greatly increased. In addition, the people of Chicago would have lost heavily as the country at large would justly have resented the refusal to permit the use of outside materials.

WATER WORKS

Methods Employed in Maintenance of the Water Distributing System of New York City.

(Staff Abstract.)

The water supply distribution system of the city of New York covers an area 35x20 miles in extent. This area is divided by canals, rivers and bays which are crossed by the water mains. A number of islands with populations ranging from a few hundred to several thousand are also supplied and add to the complexity of the problem.

MAGNITUDE OF THE SYSTEM.

There are eight distribution reservoirs of an aggregate capacity of 2,500 million gallons, with surfaces varying from 119 to 250 ft. above tide level, and eight standpipes with overflows varying from 140 to 453 ft. above tide level. These are used to equalize the flow to the 14 separate services in the five boroughs.

Excluding tunnels and masonry conduits there are 2,800 miles of mains from 4 to 60 ins. in diameter. To these mains are connected 60,000 valves, 43,000 hydrants and over 360,000 services. Over 500,000,000 gals. per day are delivered through this system.

In addition to the domestic system there are three separate high-pressure fire systems covering over 7,200 acres and with 170 miles of mains from 8 to 24 ins. in diameter, on which are located 4,100 hydrants and 6,650 valves. The Catskill system, when placed in operation, will add 17 miles of rock tunnel, 22 feeding shafts and 16 miles of delivery mains varying on land from 48 to 66 ins. in diameter, and including two miles of 36-in. submerged pipe connecting Brooklyn with Richmond.

The maintenance of this system involves an organization and equipment of sufficient size and capacity to respond promptly and shut off the flow of water in case of accident, to repair promptly a broken main of whatever size it may be, to repair or replace defective hydrants and valves, to cut in new hydrants and valves, to make new connections, to tap the mains for new services, to test service boundaries, to measure flow in trunk and lateral mains, to locate mains and services, to locate and repair leaks on mains, to test meters, to record pressures in system, to control pressures by operation of head gates at reservoirs, to respond to fire alarms, to investigate causes of lack of pressure, to locate and stop leaks and waste in premises, etc.

The organization to handle this work is controlled by the chief engineer, and is directed by four borough engineers, one for each borough except the Bronx, which is consolidated with Manhattan, the sources of supply being mainly the same for these two boroughs. Under each borough engineer there is an assistant engineer in charge of distribution, with his assistants, foremen, assistant foremen, caulkers, laborers, etc. In Manhattan and the Bronx a superintendent is in direct charge of all the repair companies, while in Brooklyn a general foreman has charge of these companies. The meter shops and the machine shops have their separate forces.

In Brooklyn an assistant engineer with one field party handles all measurements of flow in mains, while for the other boroughs an assistant engineer with two field parties is assigned to this work. Separate labor gangs operate gates, place taps for measurement of flow, locate leaks, etc., under the direct control of the measurement of flow parties.

THE REPAIR COMPANIES OR GANGS.

To handle promptly and economically the field maintenance work connected with the distribution system it is necessary to divide the territory covered by the system. As borough lines are generally recognized as lines of division for New York City activities these have been used as the boundaries of the major divisions of territory. Each borough has been divided into districts, with a repair company under the direction of a foreman assigned to such district. Separate provision has been made for the high-pressure fire service system. The repair companies in the various boroughs are as follows:

Manhattan.—Four low-pressure companies and one high-pressure repair company. *Brooklyn*—Four companies, the high-pressure system being handled by an assistant foreman and gang under the foreman of a repair company. *Bronx*—Three companies. *Queens*—Two companies. *Richmond*—Three companies.

Organization.—The gang organization has a caulker as the head, with from three to six laborers as assistants, depending upon the nature of the work. To each such gang is assigned a horse and wagon that transport the gang to and from the work, and deliver material and tools required. Where a larger force is required two or more gangs are consolidated, working under the direction of one of the caulkers or an assistant foreman.

The foreman has general supervision over all the gangs and is expected to spend a large percentage of his time in the field. The assistant foreman takes charge in the field of major repairs, and supplements the foreman's supervision of field work. A clerk assigned to each company, except the small companies in Queens and Richmond, records time, material and labor expended on each job, complaints received and action thereon, etc.

Headquarters.—In general, the buildings used for repair company headquarters are inadequate, only one modern building—that on East Twenty-fourth street—being now in use. Efforts are being made to remedy this condition. One new building in Manhattan and two in Brooklyn are nearing completion and plans have been prepared and money authorized for three additional buildings for headquarters in Brooklyn, Queens and Richmond respectively.

The Twenty-fourth street station serves as headquarters for a repair company, the meter testing shop, garage, blacksmith shop, machine shop and storeyard.

Headquarters such as that erected at East New York station cost about $25,000 exclusive of land, and can adequately provide for a force of 40 men, six horses and six wagons or automobiles. Space is provided under the sheds for the storage of valves and hydrants, it being expected that pipe and special castings would be stored in the open.

EQUIPMENT, MATERIALS AND SUPPLIES.

There is a natural tendency to hoard articles which may at some time be useful and which one may have had difficulty in obtaining in the past. Foremen in charge of repair companies have this very human trait, and the resulting accumulation of useful and useless material makes for confusion and inefficiency. As a corrective a standard quota is set up for each repair company, the same quota being used where companies are of approximately equal size. This quota represents the equipment, materials and supplies that should always be on hand, plus about one month's consumption of the materials and supplies. After such quota has been fixed the surplus at each headquarters is removed and sent to a central storehouse, where it is placed in stock or consigned to the scrap heap if it is useless. At approximately the end of the month the clerk makes a list of all equipment, materials and supplies consumed during the month, and requisitions the storekeeper for such articles to replenish the depleted quota. If there is any unusual demand, the quota can be replenished at any time.

The following tentative quota of equipment may be useful for those who are setting up a similar standard:

STANDARD QUOTA OF EQUIPMENT FOR REPAIR COMPANIES ON WATER WORKS MAINTENANCE IN MANHATTAN AND THE BRONX.

For Office Use.—Two mops complete, 1 mop wringer, 2 whiskbrooms, 1 duster, 2 corn brooms, 2 fire extinguishers and 2 ash cans.

For Shop Use.—One buck saw, 1 saw horse, 50 ft. of garden hose, 1 step ladder, 1 platform scale, 1 anvil, 1 kerosene cabinet, 1 iron rake, 1 work bench, 1 combination vise, 1 breast drill, 3 stocks and dies for pipe thread, 3 stocks and dies for machine thread, 1 ratchet brace and set of bits, 1 drawknife, 1 spirit level and 1 grindstone.

For General Use.—Rubber boots and rubber hats for each man, oil suits for all except foreman and a rubber coat for each foreman. Also 3 3-lb. axes, 3 5-lb. axes, 3 hatchets, 2 aquaphones, 3 6-ft. crowbars, 3 6-ft. telegraph bars, 2 4-ft. pinch bars, 12 bull point cutters, 3 casting brushes, 12 asphalt cutters, 2 ½ in. by 12 ft. hook chains, 2 ¾ in. by 12 ft. hook chains, 2 pipe cutters, 1 1-ton derrick, 1 2-ton derrick, 2 rope chain slings, 2 rope slings for 12, 20 and 36-in. pipe (2 of each), 3 8, 10 and 14-in. files, 3 of each of the following files: bastards, half-rounds, hand and square, and second-cut (flat), 3 8-in. saw files, 6 hydrant pressure gages and connections, 6 striking hammers, 2 mauls, 2 mortar hoes, 50 ft. 2½-in. water hose, 2 hydrant pumps, 1 plumber's furnace, 1 18-in. caulker's furnace, 12 gate keys of different lengths, 2 "Wells" lights, 5 dozen lanterns, 2 electric searchlights, 2 9-in. ladles, 2 7-in. ladles, 2 pouring pots and hooks, 2 melting ladles and tripods, 2 galvanized iron ditch pumps, 2 No. 2 and No. 3 diaphragm pumps, 1 gas-driven diaphragm pump, 1 dozen picks, 6 galvanized iron pails, 6 rammers, 1 48-in. and 1 30-in. asbestos joint runner, 2 20-in. and 2 12-in. asbestos joint runners, 4 8-in. and 4 6-in. asbestos joint runners, 15 D-handle round-pointed shovels, 4 long-handle round-pointed shovels, 6 D-handle square-pointed shovels, 6 long-handle square-pointed shovels, 2 telegraph spoons, 4 24-in. and 2 6-in. screwdrivers, 3 24-lb. and 3 20-lb. sledges, 1 wheel tool box, 3 trowels, 2 50-ft. tapes, 6 folding rules, 2 portable pipe vises, 6 street brooms, 9 6-in. to 8-in. monkeywrenches, 9 8-in. to 26-in. Stillson wrenches, 12 hydrant wrenches, special wrenches for various makes of hydrants, 2 2-man saws, 2 crosscut saws, 3 hack saws, 3 pairs 4-in. and 3 pairs 12-in. pliers, 1 pair tin snips, 1 1-lb. soldering iron, 1 extra length of 2½-in. and 3-in. suction hose with strainer. The following caulking tools and implements for each caulker employed: One hammer, 2 yarning irons, 2 small bursting, 2 lifting, 2 cold, 1 dog, 1 diamond-point dog and 2 hand diamond-point chisels, 2 large bursting wedges, 1 3½-lb. hammer and 1 tool bag.

STANDARDIZING MATERIALS, PIPES, VALVES AND HYDRANTS.

All materials are purchased under definite specifications and are subjected to chemical and physical tests to determine compliance with standards. Samples are used as standards where it is difficult if not impossible to set up definite specifications.

The sizes of pipe used are 6, 8, 12, 16, 20, 24, 30, 36, 48, 60 and 66-in. For sizes above 48 ins. steel is generally used; while for 48 ins. and smaller sizes, cast iron is adopted. The pipe and specials are made from department designs, although a change to American Water Works Association standards for the pipe at least, will be made before long.

Valves are made from department design under definite specifications. The sizes adopted are 6, 8, 12, 20, 36 and 48-in. Intermediate sized mains have valves with reducers. Thus, 36-in. valves are used on 48-in. and 36-in. mains, 20-in. valves on 30-in., 24-in. and 20-in. mains, 12-in. valves on 16-in. and 12-in. mains. This practice requires fewer valves in stock, greater ease and speed in operation of valves and less parts for repairs. The additional loss in head, due to contraction of waterway is negligible. Thus, with a velocity in the main of 3 ft. per second, the loss at the valve, due to placing a 20-in. valve on a 30-in. main, is about a half an inch, while the frictional loss per 1,000 ft. would be about a foot. As valves are only placed at intervals of about 2,000 ft. on the larger mains the effect is not practically measurable.

The use of department designed valves has not materially increased the cost, as the prices quoted for valves delivered during the past year have been approximately as follows: these valves being a heavy bronze stem bronze mounted type:

Size Ins.	Av. cost.	Size Ins.	Av. cost.
4	$8.00	12	$31.00
6	12.00	16	65.00
8	18.50	20	115.00

The hydrants used are also manufactured from department drawings and specifications. The body is 8 ins. in diameter, with one 2½-in. and one 4½-in. outlet. These hydrants manufactured of high grade materials, and under careful inspection are now delivered at less than $25 per hydrant.

To receive all equipment, materials and supplies, and care for same before use, three general store yards have been established, one in Manhattan to serve Manhattan, The Bronx and Queens, and one each in Brooklyn and Richmond to serve those boroughs. For pipe, special castings and other heavy materials additional yards have been established in each borough.

MACHINE SHOPS.

Repairs to valves, hydrants and other appurtenances require machine work which is carried out in a well equipped shop in Brooklyn, where eight machinists and an equal number of helpers are employed. In Manhattan, less work of this character is performed by the city force, and only two machinists and helpers are assigned to distribution work. The Brooklyn shop is headquarters for the automobile repairs and as the department has over 30 cars with approximately as many more to be purchased in 1915, this part of the work is important.

METER SHOPS.

Under the New York City charter, meters are furnished and set by property owners upon the direction of the department. Under present regulations the department cannot require meters to be set except where water is used for business purposes. The meter rate is 10 cts. per 100 cu. ft., irrespective of quantity used. This rate is approximately double the average income per million gallons delivered into the mains. It is therefore to be expected, as the frontage rate is in general materially less than meter rates, that meters will not be set except upon the order of the department. There are approximately 90,000 meters in use in the city. The charter further requires that all meters shall be of a type and sold at a price approved by the Board of Aldermen, upon recommendation of the commissioner of the department. There are 17 makes of meters approved, thus affording the consumer a wide range in choosing his meter.

Before meters are set they must be tested for accuracy at one of the department shops, no charge being made for such test. After being set they are subject to retest at such times as may be directed by the department. The department does not make any repairs to meters, but requires the plumber to remove the meter, attend to the repairs and deliver the meter to the meter shop for test and certification. These meter shops are equipped with modern appliances. Large meters, above 2 ins. in diameter, are frequently tested on the premises without moving same, by the installation of a test tee on the delivery line just beyond the meter and the use of a portable test meter which is attached by the inspector to the test-tee outlet. Where a large meter is found to be registering incorrectly the same may be repaired either in place or removed for repairs, at the option of the owner. The number of meters tested annually by the Manhattan shop is as follows:

Premises	2,547
Shop	18,196*

*Includes meters sent from Queens and Richmond.

The force employed in the Manhattan shop, where the largest amount of work is done, is as follows:

1 Inspector	$1,500
2 Inspectors	1,100
1 Clerk	900
1 Stenographer	1,050
1 Plumber	5.50 a day
1 Machinist's Helper	3.00 a day
5 Laborers	2.50 a day

TRANSPORTATION.

Until approximately 1913, all transportation was by horse-drawn vehicles, city owned horses and vehicles being used in the boroughs of Brooklyn and Richmond and hired horses and vehicles in the other three boroughs. This difference resulted from continuation of practices followed before consolidation in 1898, there being no local transportation conditions which warranted a different system in one borough as compared with another.

The development of the automobile has resulted in a change in policy and light auto runabouts, with small wagon bodies, are used for the foremen, tappers and for light material, while auto trucks are being substituted for the horse-drawn trucks. It is estimated that the cost of transportation by horse-drawn and by motor-driven vehicles is approximately the same, based on mileage. The load transported, however, is mainly labor, and therefore the saving in time should be multiplied by the number of men transported, which is usually six to each gang. The main advantage in the use of motor vehicles is in the reduction in time in responding to emergency calls, and the resultant reduction in damage caused by breaks in large mains, and the much more efficient supervision by the foremen, where automobiles are available.

The department records on automobile service show the following cost per mile for runabouts, touring cars and trucks, exclusive of the cost of driving:

Runabouts	4.6 cts. per mile
Touring cars	7.7 cts. per mile
Trucks	6.3 cts. per mile

The touring cars are used by the superintendent and assistant engineers in charge of maintenance work.

The department has one 3-horse truck, which has sufficient carrying capacity to handle any pipe or valve that might be required for repair or extension work, and it is proposed to continue this truck in use for emergencies even though automobiles may be substituted for all other transportation.

METHOD OF REPORTING REPAIRS REQUIRED.

When a complaint is received at a repair company's headquarters, entry is made in a blotter kept for the purpose and the complaint is transmitted by telephone to the borough office. Here a complaint slip is made out in triplicate, two copies being forwarded to the repair company's headquarters, the third being retained as an office record. If a complaint is received directly at the borough office, a similar complaint slip is made out and forwarded to the repair company. Each complaint is given a job number and all time and material consumed is charged to that job. When the complaint has been attended to, the clerk at the yard notes the action taken on the complaint slip and the duplicate is returned to the borough office. The record of material and time charged to the job is sent to the division of costs and statistics, which records all departmental expenditures.

Immediate action on complaints of an urgent character is taken by the foreman in charge of the repair company, the regular complaint slip being later forwarded to headquarters.

In the borough office there is a street map, mounted on soft wood, and pins with varicolored heads are daily placed at the locations of the different complaints. The assignments of gangs to jobs for the following day are also shown on this map; so that it can be determined at a glance the number and kind of complaints that have not yet been attended to, as well as the location of each gang. For the high pressure fire system, the procedure provides for notification of the fire department of all changes which affect that part of the system. If, for any cause, a hydrant cannot be utilized, a chain is attached thereto, carrying a metal tag on which are inscribed the words "Out of Order."

In general, the repair work is kept up so that routine repairs are made within two or three days from the receipt of complaint and emergency repairs are, of course, attended to immediately.

TAPS.

The department furnishes and places all taps and connections to city mains, the taps including wet connection sleeves and valves up to 20 by 24 ins. being manufactured under departmental designs and specifications. Application for the tap is presented by a licensed plumber, and the size of tap granted is based upon the number of square feet of floor area in the building, the general standard being shown in the following schedule:

The area of one ⅝-in. tap shall be credited for the first 7,500 sq. ft. of floor area, one ¾-in. for the first 15,000 sq. ft. and above 15,000 sq. ft. one ⅝-in. tap for every 10,000 sq. ft. of floor space thus computed (or an equivalent combination of larger taps) viz.:

Up to 7,500 sq. ft.	1 ⅝-in. tap
7,500 to 15,000 sq. ft.	1 ¾-in. tap
15,000 to 20,000 sq. ft.	2 ⅝-in. taps
20,000 to 30,000 sq. ft.	3 ⅝-in. taps*
30,000 to 40,000 sq. ft.	4 ⅝-in. taps†
40,000 to 50,000 sq. ft., etc.	5 ⅝-in. taps‡

*Or 2 ¾-in. taps.
†Or 3 ¾-in. taps.
‡Or 2 1-in. taps.

Where the occupancy of a building will require an unusual volume of water, the size of tap granted is in accordance with the probable demand. This system of floor area as a basis for determining the size of tap has been in use for the past three years and has given general satisfaction. Prior to its adoption, there was no standard by which to judge the size of tap to be allowed and there was, naturally, resultant dissatisfaction and charges of favoritism. After the size of tap has been determined, the excavation is made by the plumber, who notifies the department that the opening will be ready for the tapper on a given date and hour. The tapper is furnished with a card authorizing him to insert a given sized tap and he returns this card with endorsement showing the size of tap inserted and the location of same. This information is then transferred to a tap card for filing.

The department charges the property owner a fixed price for each size of tap, the present schedule being as follows:

CHARGES FOR WET CONNECTIONS.

Connection.	Pipe Inches.	Rate.
2 inch	6	$23.95
	8	25.45
	12	34.70
	16	40.45
	20	48.20
4 inch	6	27.50
	8	30.20
	12	38.15
	16	43.90
	20	51.65
6 inch	8	36.55
	12	45.95
	16	54.70
	20	59.95
8 inch	12	55.00
	16	66.75
	20	71.25

CHARGES FOR TAPS

Size.	Rate.
⅝-inch	$4.50
¾-inch	5.00
1-inch	6.00
2-inch	15.00

All house services up to and including 2 ins. in diameter are required to be of lead from the tap to the property line. The tap and service is inspected by an employee of the Bureau of Water Register, and the charge for water dates from the approval of the service and the turning on of the corporation cock. This cock is buried in the street and a curb cock set at the curb line.

SHUTTING OFF LEAKY SERVICE.

When notice of a leak is received effort is made by examination of the surface and use of the aquaphone to determine whether the leak is on a service or the city main. As the services are owned by the property holder, he is notified to make repairs, if the leak is probably on his service. If its location is uncertain, the department gang digs up the main and continues excavation until the leak is found. If the leak is finally found on the city main it is repaired by the city force. If the leak is on a private service, the corporation cock is shut off and the repair work is turned over to the plumber representing the property owner. The department formerly billed the property owner for all excavations necessary to locate the leak. This procedure resulted at times in a severe burden being placed upon the property owner, as where the subsurface conditions were favorable, such as in a rock filled street, the leaking water might run for several hundred feet before it appeared at the surface. Numerous openings had to be made before the leak was discovered, and bills of several hundred dollars were not uncommon. Now the department charges only for the excavation which finally locates the leak, believing that the city should carry the extra charge as an insurance against any one property owner being heavily penalized, due to no fault of his own.

While curb cocks are installed, they are not of material use in locating leaks on services, as such leaks are usually between the main and the curb cock.

To insure payment for work done by the department, the plumber is called on to assume responsibility for the pavement disturbed and excavation made before the water is again turned on.

PRESSURE IN PREMISES.

New York City has, in general, a low pressure, the average in Manhattan and The Bronx being about 30 lbs., Brooklyn and Queens have approximately 35 to 40 lbs., while Richmond varies from over 100 lbs. down to 20 lbs. or less.

Many Manhattan and Bronx premises have tanks or house pumps, or both, but even with such auxiliaries in use the complaints of lack of pressure are quite frequent. Such complaints are turned over to an inspector who takes the pressure at the nearest hydrant, in the basement and on each floor, with and without a faucet flowing, and notes the size of the supply pipe from the main and the size of each riser and number of floors supplied by each. After the data obtained have been studied, the owner is notified of the conditions found, the probable cause of lack of pressure, and what action is necessary to remedy the conditions complained of.

HYDRANT REPAIRS DURING FREEZING WEATHER.

The fire department force make continual inspections of hydrants during the winter months and report to the repair company headquarters hydrants that are frozen or in danger of freezing. These are then examined by the department force and the waste drip cleared and hydrant drained or else pumped out. Salt is placed in hydrants which leak slightly and do not drain properly. Experiments with the use of glycerine, alcohol, and carbide of lime as substitutes for salt are being made, but there is not sufficient data available on which to draw conclusions. Hydrants that are frozen are thawed out by the fire department, using the standard steamer, and by the water department, using a special portable boiler.

OPERATION OF VALVES.

With about 60,000 valves in the system, it is difficult to operate the valves frequently enough to keep all valves in good condition. The department plans to operate and oil every valve once a year, but so far has been able to keep up to this schedule for the large valves only, i. e., larger than 20 ins. in diameter. With New York City water if valves are operated once each year they are kept in good general condition ready for operation at any time. It has recently been the practice to place metal pans over the gears to protect them from dirt. The boundaries of services are usually formed by closing valves, thus creating dead ends. Sediment collects in such dead ends and can only be removed by partially opening the valve and blowing off the sediment laden water through the adjoining hydrants. Special gangs are operating continuously on this work, the mains being blown out at intervals of from two weeks to several months, the time depending upon the rapidity with which sediment forms in objectionable quantities.

RESPONSE TO FIRE ALARMS.

The water department is responsible for the adequacy of the supply for fire extinguishment. Fire alarm gongs are located in all repair company headquarters, and a repair company gang responds to all two alarm fires in the low or domestic pressure districts. To all alarms in the high pressure fire service district, a special repair gang responds. On arriving at the fire the driver gets in touch with his headquarters so the gang can be located, and the men are held to act in case of emergency, such as lack of water, which might be relieved by opening adjacent district boundary gates. The foreman notes the location and number of engines, water pressure, etc.

ASSIGNMENT OF ASSISTANT ENGINEER FOR NIGHT AND HOLIDAY DUTY.

On the theory that men familiar with the water supply system and competent to act in emergencies should always be available, assignments are made so that two engineers, one for Manhattan and The Bronx, and one for Brooklyn, are always in reach of the telephone from the time the office closes until it is again opened. The city furnishes telephones in the homes of these men, but they do not receive any added compensation due to such additional duty. These men are called out for three or four alarm fires, as well as in emergencies resulting from any cause. They take charge until they are relieved by a higher official.

CONTROLLING PRESSURES IN MAINS.

Recording pressure gages are located in the various repair headquarters and pumping stations, and also in some 60 fire company engine houses scattered throughout the city. These gage charts show if there has been any unusual pressure changes and studies can then be made to determine cause and remedy.

The pressure in the Brooklyn low pressure system and the First Ward, Queens, is controlled by the operation, day and night, of headgates at the reservoir. If the pressure is normally in the day time between 35 and 40 lbs., it will rise above 45 lbs. at night when such increase in pressure is useless. The pressure is, therefore, kept high from 5 a. m. to 11 a. m. From then until midnight it is kept about 5 lbs. lower than during the morning, and at midnight it is further lowered about 6 lbs. and kept at the low point until five in the morning, when the gates are again opened. With four 48-in. and two 36-in. mains feeding the service from the reservoir through six 36-in. valves, it is found necessary to have all valves opened from 12 ins. to 18 ins. in the morning, there being no effect if the valves are opened more than 18 ins. During the early morning hours three of these valves will be shut, two opened about 4 ins., and one, on a main that feeds a service pumping station, about 12 ins. Pressures are telephoned to the reservoir every hour and more frequently, if required, and men are on hand to immediately open valves if required. If a three alarm fire is recorded the valves are immediately opened, about ten minutes being required to give full pressure.

This system has been in use for nearly ten years, and no trouble has been experienced. The control of the pressures reduces the consumption by over 5,000,000 gals. daily, or about five per cent of the total supply to this service. When all the water is pumped and difficult to obtain, this saving in water is material and is worth financially between $100 and $200 per day.

MEASUREMENTS OF FLOW IN MAINS AND FROM HYDRANTS.

In studying trunk main capacity, the distribution of the flow is an important factor in determining whether existing mains are being utilized to full capacity, and also whether new mains are needed. Pitometer surveys are being made from time to time for this purpose, three parties being continuously employed on this and similar work, the department owning 15 instruments. Measurements of flow are also undertaken to determine leaks outside of premises and as a result of such work during the past four years, i. e., from 1910 to date, leaks in mains and services have been located and stopped, amounting to 33 m.g.d. One leak was considered by the local inhabitants to be a spring which yielded water of a superior quality to the city water, and they were much surprised when the leak was discovered and the spring ceased to flow. The volume of water lost through fixture leakage is determined by the pitometer measurements, flows being recorded into districts before and after water waste prevention inspections have been made. The adequacy of the distribution system to deliver an ample supply for fire extinguishment is determined by testing the flow from hydrants, usually using a group of six and noting the drop in pressure and the discharge from each hydrant. Pitot nozzle gages are used for this purpose, the force employed being the regular pitometer survey force.

RECORD MAPS OF DISTRIBUTION SYSTEM.

For general use as wall maps and for the use of foremen and others in the field, tracings to a scale of 400 ft. to the inch have been prepared, showing by symbol size of mains, connections, valves, hydrants, blowoffs, etc. Street lines are omitted except in outlying sections, as the mains indicate the streets and the additional lines are confusing. These maps are kept up to date and prints in the repair companies' headquarters are corrected each month as far as practicable. The boundaries of services are shown by colors.

Atlases to scales of 100 ft. to an inch and 160 ft. to an inch have been tried to record actual locations of mains, valves, hydrants and appurtenances, with depth of cover, when laid, etc. These have not been a success and it is considered that drawings to a scale of 40 ft. to an inch will be more suitable with a scale of 20 ft. to an inch being used where there are very complicated intersections. On the large sized scales can be shown location of taps as well as other details.

For the high pressure fire system each hydrant is numbered and maps to a scale of 300 ft. to an inch are used for general maps, with the same sized scales for the detailed maps.

All the work of collecting, transporting, pumping and distributing the water supply for Greater New York is under Mr. Merritt H. Smith. Chief Engineer of the Bureau of Water Supply. Mr. William W. Brush as Deputy Chief Engineer has come in close touch with the maintenance and operating problems and has found these studies most interesting. A more general statement of practice by the various water departments of our cities would be helpful in developing sound procedure in this branch of water supply.

ACKNOWLEDGMENT.

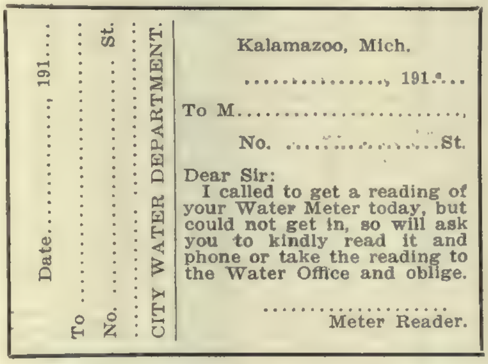
The foregoing article is the major portion of a paper read by Mr. W. W. Brush before the New York Section of the American Water Works Association as printed in the Journal of the Association for March, 1915.

Efficient Meter Reading at Kalamazoo, Mich.

(Staff Article.)

The reading of water meters at Kalamazoo, Mich., is on a high plane of efficiency. There are about 7,000 meters in use and one man reads them all. Readings are taken quarterly. Of this total about 6,000 have straight reading dials and the balance have the so-called clock dials. The use of the straight reading dial is the basis of the economy attained. Such dials can be read with accuracy by anyone and this fact is turned to good account by George Houston, Water Commissioner.

When the meter reader calls to take a reading it is a common experience to find the house closed. Sometimes the reader will have to make as many as four or five calls at a place before he can get in to read the meter when it is set in the basement. This trouble and expense is obviated at Kalamazoo by enlisting the householders' co-operation in meter reading. If the house is closed when the reader calls he leaves a memorandum of the form shown herewith. The householder reads the meter and either telephones the reading to the water office or, if more convenient, calls in person and reports it. As stated previously, this reading is accurate because of the simplicity of the straight reading dial.


Date................, 191....
To ....
No. .... St.
CITY WATER DEPARTMENT.

Kalamazoo, Mich.
................., 191....
To M...........................,
No. ....St.

Dear Sir:
I called to get a reading of your Water Meter today, but could not get in, so will ask you to kindly read it and phone or take the reading to the Water Office and oblige.

....
Meter Reader.

Form of Memorandum Left by Kalamazoo Water Meter Reader When Householder Is Out.

Mr. Houston states that the procedure here described saves thousands of miles of travel annually, by the meter reader, and enables the department to render and collect its bills regularly.

Notes on the Design, Construction and Durability of Reinforced Concrete Standpipes.

(Staff Abstract.)

The first concrete standpipe built in this country was at Little Falls, N. J., by the East Jersey Co. in 1899. Since then over 40 have been constructed. Table I (see p. 48) gives data on 42 concrete standpoints. Since the building of the first standpipe of this type there has been a considerable accumulation of experience bearing on the proper design and construction of reinforced concrete standpipes and their probable durability can now be predicted with some degree of precision. A recent topical discussion before the New England Water Works Association brought out considerable information along these lines.

Mr. H. B. Andrews, Engineer of the Simpson Bros. Corporation, stated that his company has built 17 reinforced concrete standpipes in New England. In some cases difficulties have arisen, in others no trouble has been experienced. We quote from Mr. Andrews' discussion as follows:

Waltham, Mass.—We commenced our work by building the Waltham reservoir in 1904, see Table I for dimensions. We had nothing to say in regard to the design of this reservoir. It was designed by the city engineer of Waltham, and the plans were gone over by Mr. Worcester, consulting engineer. There was not very much precedent at that time for the design of reinforced concrete standpipes. The proportion of concrete was 1:2:4, and the aggregate was especially selected to make it waterproof. The reservoir was built in successive lifts of about 3 ft. We anticipated some trouble at the joints if special precautions were not taken to prevent it. The joints were cleaned as we went up, and recesses were made in the preceding day's work by putting in strips of wood entirely round the tank to form a slot to engage the next day's work. The reservoir was plastered on the inside with ½ or ¾-in. plaster, and in the top half was painted with a neat cement wash. We found after the water was turned into the reservoir that the concrete in itself was not entirely waterproof and that the joints leaked to a certain extent. We decided to make some changes in the next reservior we built.

Manchester, Mass.—This reservoir was 50 ft. in diameter and 72 ft. in height. We increased the richness of the mix to 1:1.5:3; we also increased the amount of the reinforcement between base and walls. We plastered this reservoir also on the inside, and when it was filled there was but very little leakage. Subsequently two or three cracks developed on the south side of the reservoir, caused by the unequal expansion due to the rigidity of the base and the expansion of its circular shell above, which caused a shear in the concrete and opened up a joint perhaps 30 ft. in length. That was repaired by putting a lead lining over that joint. But the continued change in expansion, due to the filling and the refilling of the tank and the change in the temperature, caused that joint to open again and some water to get in it, so that the leakage reappeared. This reservoir has been repaired by lining it with asphalt and felt over a certain extent of it, so that no leakage appears there now. But it was found necessary to increase the amount and length of vertical reinforcement as cracks appeared at the end of the rod which joined the floor to the wall.

Lisbon Falls, Me.—This we did in the succeeding tank which we built at Lisbon Falls. That tank also was built with 1:1:2 mix, and plastered, and it has not shown any leakage. That was built in 1909. I saw it last summer, and there was no water that leaked out through the tank and reached the ground. There was but one little spot half an inch in depth and the size of the hand where the frost had scaled off the surface. We found some vertical cracks in the reservoir at Manchester in the plastering and decided that the concrete was not thick enough. That is, there must be thickness enough of concrete to resist the tension in the tank, or else the tank will crack.

Rockland, Mass.—In the one we built at Rockland we built the tank with concrete walls thick enough and strong enough to resist all tension. We did not plaster the tank. The forms used consisted of movable wooden sections connected by a bolt extending to 1½ ins. from surface fitted with threaded sleeves. Into these threaded sleeves were screwed tap bolts fastening the forms together, and these tap bolts were later removed and the holes plugged for the 1½ ins. depth. We found that after the pressure had exceeded some 60 or 70 ft. of water there was enough pressure to force the water through at the plugs that we put in. There was a little channel under the bolts caused by settlement of concrete, and the water filtered through there to the outside plug and caused some trouble through the freezing of water near the surface, causing the scaling off of quite an area. We took out some of those bolts and replugged the holes, and had no further trouble in that respect. We had had some trouble with the joints in the first reservoir built. The Rockland reservoir was 104 ft. in height, and the Lexington reservoir was the same.

The later reservoirs that we have built have not exceeded 50 or 60 ft. in height. In those we used a 1:1:2 mix of cement, and we find that is impervious to water. We have had no leakage through the concrete whatever, and we have found that that proportion of cement is as good waterproofing material as we can put in concrete. We find that it also increases the strength of the concrete against cracking. The only trouble we have now—and we have had very little of that—is in the joints. Since we built our first reservoirs we have made some experiments on the protection of joints that have worked out very well.

I do not think we have had any leakage whatever in the standpipe at Winchester, Mass. On the one at West Falmouth, Mass., there has been no leakage. On the one at Woonsocket, R. I., there was a little efflorescence that showed around the joints when the tank was first built; it has now disappeared, and I do not think there is any there now. The one that was built at Jamestown, R. I., shows some seepage. There is a peculiar thing about that. I was down there three months after the tank was filled this winter. The superintendent of the water works, Mr. Kent, said there was no leakage of water whatever. I went over there, and as I approached I could see absolutely no seepage on that side of the tank, but there was a little seepage on the other side. Mr. Kent says these spots show more prominently on days when the huidity is high.

In these reservoirs up to 50 or 60 ft. in height we have had no trouble with surface damage by the frost—only in three reservoirs that I know of. That is the Rockland reservoir, the one that was built in Manchester, and the one that was built at Lexington—for the first 30 or 35 ft. in height, above that no trouble.

TABLE I.—DATA ON REINFORCED CONCRETE STANDPIPES.

Location.	Inside diam. in feet.	Height of tank in feet (shell).	Depth of water in feet.	Capacity in gallons.	Date constructed.	Total cost.
Little Falls, N. J.[1]	10	43	43	25,260	1899	.....
Milford, Ohio	14	81	78	93,000	1903	.....
Fort Revere, Hull, Mass.[2]	20	50	49±	118,000	1903	$4,000[3]
Attleboro, Mass.	50	102	100	1,500,000	1904	35,000
Waltham, Mass.	100	37	35±	2,000,000	1906	26,000
Bondsville, Mass.	70	20	20	576,000	1908	.....
Empalme, Senora, Mex.	30	90	90	475,000	1908	.....
New Haven, Conn.	50	25	..	375,000	1908	.....
Lenoir, N. C.	..	..	..	500,000	1908	.....
Bridgewater, Mass.	30	78	78	413,000	1909	.....
Manchester, Mass.	50	72	70	1,060,000	1909	30,291
Lisbon Falls, Me.	50	62	60	910,600	1909	19,288
Westerly, R. I.	40	70	70	650,000	1910	18,722
Rockland, Mass.	46	104	102	1,300,000	1910	36,300
Cherry Valley, Mass.	40	21' 4"	20' 9"	195,000	1910	4,976[4]
Rochdale, Mass.	40	21' 4"	29' 9"	195,000	1910	4,976[4]
Kensington, Conn.	50	21	20' 5"±	300,000	1910	5,100[5]
Key West, Fla.	78	40	..	1,500,000	1911	24,950[6]
Laconia, N. H.	28	46' 1"	43' 6"	200,000	1911	6,575[7]
Brockton, Mass.	160*	26' 6"	25	3,760,000*	1911	82,200[8]
Western, Mass.[9]	50	38	36	441,000	1911	6,706[4]
Waverley, Ohio	16	82	80	120,000	1911	4,500
Ashland, Mass.	40	32' 2"	31' 8"	298,000	1911	5,810[4]
Northbridge, Mass.	25	28	27	90,000	1911	2,899[4]
Suffern, N. Y.	69	20' 6"[10]	19' 9"	559,000	1911	6,500
Lexington, Mass.	30	104' 6"	104	550,000	1912	19,900
Belton, Tex.	24	75	75	254,000	1912	6,000
Winchester, Mass.	29	43' 6"	40' 6"	200,000	1912	8,000
Penetanguishene, Ont., Can.	50	21	20' 5"±	300,000	1912	.....
Austin, Minn.	40	29' 8"	29	300,000	1912	.....
Topsham, Me.	97	47' 9"	46' 3"	2,500,000	1913	38,000
Fulton, N. Y.	40	100' 4"	100	940,000	1913	24,335
San Francisco, Cal.	60	35' 10"	35' 5"±	750,000	1913	.....
St. Louis, Mo.	153' 6"[11]	33	31	4,250,000	1913	51,850
Chelmsford, Mass.	40	20	20	188,000	1913	5,180[4]
West Falmouth, Mass.	30	45	45	238,000	1913	9,800[4]
Woonsocket, R. I.	79	45	44	1,600,000	1913	23,514[4]
Sioux City, Ia.	142	33' 1"	32' 1"	....	1913	.....
Duxbury, Mass.	40	35	35	328,000	1914	7,115[4]
Webster, Mass.[12]	46	20	20	249,000	1914	5,260
Jamestown, R. I.	35	50	49	350,000	1914	10,010[4]
Halifax, N. S.	160	29	..	3,250,000	1914	56,000

*Each.

[1] Inside filter house. [2] Inside concrete, brick tower. [3] Excluding tower. [4] Contract price. [5] Construction only. [6] Including roof, $5,000. [7] Excluding foundation. [8] Two tanks, cost of both. [9] Partly below ground surface. [10] Lower half is constructed below ground. Earth backing for retaining wall. [11] At top, 23 ft.; below top diameter = 151 ft. 6 ins. [12] Protected by earth bank.

Mr. Bertram Brewer, City Engineer of Waltham, Mass., made the following statement relative to the performance and present condition of the Waltham standpipe:

The first year or two there was very little seepage; some at the joints, and a good deal of efflorescence and some stalactite formation on the outside of the wall. After being in use for a year or two the seepage began to increase considerably, so that when the tank was full (it is 35 ft. high) a considerable portion of it has been and is quite wet. It never has leaked or seeped sufficiently to cause the water to run down the sides to any extent. It has mostly evaporated before it got to the bottom. After the first two years this seepage has continued about the same every year.

The question is vital as to whether this seepage has endangered the tank enough to affect its stability. We do not believe it has. On the lower 2 ft. of the tank, and in one spot higher up, there has been some frost action, so that in places pieces of the concrete have spalled off. In two places around the base of the tank there are small areas where the spalling has reached a depth of 3 ins. I think that on its ninth birthday it will need a little repairing.

An attempt was made the summer before last to do some repairing on the inside by applying a waterproof film. The work was done by a local contractor, and no engineer was consulted in connection with it. As I understand it, it cost something like six or seven hundred dollars. A brush coat of hot tar was painted upon the interior wall. This attempt at waterproofing does not appear to have reduced the seepage at all.

Mr. Raymond C. Allen, Civil Engineer, Manchester, Mass., reported his observations on the Manchester standpipe as follows:

The standpipe at Manchester was built very carefully, and of the best materials. Shortly after it was filled a fracture appeared at the first joint at the base, which in a short time extended a length of about 30 ft. Through this fracture the water in a short time came in a sheet, over a length of from 10 to 12 ft., and trickled through at other points. One other leak of quite considerable proportions appeared about 15 or 16 ft. up. This was not as wide as the other, but similar. There was no other leak, but there was a seepage at many of the joints.

We tried first a cement coating. We found it unsuccessful. Then the two joints which were in the worst condition were repaired by putting a layer of lead with tar over them, as Mr. Andrews has described. This sealed these joints until a year or two ago, when the pressure forced the water into that crack to the extent of fracture, and the leaks again appeared.

Those two leaks were repaired about a year ago by an asphalt and felt waterproofing process, and the standpipe has been protected within by some further construction against ice and other damage.

I have noticed that the greatest amount of seepage and of leaks has occurred on the south and west sides, where the expansion seems to be most unequal. I have also noticed that as from time to time the standpipe is lowered entirely and filled again, the successive fillings have produced new points of seepage. At all events they act a little differently, and are cumulative in their effect. Thus each time a standpipe is emptied and filled, I believe that a slight increase in seepage for a time at least takes place.

We at first feared the action of frost—although our fears were somewhat allayed at the time by others who had built concrete standpipes. Last year we had a piece about 8 ft. square thrown off at about the location of the upper leak to which I have referred. This was clearly the action of frost, and the action of it upon the concrete was completely to disintegrate it. It was just so much sand. That was true upon some portions of the base upon which the water had been constantly running and freezing, but behind the reinforcement, where no movement of concrete had taken place, there was no disintegration. It was only in the outer shell where disintegration took place or any damage appeared in the concrete.

I have come to the conclusion, myself, that such standpipes as are over about 50 ft. in height should be entirely waterproofed on the inside by some preparation. I will go a little further and say that I feel that the outside of the tank itself should be protected from the elements. For while the greatest danger from frost comes from the freezing of seepage through the structure, I believe that in time at least the action of snow and rain and the water coming down from the roof will have the same effect as it will when a larger amount of water comes through from the inside in the form of seepage.

Mr. Francis W. Dean, of Boston, gave the following information relative to the standpipe at Lexington, Mass.:

If I remember rightly, an effort was made to prevent leakage in the first place by pasting canvas on the inside, using marine glue. It was supposed not to dissolve, but some months later it was found that most of the canvas was at the bottom of the standpipe.

Furthermore, the leakage was confined to quite a small area, and chiefly on one side, about 25 ft. from the bottom, as I remember it. Afterwards, when cold weather came, a small part of it spalled off, and that has been repaired. I believe the leakage now is almost nothing.

Mr. William S. Johnson, Civil Engineer, Boston, Mass., gave his views on concrete standpipe as follows:

My experience has been limited to rather low tanks, and unless I change my opinion very materially, my future experience will have the same limitations. None of the tanks which I have built is over 40 ft. in height, but they all leak more or less. There has been no spalling off of the outside surface, and the actual quantity of water passing through the concrete is very small, but it is enough to make the tanks unsightly, and, of course, arouses a certain suspicion as to the safety of the structure in the minds of those who know little about these matters.

I am convinced that high standpipes are much better built of steel than of concrete.

To be sure, the steel tanks are unsightly, but so are concrete structures, discolored by leakage. The repairs on a steel tank are expensive and annoying, but they cannot be more so than the repairs to concrete tanks. As to the durability, the evidence indicates that concrete tanks are far from indestructible, and there is much uncertainty as to how long they will really last.

Until some better method of designing and constructng concrete tanks is found, it seems to me very unwise to install them to hold more than 50 ft. of water.

Lisbon, Me.—Mr. Stephen Litchfield, City Engineer of Bath, Me., gave the following information relative to the Lisbon standpipe:

The standpipe for the town of Lisbon was completed in October, 1909, and put into commission in January, 1910. The diameter is 50 ft.; the height, 62 ft. (internal dimensions); capacity, 190,600 gals.; thickness of shell at base, 20 ins.; at top, 12 ins.

The structure is designed on the basis of the steel reinforcement, taking all tensile stresses at a working unit stress of 12,000 lbs. per square inch in the steel with the standpipe full.

The structure rests on a hard-pan bottom. Floor slab is 20 ins. in thickness, of 1:2:4 concrete reinforced with 3 ins. No. 10 standard expanded metal. Over the concrete base or floor is a 1-in. granolithic surface 1:1 mortar with 2 per cent of Medusa Compound added to the mix.

The walls are composed of 2:1.5:3 concrete. Bank gravel, screened and washed, was used in the mixture. In the top of the floor and in walls 5 per cent of hydrated lime added to the weight of the cement was used. The entire inside perimeter of the standpipe is plastered with ½ in. of cement mortar mixed 1:1, with 2 per cent of Medusa Compound added to the weight of cement. The plaster to a height of 30 ft. is painted with waterproofing compound.

Forms were constructed in three sections, the lower section being transferred to the top each day, one day's work consisting of one lift or section of 30 ins.; in one instance, however, two lifts were placed in one day.

Horizontal steel bars or hoops varying in size from 1¾ ins. to ¾ in. were held in place by 14 latticed steel columns.

The tank is roofed with a Gustavino dome, outer covering of which is plastic slate. Dome has a rise of 8 ft. The standpipe was designed and built by Simpson Bros. Corporation, Boston, Mass.; contract price, $19,288. There have been no items of repair or maintenance since the work was completed.

There is more or less seepage apparent at times, which shows at joints or where one day's work ends and another begins. Many places where seepage has occurred in the past are now entirely free from it, which leads us to believe that the structure is improving with age.

We are well pleased with the standpipe and consider it as near an approach to a permanent structure as it is possible to obtain. We feel, however, that if we had made the placing of concrete continuous, or nearly so, we would have eliminated the cause of seepage. Instead of depreciation, as is the case when other materials are used in similar structures, we consider that this one is improving. As stated above, there has been no item of maintenance to date, and there is every reason to indicate that this item is practically eliminated.

Topsham, Me.—Mr. Chas. L. Bowker described the design and construction of the Topsham standpipe as follows:

The Topsham standpipe of the Brunswick and Topsham Water District is 97 ft. inside diameter, with a conical bottom, the incline from the bottom to the beginning of the wall being 3.25 ft. rise in 10 ft. The foundation rests on solid ledge and was filled with rubble masonry laid in Portland cement mortar. The wall at the base is 3 ft. thick, and at the top 16 ins. The water line is 46.25 ft. from the floor; 18 ins. more to the roof. The roof is a concrete slab 7 ins. thick, sloping ½ in. to the foot, supported by nine concrete piers, eight of which are 18 ins. in diameter, and the ninth, having an 8-in. overflow pipe imbedded in the concrete, is 24 ins. in diameter. The top of each pier is cone shaped, the top being 5½ ft. in diameter and having a rise of 24 ins. An iron ladder is fastened to the outside of the wall. There is no ladder inside, neither is there a manhole in the wall. The 16-in. intake pipe is imbedded in concrete and is elevated 12 ins. above the floor. There is an 8-in. flush pipe connected in the gatehouse with the 8-in. overflow, operated by opening an 8-in. gate, and the opening of this pip is about an inch below the floor of the standpipe. There is a ventilator at the peak of the roof, with four ports, and numerous 4-in. holes for ventilation in the wall, close to the roof. All openings are screened.

In the construction of the standpipe particular care was taken to remove all loose rock under the foundation. In the center, considerable blasting was done. The bottom of the standpipe was built in two layers, each 6 ins. in thickness, after first leveling to the proper grade, the second layer being reinforced with ½-in. round iron. The floor was troweled to a smooth surface, the finishing coat being cement mortar, 1:2 mixture, with the addition of 5 per cent of hydrated lime, the same amount of lime also being added in the second layer of concrete.

The wall was reinforced horizontally with iron rods of various diameters, from 1¼ ins. at the base to ¾ in. near the top, supported on lattice work which was built into the wall. The proportion of the concrete mixture for the wall was 1:2:3.5, with 5 per cent of hydrated lime. A "T" iron, 6 ins. by 12 ins., was built in the foot of the wall, circling the standpipe, reinforcing rods anchoring this to the floor of the standpipe.

The method of building the wall was by placing the concrete in movable forms, the forms being held in place by bolting one section to the next, depending on the bolts entirely to hold the outside forms in place. An elevator was used to hoist the concrete to a runway around the wall, and the concrete was placed with wheelbarrows.

The roof was built during cold weather, and on the night it was finished it collapsed. There were various opinions as to the cause of this. During the time the concrete was being placed live steam was discharged into the standpipe to keep it warm underneath the roof. The supports for the forms were built and used as staging for the wall, and it is possible that the carpenters might have been careless in their work, perhaps weakening some place where strength was needed. Only one pier fell, the others being in use today. The roof was rebuilt in the spring of 1913 on exactly the same lines as before, even the reinforcing rods being straightened and used again. The roof appears perfect at this date.

When the standpipe was first filled, various small leaks developed, on one horizontal ring in particular. To remedy this the contractors cut a recess into this joint with sharp chisels and calked it with lead wool. At this date the condition of the standpipe is very good and it is practically tight. A few damp spots appear at times, depending on the weather, but they could not be called leaks. Thus far there does not appear to be any damage to the wall from frost, and the concrete is apparently as good as when first completed.

It might be possible to construct a standpipe by building an outside wall of cement blocks, built on a batter, using them in place of a form of wood. The inside forms, being vertical, could be made of wood and their position easily and quickly changed, filling in the concrete from a spout fed by an elevator, pouring it continuously, and by this means having no dry joints to bond together. In Brunswick and Topsham there are four concrete watering troughs, each of which was built in one pouring, and there is yet one to be found that is damp on the under side. If the same principle could be carried out in building a concrete standpipe there would be no leaks. The water in the standpipe would keep the wall at an even temperature, and if the wall was built strong enough there would be little danger from expansion and contraction.

Milford, O.—The concrete standpipe at Milford, O., described by S. S. Gatch, was erected in 1903 and is apparently in better condition today than when finished. After using it about two years some seepage was noticed. The water was drained out and the inside dried and coated with a cement wash. Since then there has been no seepage. The seepage was evidently caused by joints in the construction because of delaying the work at night and over Sundays.

ACKNOWLEDGMENT.

The information here given is taken from the topical discussion on concrete standpipes before the New England Water Works Association as reported in the Journal of the Association for June, 1915.

BRIDGES

Design, Construction and Detailed Costs of a Reinforced Concrete Girder Bridge Over Red Cedar River, Michigan.

Contributed by R. A. Small, Lansing, Mich.

So much has properly appeared in the engineering journals regarding big contracts and great feats of engineering that one may feel few are interested in the difficulties of the "lesser lights." He of limited experience and financial resource often lacks confidence in the possible merits of his achievements; and perhaps justly so, for, even though the problems confronting him are, within the limits of his skill and plant, apparently insurmountable at times, they are of little magnitude and less importance to the public and to the big contractor. However, there possibly are small contractors who are displaying ability quite as keen as the larger ones. The following recital of facts, without claim to originality, ingenuity, or commensurate success in solving problems, is presented in the hope that some other "little fellow" may be somewhat guided or warned.

GENERAL FEATURES.

The contract for the construction of the bridge described in this article was awarded, at a very low price, to a party possessing neither bridge gang nor construction plant; and when there remained only about six weeks before the specified date of completion the writer was engaged to superintend its construction. The bridge spans the Red Cedar River, in Michigan, and consists of two equal through girder spans of reinforced concrete, 82 ft. in length over all and 17 ft. 10 ins. in clear width. It replaces an old steel truss bridge of about 70-ft. span, which rested on heavy stone abutments. The new structure is centered over the old one, thus making the new abutments partly coincident with the old stone substructure (see Fig. 1). From the west the old bridge was approached over a fill from a high natural bank; to the east there was a similar fill, which crossed the lowland and was protected by a stone revetment. The east bank was low and springy, and in the early days there was a large spring on the site of the new west abutment. The highway served is the old State Road, and is the present trunk line between Detroit and Grand Rapids. It was therefore necessary that it be kept open to traffic during the construction of the new bridge.

DETAILS OF DESIGN.

The new abutments were designed with footing slabs 8 ft. wide and 2 ft. thick, these being so located that their toes projected about 2 ft. inside of and considerably below the backs of the old stonework. The abutments are of the cantilever type, the footings being doubly reinforced with mats of square bars near the top and bottom, while the reinforcement in the walls is hooked into the lower mat of bars. The footings, which are founded on piles, are about 22 ft. long across the front, with wings extending on each side about 13 ft., at an angle of 30° with the faces of the abutments. Figure 2 gives complete details of the reinforced concrete abutments.

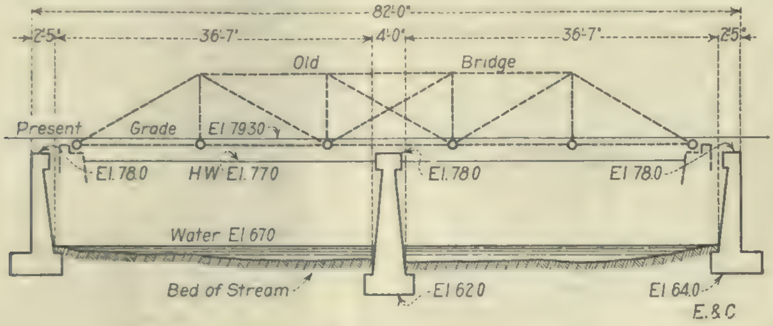
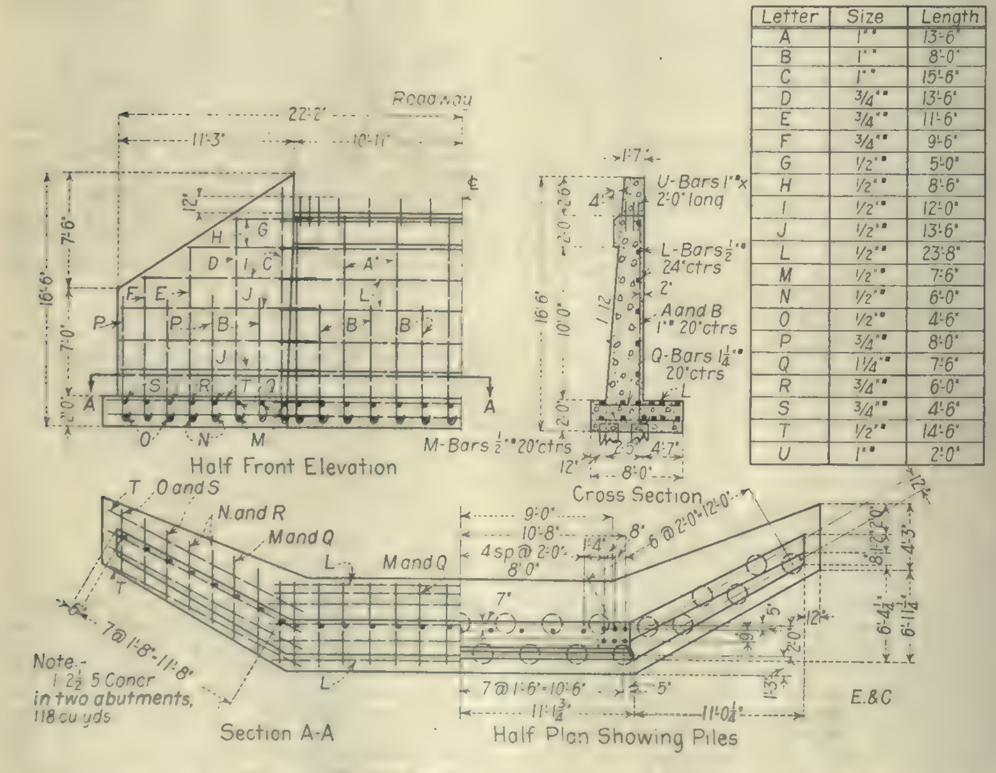


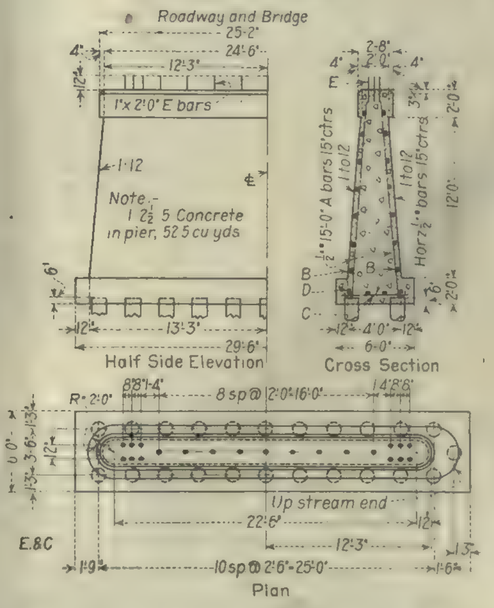
Fig. 1. General Elevation Showing Relative Positions of New and Old Bridges Over Red Cedar River, Michigan.

The reinforced concrete pier, which has a total height of 16 ft., is also supported on piles. The footing of this pier is 6 ft. wide, 29 ft. 6 ins. long, and 2 ft. thick. The pier shaft is battered on each face; at the top this shaft has dimensions of 2 ft. x 24 ft. 6 ins.; while at the bottom these dimensions are 4 ft. x27 ft. 6 ins. The coping has a width of 2 ft. 8 ins., a thickness of 2 ft., and a length of 25 ft. 2 ins. Figure 3 shows details of this pier.



Letter	Size	Length
A	1"■	13'-6"
B	1"■	8'-0"
C	1"■	15'-6"
D	3/4"■	13'-6"
E	3/4"■	11'-6"
F	3/4"■	9'-6"
G	1/2"■	5'-0"
H	1/2"■	8'-6"
I	1/2"■	12'-0"
J	1/2"■	13'-6"
L	1/2"■	23'-8"
M	1/2"■	7'-6"
N	1/2"■	6'-0"
O	1/2"■	4'-6"
P	3/4"■	8'-0"
Q	1¼"■	7'-6"
R	3/4"■	6'-0"
S	3/4"■	4'-6"
T	1/2"■	14'-6"
U	1"■	2'-0"

Fig. 2. Plan, Elevation and Cross Section of Abutments of Concrete Girder Bridge Over Red Cedar River.



Letter	Size	Length
A	3/4"■	15'-0"
B	1/2"■	23'-0"
C	1/2"■	5'-6"
D	1/2"■	29'-0"
E	1"■	2'-0"

Fig 3. Plan, Elevation and Cross Section of Center Pier of Concrete Girder Bridge Over Red Cedar River.

Each of the two duplicate girder spans has a length of 40 ft. 11⅞ ins., and a width overall of 21 ft. 10 ins., giving a clear roadway of 17 ft. The girders, which have a total depth of 5 ft. 9 ins., extend 3 ft. 9½ ins. above the roadway slab at the curb. The floor system consists of a reinforced concrete slab with end and intermediate floorbeams. The floor slab has a thickness of 9½ ins. at the curb and 10½ ins. at the center of the roadway. The bottom of this slab is 14 ins. above the bottom of the girders. With the exception of the end floorbeams at the center pier, which have a width of 13⅞ ins., all floorbeams have a width of 14 ins. and project 14 ins. below the floor slab. Figure 4 gives details of the reinforced concrete superstructure of the bridge.

It was required that all of the reinforcement be in place before any concrete was poured. This was accomplished by suspending the bars from the trench bracing by means of wires. Boxes were placed around the posts to provide for pulling them.

PRELIMINARY CONSTRUCTION WORK.

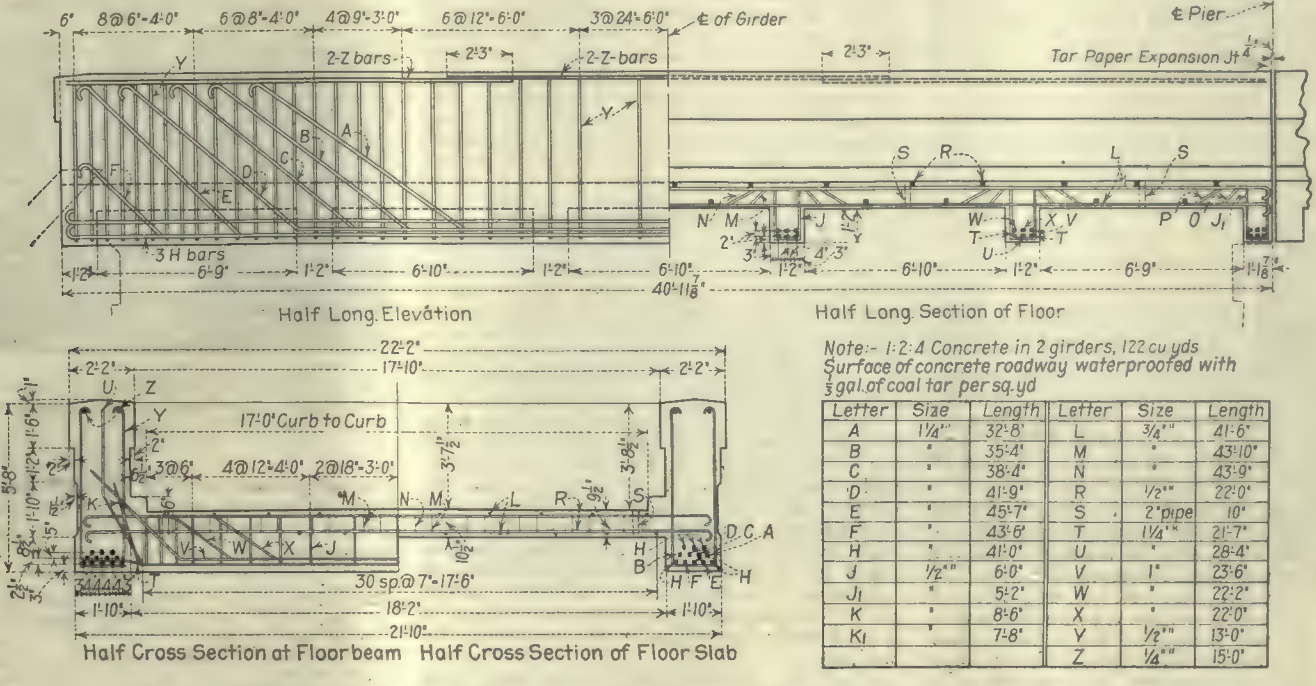
The old bridge and its abutments were preserved nearly intact to assist in holding the banks and to avoid the excessive amount of excavation which otherwise would have been required to prevent landslides.

The Red Cedar River is usually a mere creek in the summer, but is fed by drainage from open fields which yield a very rapid run-off. The water stage therefore fluctuates very rapidly according to the rainfall, and at the bridge site is somewhat subject to a miller upstream. The river bed at the bridge site is covered with a layer of rocks and gravel, in and under which there is a fine, shifting sand overlying solid clay. At a low stage of water we attempted to secure our supply of gravel from the river bed, at the pier site and adjacent areas. With water from 12 to 18 ins. deep and with a considerable current flowing, it was difficult shoveling so we tried scrapers, but the occasional rocks either would stop the horses or would dump the scrapers. The best arrangement appeared to be shoveling into an extra wheeled scraper while the team was delivering the gravel to the stock pile on the bank. The labor cost of this work was: 1 team at 50 cts. per hour; 1 foreman at 40 cts. per hour; 2 men at 20 cts. per hour each; and 1 man at 22½ cts. per hour. The gravel obtained in this manner cost about $2.20 per cubic yard; it was coarse and slime-coated, and was rejected by the inspector. This work was therefore discontinued, and the teams were used in plowing the pier site to loosen and remove the stones from the excavation.

In the absence of suitable material for a temporary bridge, excavation for the abutments was started under the cover of short temporary approaches to the existing bridge. At this time the river was too high to permit work on the piers. As soon as practicable a horse and scraper were placed in each cut, and the trench was braced, from the bank to the old stone abutments, as rapidly as it would yield a clearance for the horses. When soft material was reached the work with horses was discarded, the bracing was carried down, and a bench was prepared for the sheet piling. However, a part of the bank adjacent to the east hole gave way after a heavy car had passed, which necessitated even greater precautions. Plain 2x8-in. wooden sheet piling was thereafter driven to refusal by hand through the soft material, as required.

TEMPORARY BRIDGE.

Upon the arrival of material a temporary bridge was constructed just downstream from the permanent structure. Iron buckets, about 3 ft. in diameter and depth, were obtained from a sewer-digging company and placed bottom-side up over stones in the river bed. Two of these buckets, capped with a timber and secured with wire constituted a pier. Eight-inch I-beams were blocked up on these piers and braced, 8 ft. apart, with planks fitted edge up and bound with wire, wedged taut. Over the center of these braces there was laid a run of planks flush with the I-beams. The oak plank floor was then removed from the existing bridge to the temporary structure and fastened with 60d spikes clinched under the I-beam flanges to prevent loss during high water. A wheel guard, consisting of a line of plank, was laid on each side of the temporary roadway and a one-board railing constructed. Figure 5 is a view of the completed temporary bridge.



Note:- 1:2:4 Concrete in 2 girders, 122 cu yds
Surface of concrete roadway waterproofed with ⅓ gal. of coal tar per sq. yd

Letter	Size	Length	Letter	Size	Length
A	1¼""	32'-8"	L	¾""	41'-6"
B	"	35'-4"	M	"	43'-10"
C	"	38'-4"	N	"	43'-9"
D	"	41'-9"	R	½""	22'-0"
E	"	45'-7"	S	2" pipe	10"
F	"	43'-6"	T	1¼""	21'-7"
H	"	41'-0"	U	"	28'-4"
J	½""	6'-0"	V	1"	23'-6"
J₁	"	5'-2"	W	"	22'-2"
K	"	8'-6"	X	"	22'-0"
K₁	"	7'-8"	Y	½""	13'-0"
			Z	¼""	15'-0"

Fig. 4. Details of Girders and Floor System of Concrete Girder Bridge Over Red Cedar River.

The respective items in Table I account for all labor of men and team to haul the material about ten miles from the city, to remove the floor from the old bridge, and to complete the temporary structure.

EXCAVATION WORK.

In excavating for the abutments it was necessary to shovel over and high-bank the material out at the wings. This was slow, hard work and it was difficult to get men to do it in a farming community zealous for help. The east stone abutment had been well laid, and it extended down to within 3 ft. of the bottom of the new footing. This abutment and the adjacent natural bank made a fairly good cofferdam for the excavation so that a gasoline diaphragm pump was easily able to handle the water. Figure 6 shows the sheet piling in place and the men starting to excavate for the east abutment. This excavation was completed, with the exception of that portion under the old stone masonry, and then allowed to fill with water while the pump was used on the west side.

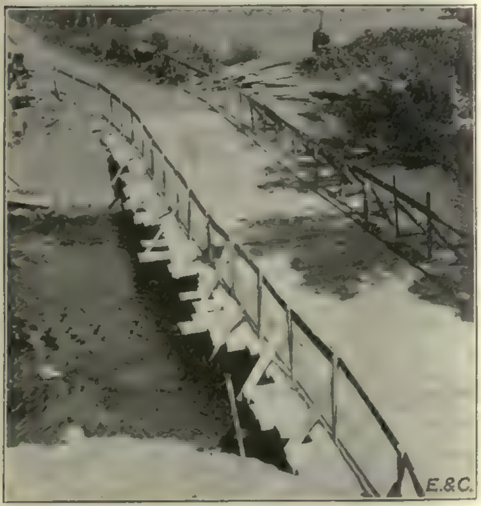


Fig. 5. View of Temporary Bridge Used During Construction of Concrete Girder Bridge Over Red Cedar River.

At the west abutment we found about a foot of quicksand, then a foot of clay, then a fine, water-bearing sand, under which was hard clay. The builders of the old abutment apparently had their troubles, as the bottom of this work was little more than a heap of stones, about 4 ft. higher than the bottom of the new footing. To preserve stability and to give the cofferdam effect these loose stones had to be held in place, as they were too high to hold in place the bottom of the bank. This work was done in the following manner:

Three 6x6-in. x 16-ft. timbers were set in holes dug about 18 ins. deeper than the excavation was to extend, the bottom of these holes being in solid clay. The posts were then braced and counterbraced between the bank and the stonework. The loose stones were supported in place by rangers held by knee-braces to the posts, which also held the lower horizontal braces against the bank. The excavation was thus completed without a cave-in, although a number of men quit through fear of a cave-in during the rainy weather. About the only thing that enabled us to keep any men on the work at times was the excellent food provided at the neighboring farmhouse.

During high stages of the river, water came through under the old abutment in such quantities that the spoil was used to construct a cofferdam outside of it. The unit costs shown in Table I covers all materials removed, and it is influenced by having to pick all of the clay and rehandle the wet materials. The labor charged as excavation included attention given to pumping. No attempt was made to segregate the labor on clay, but a certain period of the record, covering clay work only (taken at a time when just enough men were employed to make the work progress satisfactorily) showed a cost of $1.11 per cubic yard (estimated) as against $0.63 for the same kind of material in the pier, where braces did not interfere seriously, where the material did not need to be rehandled, and where only about 20 per cent of the excavation was high-banked.

SUBSTRUCTURE FORMS AND SHEETING.

The specifications required that the abutment walls be built monolithic and that the forms and all reinforcing steel be in place before any concrete was poured. A sufficient amount of the old stonework was removed to clear the forms, and the posts were rebraced therefrom. The stones, which ranged in size from 4 ins. to large boulders requiring several men to move, were piled against the bank on the heel of the footing slab, the vertical wall bars being bent where required. The form studs were set up and lagged to the first trench brace, tie wires and 2x2-in. spreaders were placed, the studs were braced and counterbraced to the banks, the trench braces were removed, and the lagging then carried up to the next trench braces. In this manner the banks were held in place until the forms were taken down. The concrete was discharged from the mixer through chutes into the forms. An efficient mixer would have reduced the costs of this work, under the same conditions.

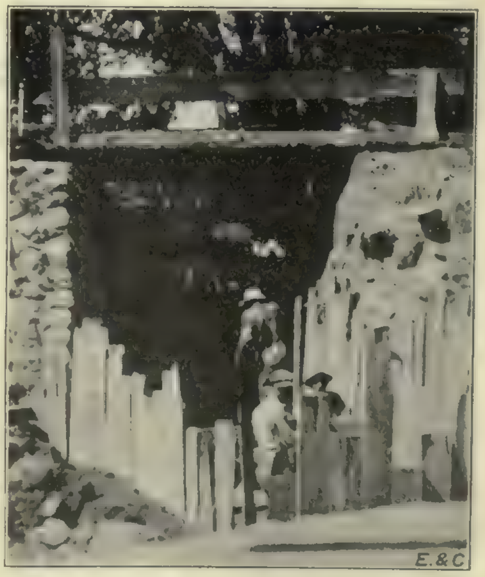


Fig. 6. View Showing Sheeting in Place for Excavating for East Abutment of Concrete Girder Bridge Over Red Cedar River.

For the center pier a frame was made of pine planks and staked in place with iron pipes. Around this frame the wood sheet piling was driven to refusal, by hand, leaving a space of 12 ins. all around. The sheet piling consisted of plain 2x8-in. planks, with 1x6-in. pieces nailed on the outside to cover the joints. As it was not possible to secure sufficient penetration by driving alone a ½-in. water jet was rigged from the force pump; and this proved fairly satisfactory. High water and engine difficulties so delayed the work that on two occasions the partially completed enclosure was demolished; at one time the water rose 39 ins. during the afternoon. A penetration of about 18 ins. was secured, and the clay spoil from the abutments was dumped around the sheet piling and protected against the current with planks. The enclosure was easily unwatered, and the spoil from within was used to strengthen the cofferdam, it being found unnecessary to drive the sheet piling further into the clay. The excavation was completed, the steel set, and the concrete placed before the water began to work through the clay to an appreciable extent.

MIXING AND PLACING CONCRETE IN SUBSTRUCTURE.

The concrete for the entire work was mixed in a new side-load, batch mixer of high repute (according to the catalog and selling talk). It proved an expensive disappointment. (The writer believes that no concrete mixer should be purchased without a thorough working test on the job—a test the really good machine need not fear.) The actual performance of the mixer used on this job was at times most wretched.

The mixer was so placed as to discharge, through chutes, to the bottom of the excavations, which were kept unwatered until the cement began to separate from the concrete; the remainder of the concrete was allowed to heap and roll slowly down into the water. A wet mix was used, and the concrete was allowed no appreciable drop. Gravel was wheeled from the far end of the stock pile, a distance of about 100 ft. It was intended to furnish water in a barrel at the mixer by means of a force pump driven by a "fourth-hand" gasoline engine. This engine, however, worked about an hour, and thereafter it was necessary to carry the water in pails from the river, a distance of about 60 ft. For the east abutment footing the gravel and water were delivered alongside the mixer and the cement was carried about 100 ft. from the shed, netting a decreased unit cost, as shown in Table I.

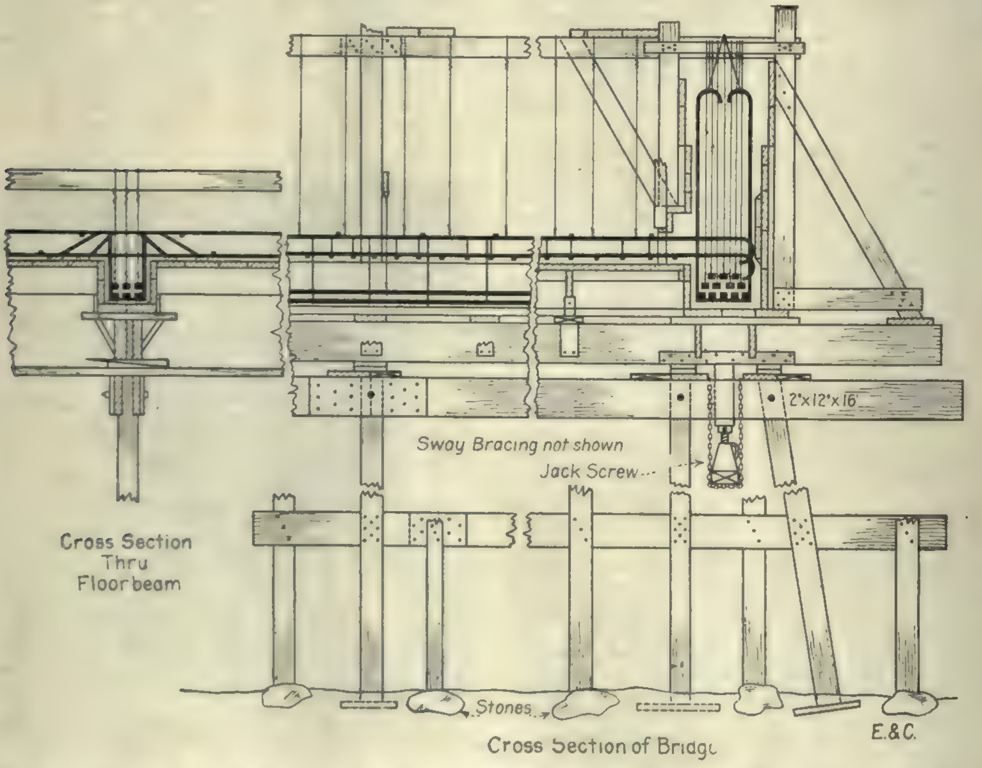


Fig. 7. Details of Falsework and Forms for Superstructure of Concrete Girder Bridge Over Red Cedar River.

SUPERSTRUCTURE FORMS AND FALSEWORK.

A pole trestle was constructed to support the girder and floor forms. The poles were obtained from a wood lot about ¾ mile distant. They were squared at the butt to receive short pieces of plank, and were set (using a tape and plumb-bob) in shallow holes dug in the river bed, five poles to the bent. Each bent was so located as to subtend a floorbeam, and was secured at the top by means of planks bolted to each side of the poles, the latter being notched to receive them. The poles were cut off flush with these caps, over which planks were laid, both for convenience and to secure full bearing. Additional bearing was later obtained by spiking planks alongside the bents, above the water level, and legging up from large submerged stones, as shown in Fig. 7.

The 3x12-in. oak stringers of the old bridge were built into three-ply beams about 32 ft. long, with 2-in. planks spiked in, sandwich fashion. As old planks were used for this and other suitable work, and as none were cut, the salvage rate was high. One of these built-up beams was laid over and parallel to each bent. The floorbeams and trusses of the old bridge were then removed, as will be noted later.

Short pieces of plank and sheet piling were nailed across the three-ply beams to receive the soffit forms of the floorbeams and girders, and of the sides of these members and the floor forms. The three-ply beams were wedged up to the proper elevation and camber with 2x8x24-in. wedges, which were left in place for adjustment later, in the event of settlement. As the wedges under the girders proved inadequate a jackscrew was slung in a steel chain (see Fig. 7) to supplement the wedges.

After the outside girder forms were built and braced to the three-ply beams the girder stirrups, 208 in number, were fastened in place with nails partly driven into the forms. The girder and main tension bars were then placed. These bars were 1¼-in. square, and those in the girders weighed over 200 lbs. each. The forms for the curbs were made up, and the inside studs were set opposite the outside ones on 4 ft. centers in such a manner that the alternate studs had bearing on the drain pipes required in the finished floor (see Fig. 7). The studs were tied across with boards, and strips were nailed on up to the coping to provide for the offset without mutilating the studs. The inside forms were carried up no higher than the curb at this time. Each of the main reinforcing bars was supported in place with a single piece of No. 12 wire from each of the wooden ties where the inside stud had bearing, with the exception of the lower layer of rods, which was slung in the stirrups in like manner. The intermediate stirrups were suspended from a catenary made of No. 12 wire drawn taut over the wooden ties, from end to end of the girders. After the remainder of the reinforcement had been placed in the beams and

Fig. 8. View of Completed Concrete Girder Bridge Over Red Cedar River, Michigan.

TABLE I. — ITEMIZED QUANTITIES OF MATERIALS AND ACTUAL UNIT COSTS.

Item and quantity.	Unit cost.
Excavation for abutments, various soils, 233 cu. yds.	$ 0.83
Trench bracing for abutments	0.14
Excavation for pier, hard clay, 40 cu. yds.	0.63
Cofferdam, sheet piling and puddle, 8 ft. x 31 ft. 6 ins.	*37.73
Temporary bridge, 75 lin. ft.	*21.97
Removing old stonework, 1,220 cu. ft.	0.027
Removing old bridge steelwork, wooden stringers charged to forms	*22.60
Concrete in west abutment footing: gravel hauled 100 ft.; cement, 15 ft.; water carried in pails 60 ft.; mixing and placing, 27.5 cu. yds.	1.00
Concrete in east abutment footing: gravel alongside; water in barrel, 25 ft.; cement carried 100 ft.; mixing and placing 26 cu. yds.	0.24
Concrete in west abutment wall: gravel hauled 30 ft.; cement, 20 ft.; water, one-half in barrel alongside, other half carried in pails 60 ft.; mixing and placing, 31.5 cu. yds.	0.53
Concrete in east abutment wall: gravel alongside, except 2 cu. yds., hauled 115 ft.; water in barrel, 25 ft.; cement carried 100 ft.; mixing and placing, 33 cu. yds.	0.635
Concrete in pier footing: gravel hauled 60 ft.; cement, 50 ft.; water in barrel alongside; mixing and placing, 15 cu. yds.	0.48
Concrete in pier shaft (same supply as for pier footing), 40 cu. yds.	0.451
Concrete in bridge superstructure: gravel hauled 20 ft.; cement, 25 ft.; water in barrel alongside; average delivery of concrete, 60 ft. by wheelbarrows; mixing and placing, 122 cu. yds.	0.648
Forms, west abutment, erection, 1,140 sq. ft.	0.038
Forms, east abutment, erection, 1,175 sq. ft.	0.032
Forms, west abutment, strip, pull nails, and pile, 1,140 sq. ft.	0.011
Forms, east abutment, strip, pull nails, and pile, 1,175 sq. ft.	0.006
Forms, pier, erection, 900 sq. ft.	0.034
Forms, pier, strip, pull nails, 900 sq. ft.	0.008
Forms, superstructure, all told, 4,875 sq. ft.	0.038
Trestle falsework, delivery and erection, 8 bents	*43.13
Trestle falsework, if charged in full to superstructure, except discarded floor forms. per sq. ft. of net forms, 3,975 sq. ft.	0.011
Cement, loading, hauling storing, 518 bbls.	0.116
Cement shed and tool house, 12x16x6 ft. under eaves, hillside	*9.29
Steel, west abutment, placing and wiring, 2,731 lbs.	0.0029
Steel, east abutment, placing and wiring, 2,731 lbs.	0.003
Steel pier, placing and wiring, 1,718 lbs.	0.0056
Steel, placing in superstructure, including 3,302 lbs. placed twice on east span, 32,273 lbs.	0.0023

*Total cost.

floor the girder forms were completed and tied together from rail to rail with 2x6-in. x 12-ft. pieces (see Fig. 7), the lapped ends being spiked and supported from the floor by 2x6-in. pieces. These ties supported the upper mat of floor steel and the runway overhead. The lower mat was blocked from the floor with 2x2-in. concrete pats.

REMOVING OLD STEEL TRUSSES AND CONCRETING NEW SUPERSTRUCTURE.

For removing the trusses of the old steel span a long gin-pole, made of planks, was set up at the center of the span, with its bottom resting on the river bed and its top rigged with tackle to the center of the upper chord of the south truss, for safety. A short gin-pole was then set up on a three-ply beam near each haunch of the upper chord and rigged with a steel chain which was given one turn around the chord and was held at its free end by a man. After this equipment was in place four men tipped and lowered the truss on its side to the trestle. The north truss was taken down in like manner, as the trusses were required to be salvaged, not wrecked. The trusses were dismembered only as far as was necessary for their removal by the four men. The costs given in Table I cover all labor required for removing the steelwork and piling it in alongside the road.

For concreting the superstructure the mixer was placed at the west end of the bridge, as close as possible to the approach to the runways. The concrete was transported in wheelbarrows and dumped into place. The average distance to the stock piles was 20 ft. and that to the cement shed about 25 ft.

Figure 8 is a view of the finished bridge.

COST DATA.

The rate of pay for labor varied from 20 to 30 cts. per hour, averaging 25 cts. per hour. The foreman was paid 40 cts. per hour, and the teams used on the work covered in Table I, 50 cts. per hour. A total of 69 men was employed at various times, not one of whom had previous experience in bridge work and none of whom were carpenters. The costs given do not include fuel or supplies. The cement was received in cloth sacks and was hauled about 1½ miles over a sandy road having steep grades. The heaviest team could haul only 65 sacks per load, while the lighter teams sometimes hauled only 40 sacks. The lighter teams were finally discarded and all were paid 50 cts. per hour. During the cement hauling one man remained in the car, with an extra wagon alongside. The quantities of materials represented by the various items of the work, together with the actual unit cost of each item, are given in Table I.

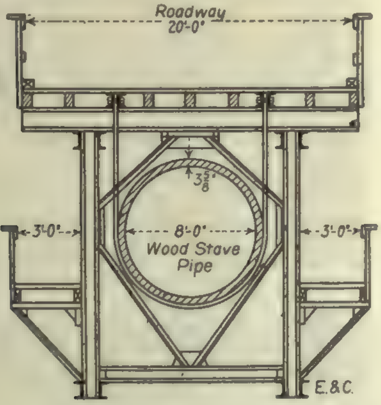


Fig. 1. Cross Section of 120-ft. Riveted Truss Spans of Bow River Bridge in Alberta, Canada.

The New York office of the American Society of Engineering Contractors has been removed from 11 Broadway to the South Ferry Building, 40 Whitehall street.

Some Features of a Unique Bridge Over the Bow River in Alberta, Canada.

(Staff Article.)

In Fig. 1 there is shown in cross section a rather unique bridge completed in 1914 for the Southern Alberta Land Co., Ltd., at a site about 57 miles north of Medicine Hat, Alberta, Can. This structure consists of six 120-ft. riveted truss spans, which carry an 8-ft. wood-stave pipe line over the Bow River and also provide a 20-ft. roadway and two 3-ft. sidewalks. The truss spans are designed for carrying, at some future time, a single-track electric railway. The sidewalks are cantilevered from the trusses in such positions as to permit inspection of the pipe line, which is supported on cradles, hung from the roadway stringers by means of steel slugs (see Fig. 1).

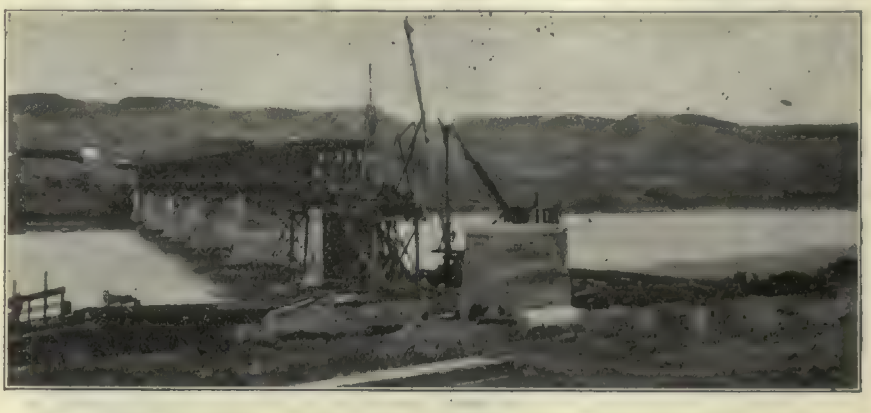


Fig. 2. View of Site of Bow River Bridge Illustrating Erection Procedure.

The bridge is a part of one of the largest irrigation projects in North America, comprising 204 miles of main canal and irrigating about 250,000 acres. The wood-stave pipe line, where it crosses the Bow River, is a syphon having a total head of 193 ft. The syphon is 96 ins. in inside diameter, and is constructed of fir staves which have a finished thickness of 3⅝ ins. and are banded together with ¾-in. and ⅞-in. bands. The supporting cradles are of concrete, spaced 6 ft. on centers. The total length of the syphon is 6518.5 ft., 720 ft. of which are supported by the Bow River Bridge.

In building the bridge it was necessary to haul all materials entering into it from Suffield, Alberta, a distance of 25 miles. This town is located on the Canadian Pacific Ry. and is the nearest railway station. Figure 2 is a construction view illustrating the manner of erecting the bridge. The construction of the piers and the erection of the superstructure were made exceedingly difficult by the ice gorges and by the rapidly fluctuating river stage.

The steelwork and piers were designed and erected by the Wisconsin Bridge and Iron Co., of Milwaukee, Wis., while the design and erection of the timber approaches were in charge of D. W. Hays, Chief Engineer of the Southern Alberta Land Co., Ltd.

Some Data on Nickel Steels.

(Staff Abstract.)

The increasing use of nickel steels in bridge work makes a better knowledge of their properties essential. In addition to their use in long-span bridges nickel steels are used in rails, castings and automobile parts, where their superior qualities more than compensate for their greater cost. Not only do these steels possess greater strength, but they are freer from segregation, less apt to corrode, have a lower melting point (thus facilitating casting), and are harder than ordinary straight carbon steels. The nickel steels in common use seldom contain more than 5 per cent of nickel and 0.5 per cent of carbon.

The strength of nickel steels depends both on the nickel and on the carbon content. Table I gives the results of some comparative tests of nickel and straight carbon steels, each grain refined and hardened at the best hardening temperature, and tempered to various degrees.

It will be noted that the nickel steel has a higher elastic limit, with only a slight decrease in ductility, as indicated by the extension. It is this increase in elastic limit which is the chief reason for the increased resistance of nickel steels to alternate stresses under which all steels will ultimately break down.

The heat treatment of nickel steel is very similar to that of straight carbon steel except that the critical range, above which all steels must be heated to harden or anneal, is lower. For example, if it is desired to harden a steel containing 0.30 per cent carbon and 3.50 per cent nickel, the steel must be heated above 740° C. It is good practice to heat the steel about 25° C. above the critical range to allow for any errors in the determination of the critical range and temperature measurement both during heating and during the cooling which takes place while the steel is being transferred from the furnace to the quenching medium.

The hardness of a steel depends on the rate at which it is cooled through the critical range down to atmospheric temperature, and also on the location of the critical range. If the latter is at a low temperature the steel is so rigid that the changes which cause the steel to become soft can only take place with difficulty. This explains the fact that nickel steels are harder than straight carbon steels.

TABLE I—RESULTS OF COMPARATIVE TESTS OF NICKEL AND STRAIGHT CARBON STEELS.

Drawing temperature, degrees centigrade.	Time held, hours.	Tensile strength, lbs. per sq. in.	Elastic limit, lbs. per sq. in.	Extension, per cent.	Contraction, per cent.
Straight carbon steel, carbon 0.30 per cent					
Undrawn	...	112,000	88,000	16	51
204	½	108,500	74,400	21	62
316	1	108,500	76,700	21.6	64.4
427	1	108,000	70,500	17	64
538	½	91,600	58,100	28.1	65
649	½	84,300	49,000	31	69.9
Nickel steel, nickel 3.50 per cent. carbon 0.30 per cent					
Undrawn	...	Breaks short		...	...
204	1	250,000	218,000	7.7	22.7
316	1	216,000	190,800	11.7	43.2
427	1	148,400	137,500	16.1	50.4
538	½	121,500	100,000	21.2	58.7
649	½	102,000	60,000	27.0	66.4

Another beneficial effect of nickel steel is to decrease the rate at which the grain size increases. This is one of the reasons for the superior physical properties of nickel steels. It was very evident (from a microscopic examination) that in straight carbon steel the grain size, as indicated by the polygonal structure, is much larger than in nickel steel. This property makes nickel steels well suited for case hardening since the soft core does not become coarse grained under the high temperature to which it is subjected for a long time.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by G. W. Armstrong, instructor in chemical engineering, University of Wisconsin, in The Wisconsin Engineer.

Some Data on Final Results of Havre de Grace Bridge Tests of Protective Coatings for Steel.

(Staff Abstract.)

The annual report of Committee D-1 of the American Society for Testing Materials, on preservative coatings for structural steel, was presented at the meeting of the society in Atlantic City, July 22-26, 1915. The report of Sub-committee II, W. A. Aiken, chairman, on the inspection of the Havre de Grace Bridge, was as follows:

> In accordance with a resolution to discontinue the inspection of the Havre de Grace Bridge, one complete set of these plate panels, 57 in all—three for each of the 19 paints, one each at the several spreading rates of 600 sq. ft., 900 sq. ft. and 1,200 sq. ft. per gallon of paint—were removed from the bridge site and delivered to the U. S. Bureau of Standards and one complete set to the Institute of Industrial Research at Washington, D. C. The remaining panel plates, 38 in all—2 for each of the 19 paints, one each at the two spreading rates of 600 sq. ft. and 1,200 sq. ft. per gallon of paint—were delivered to the laboratory of the National Lead Company, 129 York Street, Brooklyn, N. Y., in care of Mr. G. W. Thompson, Secretary of Committee D-1, 19 plates—one for each of the paints at the spreading rate of 900 sq. ft. per gallon of paint—having been utilized by the committee several years ago, as reported at the time, in an investigation of the condition of the metal after removal of the paints on these particular plates. These plates are in storage and cared for at the laboratory of the National Lead Company.

RESULTS OF PAINT TESTS.

The report of the special sub-committee on paints used in the Havre de Grace Bridge tests showed that of the original 19 paints, paint No. 11 had revealed itself as excellent from the date of application to the end of the test, a period of 7½ years. The committee's description of this paint follows:

> The first and second coats, red lead in linseed oil. The third coat, red lead and a very small amount of carbon pigment in linseed oil. The red lead used showed, on analysis, 95.9 per cent true red lead, Pb_3O_4. Three coats were applied. (The manufacturer of this paint offered no change in this description.)

Paint No. 10 ranked second, being excellent from the date of application for 5½ years, being good thereafter to the end of the test, 2 years. The committee's description of this paint was as follows:

> The first and second coats, red lead and linseed oil. The third coat, red lead and a small amount of carbon pigments in linseed oil. The red lead used, on analysis, showed 88.5 per cent true red lead, Pb_3O_4. Three coats were applied.

The following statement contained in the committee's final report is pertinent:

> It must be understood that the committee fully recognized, as soon as the manufacturers refused the fullest information regarding their paint products, that a considerable part of the anticipated value of these tests would not be realized.

CORROSION TESTS OF FERROUS METALS.

Committee A-5 announced the inauguration of a comprehensive series of corrosion tests of ferrous metals, selected from various manufacturers of open-hearth, Bessemer, and basic steel sheets, pure iron and puddled sheets, coated and uncoated, the locations of the tests to be at the sea coast, at an inland industrial site, and at some country site. The estimated cost of the tests is placed at $3,500, this having been contributed by manufacturers.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A New Pneumatic Drill for Use in Close Quarters.

(Contributed.)

The tool shown in the accompanying illustration is a recent addition to the "Little David" line of pneumatic tools, manufactured by the Ingersoll-Rand Co., 11 Broadway, New York. This drill is particularly adapted for working in cramped or confined positions, where the regular type of four piston, reciprocating pneumatic drill cannot be used, the distance from the end of the casing to the center of the spindle being only 1 5/16 ins.

A Pneumatic Drill for Cramped Positions.

The motor is of a novel three cylinder design and operates in a bath of oil. The valve is of the rotary type, and is gear driven from the pinion of a three-way crank shaft. This crank shaft is operated by the three ratcheted levers which directly connect the pistons to the drill spindle.

One of the important features of this machine is that there is practically no strain on the crank shaft, as the power is transmitted direct from the pistons through the levers to the ratchet spindle. The spindle has a triple ratchet, and a noteworthy feature is that one of the ratchets is engaged on the spindle at all times. This construction is claimed by the manufacturer to develop more power and a much more constant pull on the spindle.

The casing is divided in such a way that the loosening of a few cap screws allows easy access to all moving parts.

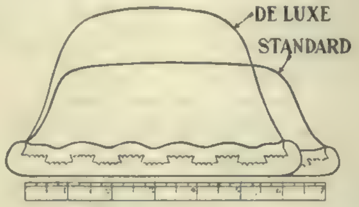
The manufacturer claims this drill to be the most powerful tool of its type and size. Owing to its extreme simplicity it is estimated that the drill can be dismantled and completely reassembled in 30 minutes. It is fitted with a No. 4 Morse Taper Socket; is rated for drilling up to 3 ins. and reaming and tapping to 2 ins. and operates at a speed of 150 r. p. m.

A New Tire for Motor Trucks.

(Contributed.)

The new truck tire illustrated here and known as the "De Luxe" tire, is built higher than standard tires of the same width. This extra volume of tread rubber affords additional resiliency, which means a greater cushion for the truck and its load, and brings more wearing rubber between the road and the rim.

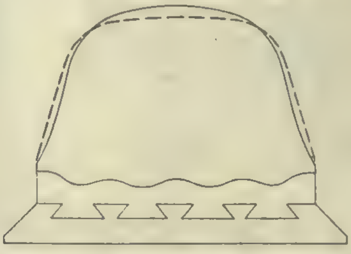
The width of a tire has nothing to do with its cushioning qualities. Tires of regular design, regardless of make, are but approximately 2¾ ins. high, whether their width is 3½ ins. or 7 ins. The wider the tire, of course, the more wearing surface there is, but building out wheels is expensive. In the "De Luxe" the extra rubber is placed on top of the tread, where it is needed, and not on the sides where it is less useful. Thus a 5-in. "De Luxe" has approximately as much rubber as a 6-in. regular, with the rubber placed where it gives more cushion and more wear. The tire carrying capacity may, for this reason, be increased to better advantage by equipping with "De Luxe" than by the old expensive method of building the wheels wider.



Comparative Sections of Standard and De Luxe Truck Tires.

The wearing qualities of a 5-in. "De Luxe" are better than a 6-in. regular for the reason that the rubber retains its vitality longer when it is of extra height. Road irregularities are more easily absorbed and without so great a strain. For example, on crowned roads the inside tire must carry more than its share of the load. With the limited compressibility of the low section tire, it is more subject to overloading in which event disintegraton must follow. Before the inside tire has worn to conform to the crown, it has been overtaxed and its vitality dissipated.

With the "De Luxe" the greater compressibility given it by the extra height of tread, permits the inside tire to compress without injury, equalizing the load between the outer and inner tires. A 6-in. "De Luxe" is, for the same reasons, more economical equipment than 3-in. duals.



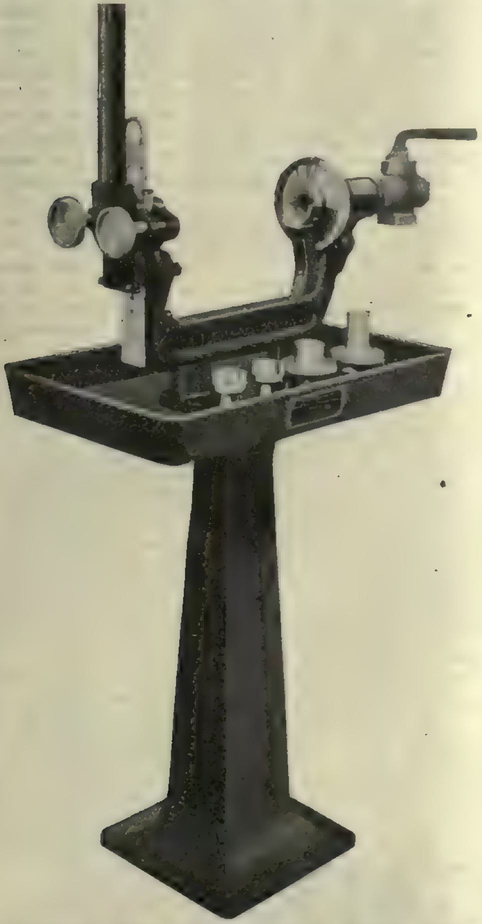
Duplex Curve of De Luxe Truck Tire.

The duplex curve design of the "De Luxe" is an improvement over the European type made necessary by the severity of American operating conditions. The semi-circular shaped tread, the European design, when under load compresses so that the tread bulges out on either side. Bad roads chop off these edges, which hastens disintegration. The duplex curve tread, under load, assumes a shape similar to the European tread when not under load. This elimination of the bulge reduces chipping to the minimum and lengthens the tire life. This tire is made by the B. F. Goodrich Co., Akron, O.

Profile surveys of the Wenatchee River in Washington have been prepared by the U. S. Geological Survey, and the results are published in Water Supply Paper 368. The river drains a heavily forested slope, and the waters are used for irrigation and hydro-electric power purposes in the lower part of the basin.

Simple, Inexpensive Machine for Testing One Water Meter at a Time.

A low-priced and simply constructed meter testing machine for testing one meter at a time was recently placed on the market by the Ford Meter Box Co. of Wabash, Ind. This machine fills a well-defined want in the very small water departments and will prove a handy accessory in the larger meter testing shops. A view of this tester, known as the "Baby Ford," is shown herewith.

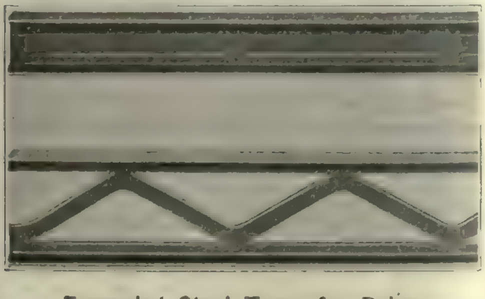


View of New Type of Ford Water Meter Tester for Testing One Meter at a Time.

This machine will test any ⅝, ¾ or 1-in. meter. It is provided with a 1-in. Mueller inverted key stop valve at the inlet end, and the outlet side is equipped with the Ford calibrated strip, used in the large Ford tester, by means of which a flow of any size from 1/32 to 1 in., in 10 steps, may be passed. The price of this machine, f. o. b. Wabash, Ind., is $45.

A One-Piece Expanded Steel Truss.

The accompanying illustration shows the manner in which the "Bates" one-piece expanded steel trusses, poles and concrete reinforcement are manufactured. These members are made by shearing "H" sections while cold, leaving unsheared intact portions; and then, by grasping the flanges throughout their length, pulling them latterally while hot. This procedure creates a triangle web lacing as shown. The original section can be expanded with flanges either parallel or tapering, as desired. This type of expanded member is manufactured and handled by the Bates Expanded Steel Truss Co., 208 S. La Salle St., Chicago, Ill.



Expanded Steel Truss for Poles.

Traction Wheel Locomotive Crane.

(Contributed.)

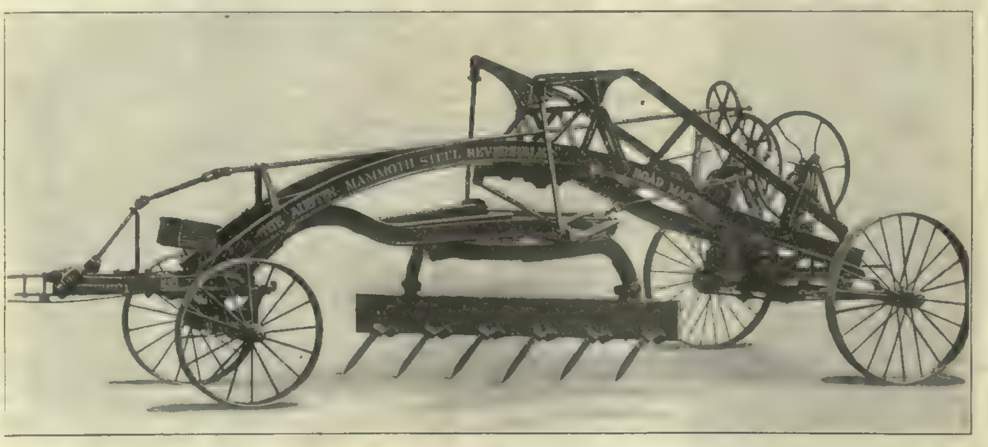
A small traction wheel locomotive crane with clam-shell bucket for loading motor trucks and wagons is now being built by the Davenport Locomotive Works, Davenport, Ia. This crane is driven by gasoline, kerosene or steam engine or electric motor. The weight is so light that it will travel on standard wheels over ordinary good hard roads without the use of plank, and for work over very soft ground caterpillar wheels ar provided. Besides being provided with the ordinary rotating, propelling and hoisting mechanism usually found on cranes, it is equipped with a device by which the operator controls the steering mechanism and travel brakes from the operator's platform.

Although primarily designed for use unloading gondola cars on team tracks and loading trucks in coal and building material yards, the crane is found to be very useful to contractors unloading material for country roads, as it travels from place to place under its own power and can be used on the average country switch track. It is also used about lumber yards and various plants which require a locomotive crane and do not have track facilities for a railroad crane. An electric lift magnet is used for handling scrap iron.

Traction Wheel Locomotive Crane.

A Scarifier Attachment for Austin Road Graders.

The illustration shows a scarifier which replaces the regular mold board on Austin mammoth senior or junior road graders. As indicated by the illustration the scarifier is a special mold board fitted with right and left angle sockets in which are set steel teeth. This mold board is made 8 ft. long and with six teeth weighs 1,050 lbs. The teeth or tines are 2½ ins. square in section and are made of special tool steel; they are held in the sockets by large cotter pins. When the machine is in working position the spaces between tines are 12 ins. The tines are set at a rooting angle of 45° and are adjustable at the will of the operator. They can be set to scarify to any depth from 1 in. to 12 ins. With all tines in place the width of road covered at one operation is 6 ft. For especially hard road one or more tines can be removed. It will be noted that the tines can be changed from one set of sockets to the other so as to scarify either right or left and also that the mold board holding the tines acts to throw the torn up material to one side (either right or left) and so prevent clogging. It will be understood that the machine illustrated is the regular Austin grader with the scarifier substituted for the standard mold board. After the old road is scarified the regular mold board is replaced and the road is smoothed and crowned by the same machine. This new machine is made by the Austin-Western Road Machinery Co., Chicago, Ill.



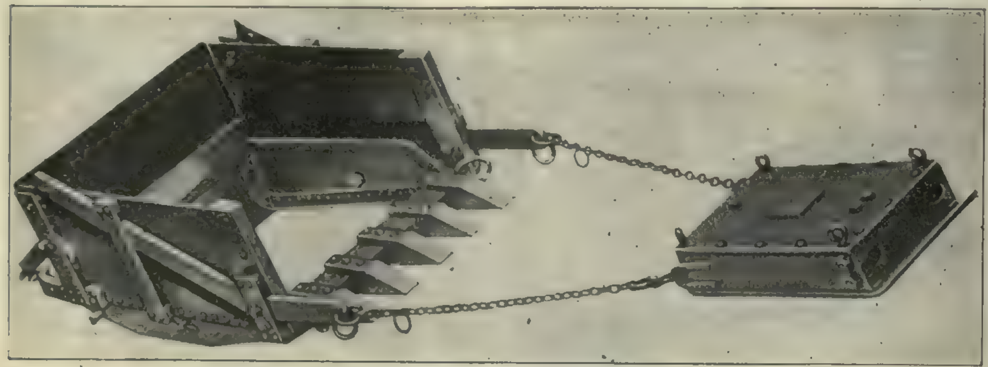
A Scarifier Attachment for Austin Road Graders.

According to a report received, about $1,000,000 worth of bridges were destroyed by the recent high water in the Kaw River Valley.

A New Drag Line Excavator.

A new drag line excavator, recently placed on the market, eliminates high towers. It works directly from a dead-man, either from a double or four-drum engine with either one or two excavators, hauled either by a single or double haul cable and with the dead-man any distance from the engine. The single haul line method is the fastest and cheapest, while the double haul line doubles the working capacity of the engine and saves more than 50 per cent in the cost of engine and boiler. Six of these excavators, each of 1½ cu. yds. capacity, made of ¼ in. steel, have been given a thorough and satisfactory trial in steam shovel materials. These excavators are now available in ¾ to 3 cu. yd. sizes, made of ⅜ to ½-in. steel plate, either with or without inside buckets of ¾ to 2 cu. yds. capacity to fit in the larger excavators. The inside bucket puts a bottom into the excavator. When filled the inside bucket is lifted out by use of a lifting cable and dumped into a wagon or car or can be taken away by a cableway.

When excavating and unloading into cars or wagons a four-drum engine and small revolving derrick placed next to engine make up the plant. When excavating and unloading automatically anywhere along the line of drag and between the engine and dead-man it calls for only the double-drum engine and boiler to complete the plant. To unload the bottomless excavator requires only a back haul cable from one engine drum to and passing around a sheave made fast by the dead-man. The other engine drum handles the haul cable, which is made fast to the turtle or is passed around the sheave in the turtle. The accompanying view shows the bottomless excavator and to it is attached the turtle. This excavator, it should be understood, is a digger and not simply a scraper. It is suitable for use in hard materials such as heavy wet clays, hard pan, glacial drift, shale formations, etc.


View of McCormick Bottomless Drag Line Excavator with Turtle Attached.

The McCormick excavator is caused to dig by its rocking action; the combination of rockers, levers and turtle produce the rocking effect. After filling the release of dogs forces the front end of the excavator to rise about 4 ins. above the ground so the teeth will clear.

Either one or two excavators are worked, either on a single haul line or by a double haul line, by the endless cable system. With the endless cable system while one excavator is loading and being hauled forward, the other excavator is on its way back to be loaded. Engines of 25 to 65 H.P. are required for ¾ to 3 cu. yd. excavators, when working in earth, and 35 to 80 H.P. when working in hard materials, if the endless cable system is used with two excavators and double haul line and the boiler carries as much as 100 lbs. steam, and has 10 per cent overload capacity. These engines should be reversible, link motion, high geared, say 7 to 1, and drums of about 30 ins. diameter. The size of engine and boiler should be increased 25 per cent when using single haul line on two excavators from the endless cable system. It is claimed that one bushel of coal per horsepower per 10 hours' work is sufficient.

Wearing parts are easily renewed and replaced by any blacksmith. Tooth points are of manganese steel. One engineer, one fireman, and one or two other men will operate a plant. For levee work two to four extra men and such track men as are necessary must be added.

It is claimed that a McCormick excavator plant built for levee construction with two 3 cu. yd. excavators will excavate and place in levees more than 1,000 cu. yds. in 10 hours at a cost of $60, allowing $6 per ton as the price of coal. Levees ranging from 5 to 30 ft. high can be built by this plant at 5 to 10 cts. per cu. yd. These excavators are also suitable for railroad work, cut and cover, stripping, irrigation ditches, river work and trunk sewers. They excavate to any depth and to any width. They can be worked either from a plant set on a skid, a wagon, or a self-propelling steel frame car, either with or without revolving derricks. Their low cost is an added advantage.

McCormick excavators are sold by the Chicago Builders' Specialty Co., 1415 Lumber Exchange, and Geo. F. Smith, 810 N. First St., St. Louis, Mo.

DRAINAGE AND IRRIGATION

Some Costs of Continuous Wood Stave Pipe Lines.

(Staff Abstract.)

The cost of continuous stave pipe of any particular size varies so much according to design, spacing of bands, location relative to transportation lines, conditions affecting erection, etc., that it is impossible to give general costs, but some data of a specific nature relative to certain pipe lines which have been built may be of value for purposes of comparison.

Eighteen-inch.—At Astoria, Ore., 7½ miles of 18-in. pipe built in 1895. Staves, fir, 1⅝ ins. thick, milled from 2x6-in. lumber. Bands, 7/16 in. diameter upset to ½ in. at threads. Clips No. 12, B. W. G., 1½ ins. wide, treated. Shoes, Allen patent, malleable iron, weight 10 ounces each. Contract prices of steel in bands, 4.8 cts. per pound. Lumber, gross measurement, $35.40 per 1,000 ft. b. m. Average spacing of bands, 5 9/16 ins. Cost of pipe to the city, 90.33 cts. per linear foot, including accessories or 76 cts. excluding them. These figures are not the actual cost of building the pipe, as Mr. Adams says: "It is presumable that the contract prices represent a profit of from 12½ to 15 per cent." The approximate cost of replacing this line with one of the same size and length in 1911 was $75,000, redwood staves 1½ ins. thick being used in the new pipe. The cost given includes engineering expense.

Thirty-inch.—At Denver, Colo., in 1889, a 30-in. pipe 16.4 miles long required 1,869,000 ft. b. m. of Texas pine, which cost $51,399.28, at $27.50 per M., and 271,900 half-inch bands, which cost $54,299.55; erection of pipe by contract, at 5.1 cts. per band, $13,866.03; total, $119,564.86, or $1.36½ per linear foot. Trenching cost 48.3 cts. per foot in addition to foregoing.

At Jerome, Idaho, 1912, 1,529 ft.; 30 ins. diameter; fir staves, 1⅝ ins. thick; bands, ½ in. diameter; pressure, 0 to 47 ft.; average haul, 10 miles; built in trench and buried 2 ft. deep. Cost, including everything except engineering and administration, $2,922, or $1.91 per linear foot.

At Idaho Falls, Idaho, 1905; 800 ft.; 30 ins. diameter; fir, ½ in. bands; maximum head, 34 ft.; supported on wood cradles. Cost, $1.55 per linear foot, including everything.

At Kennewick, Wash., 1908; 9,490 ft.; 30 ins. diameter; head, 0 to 180 ft.; built by contract on prepared foundation for $1.85 per foot. Includes delivery of material at railroad point, but no haul or earthwork.

Thirty-two Inch.—At North Yakima, Wash., 1894; Redwood siphon 940 ft. long; 32 ins. diameter; maximum head, 90 ft.; bands, ½ in. diameter; built by force account for $2,500, equals $2.66 per linear foot. Duplicated by contract, 1903, for same figure.

At Filer, Idaho, 1901; 1,300 ft.; 32 ins. diameter; fir staves, 1⅝ ins. thick, at $40 per thousand feet b. m. on basis of 2x6-in. lumber; bands, ½ in. diameter, 57 cts. each; malleable iron shoes, 4 cts. each; tongues, ⅛x1½x5 7/16 ins., 3 cts.; pressure head, 0 to 40 ft.; work done by force account; wages, $2.50 for 10 hours, and foreman $5; hauling material 8 miles, $75; erecting on top of ground, approximately $250. Cost of staves and steel laid down at Filer, $1.35 per foot of pipe; haul and erecting, 25 cts.; total approximately, $1.60 per foot.

Thirty-six Inch.—At Jerome, Idaho 1912; 650 ft.; 36 ins. diameter; head, 0 to 43 ft.; staves, fir, 1⅝ ins. thick; band, ½ in. diameter; built in trench and buried 2 ft. deep; average haul, 4 to 5 miles. Cost, including everything except engineering and administration, $1,596, or $2.46 per foot.

Forty Inch.—At Jerome, Idaho, 1912; 3,113 ft.; 40 ins. diameter; head, 0 to 100 ft.; fir staves, 1⅝ ins. thick; bands, ½ in. diameter; built in trench and buried 2 ft. deep; average haul, 10 miles; cost, $8,933, or $2.87 per foot, including everything except engineering and administration.

Forty-two Inch.—At Jerome, Idaho, 1912; 980 ft.; 42 ins. diameter; head, 0 to 51 ft.; staves, fir, 1⅝ ins. thick; bands, ½ in. diameter; built in trench and buried 2 ft. deep; average haul, 4 to 5 miles; cost, $2,556, or $2.61 per foot, including everything except engineering and administration.

Forty-four Inch.—At Wenatchee, Wash., 1902-3; 9,000 ft.; 44 ins. diameter; maximum head, 235 ft.; bands, ½ in. diameter; fir staves, 1⅝ ins. thick; laid in trench, and on bridge across Wenatchee River; contract price for pipe, $2.20 per linear foot. Excavating and backfilling not included.

At Palisades, Colo., 1909-10; three fir pipes, 44 ins. diameter; 2,850 ft.; 1,055 and 1,150 ft. in length; cost by contract, $3.15, $3.25, and $2.90 per linear foot, respectively. No earthwork included.

Forty-eight Inch.—At Palisades (orchard mesa), Colo., 1909-10; for six pipes 48 ins. in diameter and varying lengths and heads, the unit prices ranged from $2.40 per foot up to $4.75 per foot, the average of the six being $3.52; material, fir.

At Deer Park, Wash. (about 1909), 94,000 ft. of fir pipe; head, 0 to 70 ft., built in trench; contract price, $2.35 per foot, includes delivery of all material at railroad point and erection of pipe, but no haul or earthwork.

Forty-eight Inch.—At Clarkston, Wash., 1906; fir staves, 1⅝ ins. thick, ½-in. bands; built in trench by force account, for light head; cost, $2.25 per foot, no earthwork included. Foreman received $3.50 per day and other men $2.50 for 10 hours.

Fifty-eight Inch.—At Pueblo, Colo., 1907; 2,277.5 ft.; cost by contract, $6.14 per foot, no earthwork included.

Sixty Inch.—At Pueblo, Colo., 1907; on 17 fir pipes the unit price per foot ranged from $4.19 to $6.58, averaging $5.51. The combined length of 17 pipes equals 19,821.5 feet, making the average price per foot on this basis equal $6.27; earthwork not included.

Sixty Inch.—At Nissa, Ore., 1912; 6,700 ft.; average head about 65 ft.; bands, ⅝ in. diameter; staves, fir, 2x6 ins.; built on wooden cradles; contract price, $4.25 per foot, included material, erecting, and freight, but no haul or earthwork.

Extract from Bulletin 155, U. S. Department of Agriculture, by S. O. Jayne, irrigation manager.

Recommendations for Values of N for Different Kinds of Irrigation Channels.

(Staff Abstract.)

Either in the design of canals or the determination of the carrying capacity the material forming the perimeter divides into the following general classes: (1) concrete lining; (2) wooden flumes; (3) metal flumes; (4) masonry lining; (5) earth canals; (6) cobble-bottom canals, and (7) sidehill cuts with retaining walls. There are a few special cases that do not come under any one of the classes mentioned, but a proper comparison can be made by assuming parallel conditions. The following values are applicable for velocities up to about 5 ft. per second and with hydraulic radii up to about 2 ft. If velocities and radii are greatly to exceed the above figures, slightly lower values of *n* should be used.

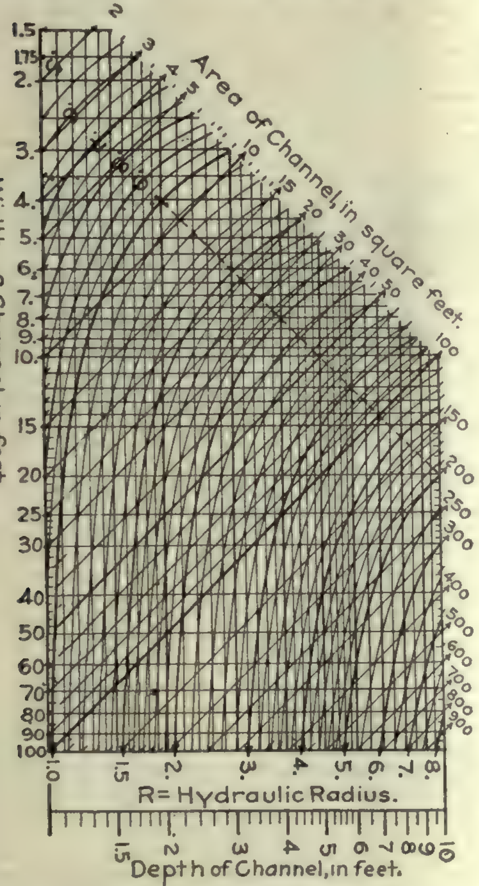


Fig. 1. Areas in Square Feet, Hydraulic Radii in Feet and Hydraulic Economic Dimensions for Rectangular Channels.

VALUES OF *n* FOR CONCRETE LINING.

I. n=0.012 for the highest grade of material and workmanship and exceptionally good conditions. The surface of the lining to be as smooth to the hand as a troweled sidewalk. The expansion joints to be so well covered that they practically fulfill the same condition. The climate and water to be such that moss does not accumulate to any great extent. The water to be practically free from shifting material. The alignment to be composed of long tangents joined by spiraled curves, while the interior of the channel must be of uniform dimensions, true to grade throughout the cross section.

(II.) n=0.013 for construction as in type I, but with curves as in the usual mountain canyon. Same construction and alignment as in type I, but with small amount of sand or debris in water. Construction as in type III, but in very favorable alignment or for water that carries a small amount of fine silt that will eventually form a slick coat.

(III) n=0.014 for linings made by good construction under favorable conditions. The surface to be as left by smooth-jointed forms or to be roughly troweled. Joints to be good, but causing some retardation. Alignment about equal in curves and tangents, with no spirals between. The bed to be clean and sides free from rough deposits. In the opinion of the writer this is the value to use for most linings on moderate-sized channels.

(IV) n=0.015 for construction as in type III, but with sharp curves and clean bottom or moderate curves and much debris on the bottom, but clean-cut sides.

(V) n=0.016 for concrete as constructed by the average gang of laborers, using forms that leave prominent lines at the cracks, no finish coat being applied. Bed to have the usual small amount of rock fragments and patches of sand and gravel. Average amount of curvature. In climates where a rough deposit accumulates, as in southern California, a lining that originally had a value of n about 0.013 quickly assumes about this type. For this reason it appears to the writer that labor and money spent in securing a very smooth surface is lost where the deposit accumulates on smooth or rough alike.

(VI) n=0.017 for roughly coated linings with uneven joints. This value also is applicable where rough deposits accumulate on the sides and conditions of alignment are poor.

(VII) n=0.018 for very rough concrete with sharp curves and deposits of gravel and moss. A broken gradient, irregular cross section, and the like, contribute to such a high value of n.

Where experiments show higher values of n than are given above for concrete linings the conditions are such, as a rule, that the containing material has lost its identity as concrete or cement, and thick coatings of sand, accumulations of moss, or deposits of sand change the general classification of the channel.

VALUE OF *n* FOR WOODEN FLUMES.

While experimental flumes have been constructed that showed values of n in the neighborhood of 0.009, yet in making tests on flumes in commercial service values of n below 0.012 are so rare that it is not thought advisable to recommend any value less than this. Wood is subject to so many changes, due to the influences of climate, wind, settling of earth, moss accumulations, warping, and so on, that even when well constructed the value of n becomes greater after a few months' use than when new, and it is better to use a value of n that will hold for the greater part of the life of the flume.

The above statements apply to the ordinary plank flume. Where staves are used, which is quite rare since the advent of the steel flume, a lower value will probably hold throughout the life of the flume, for its very construction is such that it must stay in quite good condition or fail, due to the compression existing between the edges of the staves. In many cases the designer of a flume considers only the lumber, battens, and calking, while in actual practice the good influences of well-chosen materials are often completely lost through the accumulation of rock fragments, gravel, and so on. A very common location for a flume is down a bench cut in a rocky hillside. Whenever the cut is such that the fragments sloughing from the hill would fall into the flume, care should be exercised to keep the flume out from the side of the cut, or a guard wall should be constructed to divert debris so it will fall back of the flume. If high velocities are constantly to be maintained ordinary dirt and small stones will roll on down the flume or accumulate on the inside of sharp curves. Short flumes are quite liable to take about the same value of n as the earth section above, as the same bottom becomes characteristic of both.

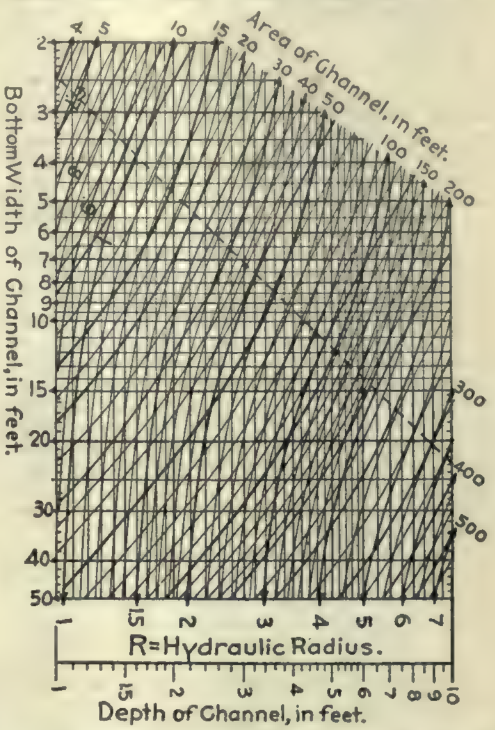


Fig. 2. Areas in Square Feet, Hydraulic Radii in Feet and Hydraulic Economic Dimensions (Broken Line) for Channels Having Side Slopes of 1½ to 1.

(I) n=0.012 for well-constructed, clean flumes with surfaced lumber for both siding and battens. All lumber to run longitudinally. Alignment to consist of long tangents with gentle curves between. Construction to be such that the grade line will remain uniform, preventing sags and wavy alignment. A flume without battens may have a very slightly lower value of n, but this difference will be inappreciable if the added length of the wetted perimeter due to the battens is considered in the design. Some very smooth grades of roofing materials used as linings also give a slightly lower value of n, but not enough to consider. If flumes are calked with oakum or other stuffing, care must be used that none projects into the water section if a high degree of efficiency is to be maintained.

(II) n=0.013 for well-constructed, clean flumes of surfaced lumber and battens, following mountain contours, where the alignment will consist of about equal gentle curves and tangents. This value will also apply to flumes with alignment and grade as described in type I, but with vertical battens at intervals, with projecting calking or a slight amount of hardened asphalt or other waterproofing retarding the velocity.

(III) n=0.014 for flumes of very smooth interior, but with many bends or sharp curves. This value also applies to those of type I with a location such that a slight amount of hillside debris is unavoidable. Construction of type I, but with cracks poured with any waterproofing material that hardens in tapering drops, is also liable to come in this type. For type I except that unsurfaced lumber is used.

(IV) n=0.015 for flumes of unplaned lumber, but otherwise as of type II. In the opinion of the writer this is about the value to use for the usual grade of construction in a mountain canyon where the flume will get about the usual grade of maintenance with repairs made with irregular-shaped scraps of boards.

(V) *n*=0.016 for flumes of type IV where sharp bends rather than curves are installed. For flumes lined with rough roofing material and for the ordinary grade of construction on a flume that is built and generally left to care for itself. The kind of an organization that is to operate the flume will determine this factor.

For values of *n* higher than 0.016 the inside of a flume has changed so that its character as a wooden flume is practically lost. Debris accumulations, warped and loose battens, excessive sagging, with consequent accumulation of debris, all contribute to make values above 0.016 rather indeterminate, except by actual test.

VALUES OF *n* FOR METAL FLUMES.

As noted in a bulletin of the Colorado Agricultural Experiment Station, metal flumes are divided into three clean-cut groups:

Group 1. Those having countersunk joints between the various sheets of metal so that there is practically no added roughness presented to the water.

Group 2. Those having joints that project into the water section presenting a shoulder every few feet that effectually retards the velocity. This type is not installed to any great extent at present, but there is a great deal of it in actual use, as it was the pioneer in steel fluming.

Group 3. Those having regular corrugations at right angles to the axis of the flume. This makes a stiff flume, not so liable to sag, but with a rather high value of *n*.

(I) *n*=0.011 for flumes of group 1, in favorable alignment and clean.

(II) *n*=0.015 for flumes of group 2, in favorable alignment and clean.

(III) *n*=0.022 for flumes of group 3, in favorable alignment and clean.

This value is based on but one observation by Mr. Cone.

Where flumes are short they are liable to accumulate the same class of detritus in the bottom as the section above them. Where the possibility of debris accumulations exists it should be considered in design.

VALUES FOR *n* IN MASONRY-LINED CHANNELS.

The writer has not sufficient tests on masonry-lined sections to make suggestions as to specific values of *n* to use, but the following general observations seem to be warranted: As a rule the proportion of the wetted perimeter extending across the bottom far exceeds that on the two sides; therefore, the preponderance of influence comes from the bottom. If this be of smooth concrete and the sides are reasonably smooth, then the value of *n* approximating that in average concrete may be used. If the sides are unchinked they will be rougher than the sides of the average earth canal, but again the bottom must be given the most weight.

VALUES OF *n* FOR EARTH CHANNELS.

The value of *n* in earth channels extends over a far greater range than in any other material. More complex conditions, more permutations and combinations of conditions exist than are possible in a channel that reasonable velocities cannot erode. If kept clean, concrete, wood, or steel must maintain about the same cross section; as a rule, uniform. Earth, on the other hand, may form a definite boundary of a channel when new, but after a few years of operation the character of the boundary has entirely changed. Grass, weeds, and fibrous roots may form the material for nearly vertical sides, while the bottom may silt up or scour deeper, be smooth, or deeply pocketed. A distinct trapezoidal form changes to a segment of an ellipse, silt depositing in the lower corners, while the middle of the bed remains about the same or becomes strewn with rocks or gravel. The values of *n* given in the following list cover the standard conditions.

(I) *n*=0.016 for excellent conditions of earth channels. The velocity to be so low that a slick deposit of silt may accumulate, or the natural material be such as to become smooth when wet. The influence of vegetation at the edges to be a minimum. The water to be free from moss and other aquatic growth. The alignment to be free from bends and sharp curves.

(II) *n*=0.020 for well-constructed canals in firm earth or fine, packed gravel where velocities are such that silt may fill the interstices in the gravel. The banks to be clean-cut and free from disturbing vegetation. The alignment to be reasonably straight.

(III) *n*=0.0225, although carried to one more significant figure, is given for the reason that it has long been used for this type and the tests do not disclose any reason for changing. This value for the average well-constructed canal in material which will eventually have a medium-smooth bottom, with graded gravel, grass on the edges and average alignment or silt at both sides of the bed and scattered stones in the middle, or a smooth bottom with an average amount of grass and roots forming the sides. Hardpan in good condition, clay and lava-ash soil takes about this value.

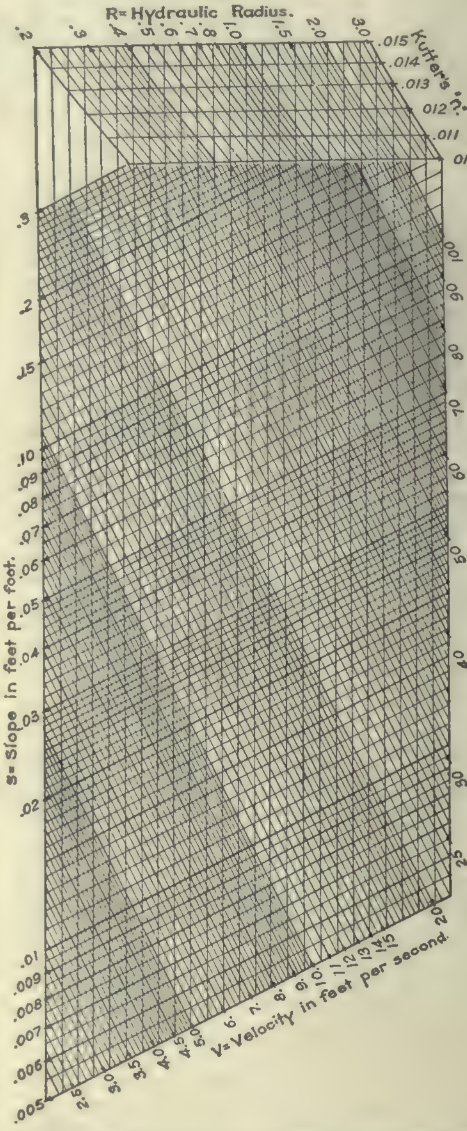


Fig. 4. Chart for Use in Designing Ordinary Concrete, Wood or Steel Channels on Very Steep Slopes; Particularly for Chute Drops.

(From the intersection of R and u follow guide lines to intersection of S and V.)

(IV) *n*=0.025 for canals where the retarding influence of moss, growths of dense grass near the edges, or scattered cobbles begins to show. The value of *n* in earth channels where the maintenance is neglected commences at this value and rapidly goes up. This is a good value to use in the design of small head ditches or a small ditch to serve but one or two farms.

(V) *n*=0.030 for canals subject to heavy growths of moss or other aquatic plants. Banks irregular or overhanging with dense rootlets. Bottom covered with large fragments of rock, or bed badly pitted by erosion. Values of *n* between 0.025 and 0.030 also cover the condition where the velocity is so high that cobbles are kept clean and unpacked in the center of the canal, but silt deposits near the sides. For values above 0.030 the channel is much choked with vegetation, very irregular, crooked, overhung with dragging trees and grasses, or there is some other condition that should not be allowed to exist in a well-kept system.

VALUES OF *n* FOR COBBLE-BOTTOM CANALS.

The typical clean-washed cobblestone ditch is very common near the mouths of canyons. Where the cobbles are graded in size and well packed the value of *n* is about 0.027, but the value rapidly increases as the larger rocks predominate and the lack of graded sizes prevents packing.

ESTIMATION CHARTS.

As an aid to the designer of irrigation channels the writer has prepared two sets of curve charts.

The first set shows values of width and depth of channel as related to area and hydraulic radius. These elements for rectangular channels are shown in Fig. 1 and for trapezoidal channels having side slopes of 1½ to 1 in Fig. 2. These cover the two shapes most commonly used, while the engineer working in materials that require other slopes may build up his own charts on the principle used in plotting Figs. 1 and 2.

The second set shows related values of velocity, slope, the friction factor *n*, and the hydraulic radius. This set is divided into three general classes. First. For construction in concrete, wood, or steel for ordinary slopes (Fig. 3). Second. For the same materials of construction on very steep slopes (Fig. 4). The latter chart is for use in the design of chute drops and covers slopes from 0.005 where Fig. 3 stops, up to 0.3, or 30 ft. per hundred. Third. For very rough materials, for earth channels and for cobble-bottom ditches (Fig. 5). The values of *n* range from 0.015 to 0.030 while the slopes cover all ranges likely to be encountered. On this chart the values of *n* cover such a wide range that the guide lines through any particular zone have not qutie the same slant, but the results obtainable from any of these charts are more accurate than the agreement between preliminary figures and results of tests made after construction.

Use of charts. Assume that it is desired to construct in well-made concrete a channel that will carry 1,000 sec.-ft. of water at a mean velocity of 10 ft. per second. Allow as a safety factor an overload of 5 per cent, making the designed capacity 1,050 sec.-ft. Therefore the area of such a channel must be 105 sq. ft. To test the possibilities of a rectangular cross section refer to Fig. 1. Any point on the "area" line representing a value of 105 will show values of depth, width, and hydraulic radius corresponding to this area, but the most economic channel—that is, the one having the least area for the greatest hydraulic radius—is at the point of intersection with the broken line. Therefore it is desirable to approach as nearly as possible to a channel 14.5 ft. wide by 7.2 ft. deep. A further study of the chart shows the hydraulic radius of such a channel to have a value of about 3.6 ft. Assume that the character of the lining, curvature, and so on should give a value of *n* of 0.012. Turning to Fig. 3, follow a line parallel to the guide lines from the point of intersection of *n* equals 0.012 and R equals 3.6 ft. This line intersects the velocity line equal to 10 ft. per second on a slope line equal to 0.00122 ft. per foot. But suppose the topography of the land to be such that a slope of 0.00122 is not obtainable or is not desirable. Suppose the best location for a canal is on a slope of 0.0015 ft. per foot. The intersection of 10 ft. per second velocity line with 0.0015 ft. per foot slope line is down the guide lines from the intersection of *n* line of 0.012 and hydraulic radius line of 3.1. With this value for hydraulic radius go back to Fig. 1, and the intersection of area line 105 sq. ft. and hydraulic radius line 3.1 shows the water section of the necessary channel to be 25.5 ft. wide and 4.1 ft. deep, while the same intersection on Fig. 2 gives a trapezoidal channel 19 ft. wide on the bottom and 4.2 ft. deep.

Figures 3, 4 and 5 may be used for the general solution of problems involving Kutter's formula. Given any three of the variables—slope, radius, *n* and velocity, and the fourth may be determined as accurately as is warranted.

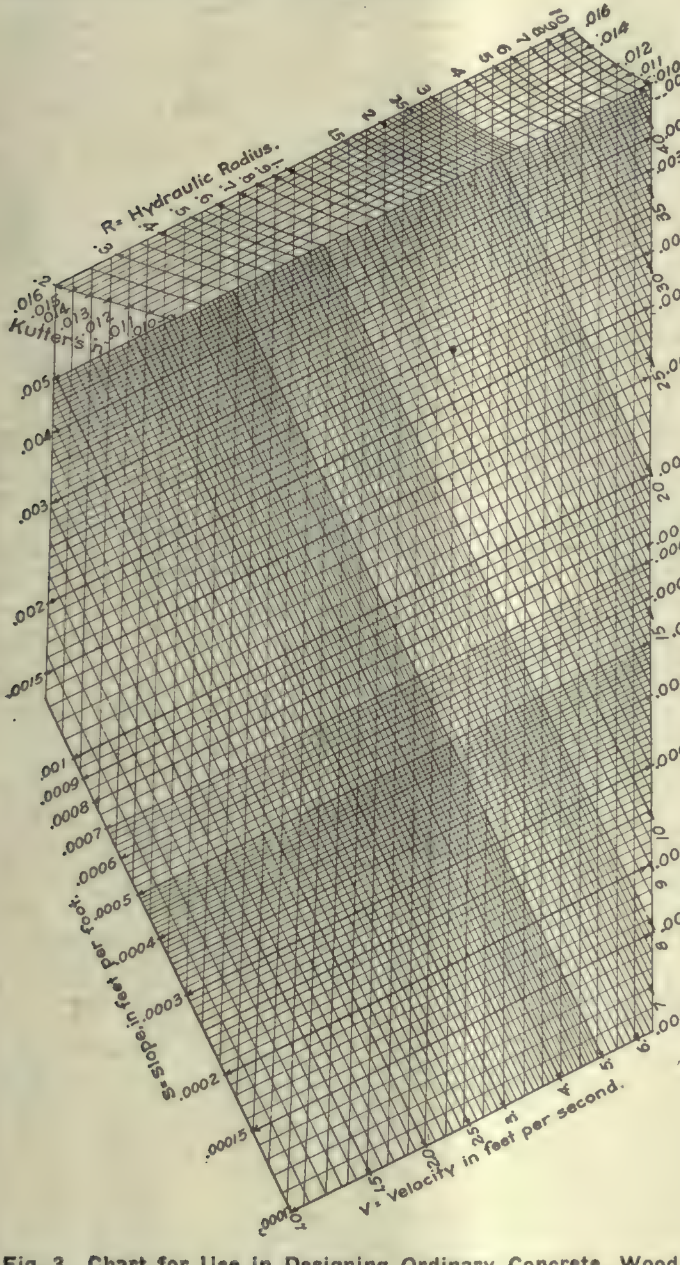


Fig. 3. Chart for Use in Designing Ordinary Concrete, Wood or Steel Channels in Model Slopes.

(From the intersection of R and u follow guide lines to intersection of S and V.)

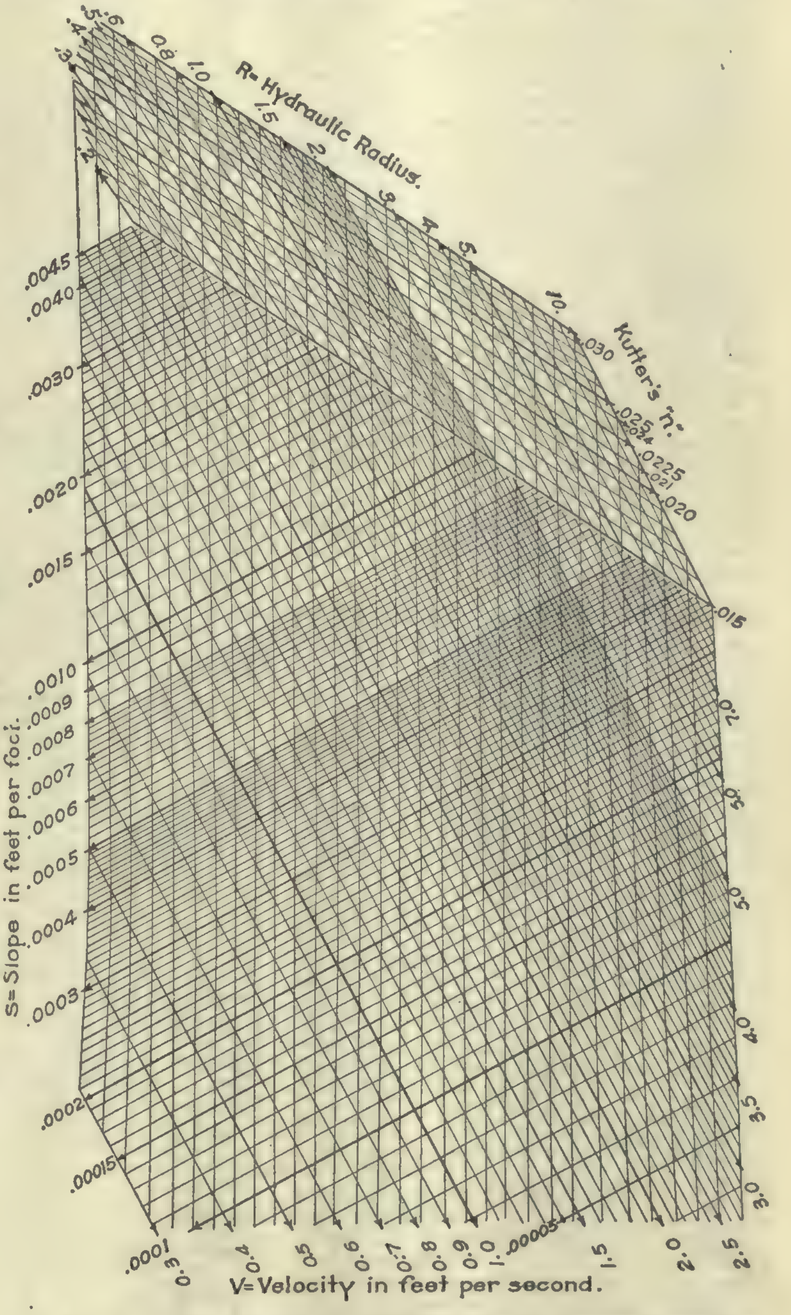


Fig. 5. Chart for Use in Designing Rough Coated Concrete or Earth Channels.

(From the intersection of R and u follow guide lines to intersection of S and V.)

CONCLUSIONS.

A careful study of the tests and of the experiments carried out by others appears to warrant the following general conclusions:

(1) That Kutter's formula is applicable to the design of any open channel.

(2) That the recommendations of the earlier writers concerning the values of *n* to be chosen were in the main correct. Any weakness was due to the fact that there was not sufficient distinction made between the various categories and that materials of construction are now used which were not covered by the tests from which early deductions were made. The influence of curves was not as a rule included. Concrete lining covered but one value of *n*, whereas in practice there are many shades of roughness, all applicable under the general head of concrete.

(3) That the factor *n* must include all the influences which tend to retard velocity. The principal of these influences are undoubtedly (*a*) rubbing friction between the water and the containing channels, and (*b*) vegetable growth extending into the main body of the water. The lack of carrying capacity in many channels is probably due to the fact that the first influence was the only one considered. Of secondary importance, but nevertheless deserving of careful consideration in about the order named, are the following: (*c*) Angles and sharp curves in the alignment. (*d*) Influences which tend to disturb parallel filaments of current. The concrete lining in a rough rock cut may be quite smooth to the feel of the hand and yet be so undulating as to cause heavy cross currents which retard velocity. All projections and irregularities in the bank of a canal disturb the filaments of current in addition to having a large area exposed to rubbing friction. (*e*) Sand and gravel cause heavy loss in velocity when allowed to enter and accumulate in shifting patches on a lined canal bed. Fine sand drifts downstream in deep, irregular pockets and may entirely change the character of the bottom of a smoothly lined canal. On the other hand, a water laden with fine silt flows far more freely after the silt has deposited in a slick coat over minor irregularities than in a new, though clean, canal. A canal carrying such a water may be designed for a far higher velocity through the same kind of soil than would be the case if the water were clear. It is necessary only to run but low heads in the new canal until a thick waxy deposit has been placed on the canal bed, after which the velocity may be nearly doubled over that which would have scoured the material in which the canal was originally excavated. (*f*) The prevailing wind direction may be given some consideration. A study of vertical velocity curves shows a marked change in form with change in wind condition. A downstream wind aids the flow of surface water to the extent that it has the maximum velocity in the vertical, while an upstream wind so shapes the velocity curve

that the surface velocity is as slow as that near the bottom.

(4) That there is a tendency toward a lower value of *n* as the velocity and hydraulic radius increase. Any experiments that are intended to bring out conclusively the extent of the variation and whether it is due to the change in velocity or the change in hydraulic radius must be conducted in very long, straight channels, in wood, or concrete, or steel, where the character of the wetted perimeter will remain unchanged as the water becomes deeper and deeper in the channel. Proper corrections must be applied for any slight changes in the mean velocity at the two ends of the reach tested. The reach must be far removed from all influence of curves and structures.

(5) That a value of *n* must be chosen that will apply to the canal in question at the critical period of the season. For instance, most canals are cleaned once a year. A growth of moss may become very heavy by July or August, but the water supply or demand will probably be much less than during the early days of June. If the canal is designed to carry its peak load on the basis of its being in good condition, there will still be sufficient carrying capacity for the smaller discharge when moss has appeared.

(6) That in the design of earth channels having a trapezoidal form when constructed, the value of R should be computed on the basis that the canal takes an elliptical form within a short time and thereafter maintains this shape unless altered artificially.

The preceding information is extracted from a report by F. C. Scobey, irrigation engineer, Office of Experiment Stations, U. S. Department of Agriculture.

Size of Drain Tile as Determined by Maryland Experience.

(Staff Abstract.)

(1) The greater the surface which sends water to the main, the larger should be the tile; this will include a hilly area draining to a flat one, though the hilly area may not need drainage.

(2) The greater the fall or slope the smaller the size of pipe required for a given area. For instance, with a fall of 1¼ in. per 100 ft. a 6-in. drain will remove ¼-in. of water from 12 acres in 24 hours, under average conditions; but with a fall of 9 ins. in 100 ft. it will do the same for 33 acres.

(3) The main drain of a tile system is often supplied with catch basins to permit surface water to enter the tile directly. If there is a desire to remove all the surface water in a given time, care should be taken to have the main sufficiently large. This will often mean that it must be larger than would be required for underdrainage alone.

(4). A single random line of tile has a reservoir composed of the ground which it drains, which reservoir holds the rainfall until the tile can take it away. If the tile is deep in the ground the storage capacity will be correspondingly larger and a slightly smaller tile can be used without injury to crops. There is little storage of water in the case of a regular system of uniform drains, because each lateral discharges into the main within a few hours after the rain falls, the time depending on the texture of the soil.

(5) A larger main and fewer laterals will be required for an open soil which drains more readily than for a tight soil.

In view of these five controlling features it is manifestly impossible to lay down hard and fast rules for use in determining the size of a main. The following Table I of tile sizes for different grades and areas drained is given only as a guide for use under average conditions, though it has proved satisfactory after several years' test in Maryland. It is based on the removal of ¼-in. of rainfall in 24 hours, which requires that some of the water from a storm find outlet over the surface of the ground. If the main is used as an outlet for a pond in a heavy soil, practically all the water that falls in the basin of the pond will pass through the drain and a drain must be provided that will carry at least one inch in 24 hours. The size required in this case is found in the following table by multiplying the actual acreage by four.

TABLE I.—AREAS DRAINED BY TILE MAINS.
(Based upon Kutters' formula, n = .015.)

Size of tile, ins.	Fall per 100 feet. 1¼ ins. or 0.1 foot.	2⅜ ins. or 0.2 foot.	3⅝ ins. or 0.3 foot.	4¾ ins. or 0.4 foot.
	Acres drained.			
4.......	4	5	7	8
5.......	7	10	12	14
6.......	12	17	21	24
7.......	19	27	33	38
8.......	28	39	48	56
10.......	51	71	88	101
12.......	86	119	147	171
	6 ins. or 0.5 foot.	9 ins. or 0.75 foot.	12 ins. or 1.0 foot.	24 ins. or 2.0 foot.
	Acres drained.			
4.......	9	10	12	18
5.......	16	20	23	32
6.......	27	33	39	55
7.......	42	52	59	84
8.......	62	75	87	122
10.......	113	140	161	223
12.......	190	232	268	379

The preceding data are taken from Bulletin No. 186, Maryland Agricultural Experiment Station, prepared by John R. Haswell, office of Public Roads and Rural Engineering, Department of Agriculture, U. S. A.

Values of n for Wood Stave Pipe.

(Staff Abstract.)

The capacity of wood pipe is generally computed according to Kutter's formula, in which a value of *n*, the coefficient of roughness, is selected somewhere between 0.010 and 0.013, depending upon conditions and the judgment of the engineer. Just what value of *n* to assume is a debatable question. Experiments are now being made to determine the carrying capacities of wood pipes and the proper coefficient of roughness to apply in such formulas as Kutter's.

As a result of measurements of flow in pipes, the following values for *n* for specific cases have been determined by various writers: Schuyler, 30-in. pipe, 0.0096; Gutelius, 24-in. pipe, 0.01; Adams, 18-in. pipe, 0.01; Adams, 14-in. pipe, 0.011; Marx, Wing, and Hoskins, 72-in. pipe, 0.012 to 0.015. Smaller values for *n* are usually assumed for small pipes than for larger ones, and there appears to be reason for believing that *n* may vary also with velocity. Moritz, from measurements of pipes 4 ins. to 55 ins. in diameter, found $V = 1.72\ D^{0.7}\ H^{0.555}$ and $Q = 1.35\ D^{2.7}\ H^{0.555}$, where Q = discharge in second-feet; V, the mean velocity of flow in feet per second; D, diameter of pipe in feet; and H, friction loss per 1,000 ft. of pipe.

Extracted from Bulletin 155, U. S. Department of Agriculture, by S. O. Jayne, irrigation manager.

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Irrigation and Crop Results on Government Regulation Projects.—Data as to the crop results on various U. S. Reclamation projects during 1914[1] are reported by the Reclamation Record as follows:

Project.	Irrigable acreage.[2]	Irrigated acreage.	Cropped acreage.	Value of crops. Total.	Per acre cropped.
Salt River	187,112	173,030	169,719	$4,039,079	$23.80
Yuma	60.000	25,207	22,568	709,409	31.43
Orland	14,300	7,354	6,540	176,331	26.99
Uncompahgre Valley	52,338	33,873	33,091	870,381	26.30
Boise	207,000	......	......	....	.....
Censused lands	......	64,767	58,064	1,033,447	17.80
Lands not censused[3]	......	18,823	16,868	300,140	17.80
Minidoka	117,090	......	......	....	.....
Gravity unit	......	45,730	39,138	661,796	16.91
S. S. pumping unit	......	35,788	33,512	558,059	16.65
Huntley	28,808	17,068	17,068	454,583	26.63
Milk River	13,440	2,201	2,163	34,618	16.00
Sun River	16,346	6,613	6,561	106,594	16.25
Lower Yellowstone	36,250	5,743	5,621	96,707	17.20
North Platte	91,504	60,532	59.536	890,202	14.95
Truckee-Carson	52,039	39,516	39,285	441,018	[4]11.23
Carlsbad	20,261	12,690	10,731	237,663	22.15
Hondo	1,224	1,224	1,172	21,458	18.31
Rio Grande	40,000	28,442	27,302	1,160,720	42.51
N. D. pumping	12,239	1,056	1,045	36,440	34.87
Umatilla	17,000	5,102	3,013	88,614	29.41
Klamath	38,000	24,440	24,440	347,344	14.22
Belle Fourche	68,852	37,454	36,709	461,188	12.56
Okanogan	10,099	7,740	3,180	104,575	32.88
Yakima:					
Sunnyside unit	81,807	64,052	49,273	2,858,845	58.02
Tieton unit	34,000	20,600	15,920	472,480	29.60
Shoshone	41,166	22,226	20,905	313,826	15.01
Total	1,240,875	761,271	703,424	$16,475,517	$23.50

[1] Data are for calendar year (irrigation season), except on Salt River project, Ariz., data are for corresponding agricultural year, October, 1913, to September, 1914.

[2] Area Reclamation Service was prepared to supply water.

[3] Figures for lands not censused, except irrigated acreage, estimated from figures for censused lands.

[4] $18.22 excluding 19,000 acres native pasture land at $1.21 per acre and 4,908 acres otherwise not in full production.

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CURRENT NEWS

The Doings of the Week.

The past week has been one of quiet and gradual improvements. Business conditions are steadily improving and there are reasons a-plenty for hoping for further bettering of the situation generally. Considerable activity has been shown on the stock market, especially with shares of the U. S. Steel Corporation, its stock having advanced to the highest mark so for this year. Then, again, there seems to be no let up in the placing of war orders by European nations. A large domestic order will probably be placed this week for steel rails to approximate $1,000,000. These are to be used by the city of New York for tracks upon the lines of the dual subway system, and bids for the same were received during the past week. It was also announced during the week that Russia has placed an order here for 350,000 tons of rails to be used in double-tracking the Siberian railway. It has been rumored a few of the larger railroads are about to enter the market for new equipment and materials. In the municipal field several cities have work ready for letting and have let contracts that are worthy of attention. At Pittsburgh a county highway tunnel job was awarded to a local firm that will cost over $1,000,000. Paving, building and sewer work has been holding up considerably. Several large sewer jobs are now being advertised. Salt Lake City wants bids on a $300,000 sewer undertaking and Sacramento on approximately 13,000 lin. ft. of large diameter trunk sewer. The Federal Government has a few dandy dredging jobs on which bids are solicited. The Iron Age prices for finished iron and steel and for sheets, nails and wire for the week ending July 14 were as follows:

Finished Iron and Steel.	July 14.	July 7.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia........	1.22½	1.22½
Iron bars, Pittsburgh..........	1.25	1.25
Iron bars, Chicago	1.20	1.20
Steel bars, Pittsburgh	1.25	1.25
Steel bars, New York	1.419	1.419
Tank plates, Pittsburgh.......	1.20	1.20
Tank plates, New York	1.369	1.369
Beams, etc., Pittsburgh.....	1.25	1.25
Beams, etc., New York	1.419	1.419
Skelp, grooved steel, P'gh....	1.20	1.15
Skelp, sheared steel, P'gh...	1.25	1.20
Steel hoops, Pittsburgh......	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	1.75	1.75
Galv. sheets, No. 28, P'gh...	4.50	4.50
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, P'gh......	1.40	1.40
Barb wire, galv., P'gh......	2.50	2.50

For structural material f. o. b. Pittsburgh the Iron Age prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.25 cts.

Railways.—Aside from prospective work in this line, nothing of real interest has been announced. Perhaps the most notable happening was the placing of orders for new equipment and material. The Public Service Commission for the First District of New York City announces that it will probably let a contract during this week for steel rails for tracks upon the lines of the dual subway system. The Bethlehem Steel Products Company and the Lackawanna Steel Company were the only bidders, and their prices were exactly the same, the total of each bid being $1,202,127. These rails will be sufficient to equip about 230 miles of single-track railroad. The Santa Fe has stated it will spend about $100,000 additional for betterments for the Los Angeles division.

Roads and Streets.—Some real good work is up for bids in the roads and streets line. California has about 25 miles of concrete and asphalt paving and 15 miles of grading to let, bids to be in by July 26. Humphreys County, Tennessee, is asking bids until July 24 on $250,000 worth of road work. Stockton, Cal., has approximately $86,727 to expend on street paving. Glen Ellyn, Ill., will receive bids until July 30 on $80,185, and Buffalo and Endicott, N. Y., have street paving on which bids will be opened the latter part of the month. Many contracts were let during the week, some of the larger ones being as follows: Allegheny County, Pennsylvania, to Booth & Flynn, Ltd., Pittsburgh, $1,347,018 for county highway tunnel; County Commissioners at Pittsburgh for six road contracts to cost $120,000; Batavia, N. Y., five street contracts aggregating $53,156; Philadelphia, approximately $635,000 worth of street improvements, for which Edwin H. Vare appeared as low bidder for most of the work; state of Connecticut, six road jobs to cost over $44,000; Kaufman County, Texas, 25 miles of gravel roads to Callihan Constr. Co., Omaha, for $161,307, and state of Maine, four jobs aggregating $30,000.

Bridges.—The city of Bridgeport, Conn., is calling for bids on a 499 ft. reinforced concrete girder bridge, the bids to be in by Aug. 7. A $120,000 bridge is to be built across the river at Minetto, N. Y., bids solicited until July 31. In the prospective line a good job is promised at Buffalo, N. Y., an appropriation of $100,000 having been made for a viaduct at Harlem Ave., Cheektowaga. The Pennsylvania R. R. has submitted plans to municipal authorities for a bridge to span the Miami River at Dayton, O. The Philadelphia & Reading R. R. plans a 12-span bridge with concrete piers over the west branch of the Susquehanna at Milton, Pa. Contracts let were: Dominion Bridge Co., superstructure of the Provencher Ave. bridge at St. Boniface, Manitoba, for $264,000; Averill-Matthews Co., for bridge over Passaic River out of Morristown, N. J.; National Concrete Co. for an additional two spans to the W. Washington St. bridge at Indianapolis for $110,000.

Drainage and Irrigation.—The Gamble Creek Drainage District, which is in the vicinity of Parish, Florida, will take bids until Aug. 4 on 896,202 cu. yds. of excavation and about 75 acres of clearing, and the Rio Grande Drainage District, Monte Vista, Colorado, is taking bids on 17 miles of drainage outlet ditches approximating 325,000 yds. of excavation. Contracts let were as follows: Guthrie-McDougal Co., Portland, Oregon, construction of the West Okanogan irrigation project for the Great Northern Ry., to cost $510,650; Howard Kenyon, Houston, Texas, 16 miles of drainage ditches with concrete culverts out of Garwood, Texas, for Colorado County Drainage District No. 1; Tibbitts-Pacific Co., San Francisco, earthern fill and concrete lined flume at Gasburg Gulch, near La Grange, for $54,950, and Utah Construction Co., Ogden, for completion of the Big Lost River irrigation project in Idaho, to cost $1,500,000.

Waterworks and Sewerage.—An improvement has been shown in these lines over the previous week. Watervliet, New York, wants bids up until Aug. 16 for installation of complete waterworks, and Watertown, South Dakota, on additions and improvements to its sewer system to cost $115,000. Salt Lake City solicits bids until Aug. 4 for about $300,000 worth of sewers. In the contracts let line two fair jobs were let at New York City (contracts 140 and 149) calling for waterworks improvements to cost $54,843. Maryville, Tennessee, will install a waterworks for $49,357, while Peoria, Illinois, awarded a sewer job that will cost over $202,000. Syracuse, New York, let the Huntley No. 2 sewer job for $82,732, and Avalon, New Jersey, a sewage disposal and main sewer for $53,000.

Buildings and Rivers and Harbors.—Apparently there has been no letup in the building construction line. Work has been started on the Field Museum at Chicago, which will cost $5,000,000 when completed. Word comes from Philadelphia that the plans have been completed for a bank and office building for the Franklin National Bank, to cost $1,000,000, while at St. Louis a theater is to be erected by the Orpheum Theater Co. at a cost of $450,000. The government has a considerable amount of dredging work to do and has already asked bids on some of these. At Greenville, Miss., $100,000 worth of levee work is being advertised by the Mississippi Levee Commission. Contracts let are: John H. Parker Co., New York, construction of building for the Interior Department at Washington, to cost $1,622,487; Cramp & Co., $278,056 for a 33-division school in Philadelphia; State Construction Co., Indianapolis, Masonic home at Franklin to cost $140,779; James Stewart & Co., Chicago, Robey Street yard buildings in Chicago for the Baltimore and Ohio R. R.; James T. Constant, Alexandria, La., $100,000 levee job in Miller County Levee District No. 2, Arkansas; John Keeley, East St. Louis, three miles of levee south of that city, while R. L. Leonard & Co., Memphis, were low bidders on 1,415,000 yds. of levee work for the Third Mississippi River District.

Advantages of Serial Municipal Bonds.

Commenting on the $71,000,000 sale of bonds by the city of New York on June 29, *The Bond Buyer* says: "There is at least one big lesson to be drawn from the results of the New York City bond sale for the benefit of all future municipal borrowers.

"The average prices paid for the two issues speak for themselves in no uncertain terms. What they say is this: The largest city in the United States, in arranging its biggest bond flotation, finds the net interest cost annually per $1,000 on a 50-year bond to be $1.40 more than on a bond of a series running from 1 to 15 years.

"In other words, the basis on which the city sold its old-fashioned 50-year bonds is about 4.437 per cent, while the basis on which the 1-15-year serial bonds were taken is only 4.297 per cent!

"These two issues, it should be remembered, are identical in every way, except as to maturity, and practically the same bidders for one issue also offered to take the other bonds. But, without exception, the bids differed in price in favor of the serial bonds!

"The fact that the great city of New York has now clearly demonstrated the market advantage of 'serials' over the old long term 'straight' maturity bonds should be sufficient for those skeptical officials of smaller municipalities. Surely, if the cities with the greatest resources, the finest credit, the widest market for their bonds, find it profitable to issue 'serials,' can there be any further question on the score when the principle is applied to the small city or town?"

Getting Public Roads Out of Politics.

An engineer who has been in the service of the U. S. Office of Public Roads for many years recently said: "For over 20 years the Department of Agriculture has been fighting to get the public roads out of politics. That is the first step toward efficient, honest and economical expenditure of the money taken from the taxpayers for road purposes. The next step is to have the roads properly planned, laid out and constructed under the direction of capable and experienced engineers."

The Lighter Side of Engineering and Contracting

Smoke Up.

Smoking is a bad habit. Our wives and other good people say it is. Engineers are universally men of good habits. We know this because "Positions Wanted" advertisements invariably say so. Now we should never "queer" a corollary, but some of our engineer acquaintances on occasions have been seen to smoke. We can't explain this. As for contractors, they smoke persistently to assert their opposition to engineers. A good story appeals to every man who smokes, particularly when he is smoking. A smoker often is a good story teller and he always is a good listener. To the elect of the tobacco pouch we appeal for stories that they have listened to or told, and for the best story received during July and August, Skinner Mulvey (a smoker from early infancy) will award a box of 50 cigars or a $5 can of any brand of smoking tobacco specified.

Beating Josephus to It.

Mortimer E. Cooley, Dean of Engineering at the University of Michigan, was once in the United States navy. Shortly after Uncle 'Sephus issued the order separating Jack from his grog the Dean was walking across the campus when he was hailed by an Irish laborer in the employ of the university. "Hey, there! Profissor! Come over, I want t' spake wid ye." The Dean indulgently crossed over to where the Celt was standing and asked, "What is it, Pat?" "Did yez see th' racint order of Sicretary Daniels about booze in th' navy?" "Yes, I saw it. What about it?" "Well, Profissor, all there is about it is this, I think y' got out av th' sarvice jist in the nick o' toime."

Simple Method of Testing Concrete.

The present reform administration of the City of Philadelphia very properly emphasizes its excellences by drawing comparisons with the shortcomings of its predecessors. Thus a Philadelphia newspaper shows several views of old and new methods in the engineering department. Among other things the apparatus now used for making tests of concrete is shown in contrast with the old method. The latter was simplicity itself, and consisted of biting tests on small specimens by a large negro, who was gifted with molars all the way around.

Safety First.

Two laborers, one white the other colored, were preparing to drive some wooden sheet piling. The white man essayed the superior task of swinging the maul while the colored man steadied the pile. Before a blow was struck the colored man noticed the crossed eyes of the white man and moving to one side, said: "Boss, is yo' gwine to hit where yo' all looks?" "Sure," said the maul swinger. "Then," said the darky, "hold de spile yo'se'f!"

A WELL-KNOWN consulting engineer of Chicago, whose father was a brilliant Confederate general, tells the following story of old General Jubal A. Early. When Lee was invading the North he took every precaution to avoid wanton destruction of private property. There was only one important exception to this rule and that was the iron foundry of Thaddeus Stevens where cannon for the Federal army were being manufactured. This was destroyed.

Years after the war, when the bitterness which characterized the rebellion had generally died out, a traveler lately returned from the North was talking to Gen. Early. "While I was up North," said the traveler, "I met Thad Stevens just before his death and he spoke very kindly of you." "What!" said the general, who never forgave his enemies, "Thad Stevens spoke kindly of me?" "Yes," said the other, "he said you didn't destroy any property but his foundry, and that you had guards posted all around it to protect it when it caught fire and burned down." "God of Israel!" said the general, "did Thad Stevens die thinking I tried to do him a favor? Why, burn him, I posted guards around that foundry so nobody could get in to put the fire out! God of Israel! God of Israel!"

Guess Again.

Near Decatur, Ala., on some road work an Irish foreman was making a rock cut. His name was Pat and he looked the part. A man came along in a buggy one day and stopped near the foreman and said: "Pat can you tell me which is the road to Trinity?" The Irishman looked at him a minute and said: "Sure, and how did ye know me name was Pat?" The man said: "Why, I guessed it." The Irishman replied: "Well, guess the road to Trinity."

R. P. B., Montgomery, Ala.

Zero in Safety.

Coroner Hoffman, of Cook County, Ill., has come out in favor of setting aside one of Chicago's streets for the exclusive use of those learning to run automobiles. "The time has come," the Coroner says, "to make our streets at least as safe as a battle field."

Powder, as every blasting man knows, sometimes explodes without just provocation, and, at other times, fails to explode when, in all conscience, it ought to explode. The following is cited as an instance of this character by G. L. Sheldon, in the Mining Press: An ignorant man threw powder down a 40 ft. shaft to a miner without its exploding. That miner, however, did explode; climbing the ladder he chased the other man off the property. The latter individual never returned.

IT MAY not be generally known among engineers and contractors in this part of the country that down East the famous Brooklyn Bridge is referred to as the "Jewish Passover."

A Coat of Asphalt?

On learning that the Commercial Club of Portland, Oregon, has a standing offer of $10 for the discovery of a hole as big as a hat in any of the city's pavements, one naturally makes a quick mental review of progress in street pavement construction. Not many years ago many pavements consisted wholly of an assemblage of hat-shaped cobble-stones. What punishment, think you, would be deemed sufficient for the engineer who would wish one of those old derby-hat cobble-stone pavements upon a modern city?

A Tip to Promoters.

A small Iowa town was talking bonds for an improvement and an old lady was asked her opinion. She suggested that the city "just build its plant and have it charged and pay off the debt in yearly installments, but bonds, oh, horrors, no!"

Special Announcement.

At the earnest solicitation of his old friends Skinner Mulvey "sat" for his picture a few weeks ago. As is the practice in the art the photographer took the old man in several attitudes. The one selected to be finished, after much deliberation, is that reproduced in this column. We believe the selection was a wise one. Mulvey's mental attitude, like that of his chief daily associates, is a calm philosophic outlook upon life. Combined with a modicum of wit and humor and a talent for epigram characteristic of men of his avocation this quality gives our friend a distinctive personality. As with all philosophers the Skinner's mental lubrications are most often voiced when in a state of physical contentment. We know of no waking attitude in which the old man is more completely contented than the one in which the picture shows him. It is thus, with a bucket of water from the creek and a companion who will toss his tobacco pouch occasionally, that Mulvey announces his thoughts on affairs and incidents by and far.

Skinner Mulvey says: The best brand of smokin' t'bacca is the brand yer bunkie smokes—if he is an easy lender.

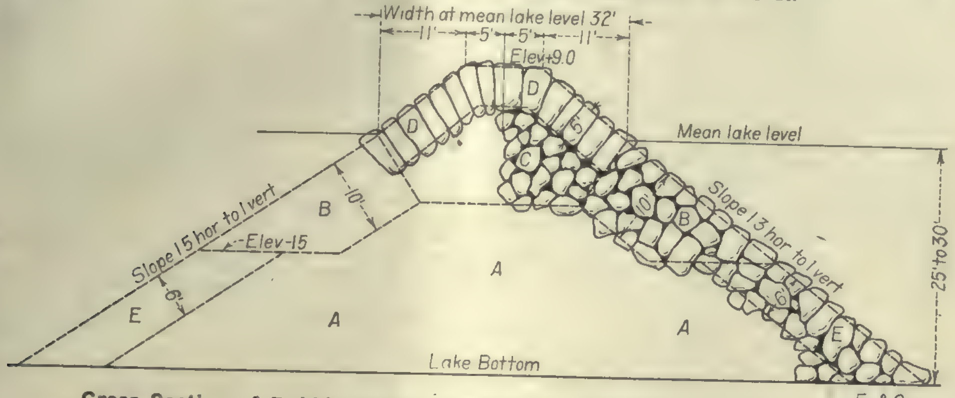
Rubble Mound Breakwater and Pierhead to Be Constructed at Conneaut Harbor, O.

Structure to Have Length of About 900 Ft.

Bids to be Opened at Cleveland, O., July 30, 1915.

Bids will be received at the U. S. Engineer Office, Cleveland, O., until noon, July 30, 1915, for the construction of a pierhead and rubble mound breakwater at Conneaut Harbor, O.

The breakwater to be built is about 900 ft. long and is an extension lakeward of the existing east breakwater; it is to be terminated by a pierhead at its outer end. The pierhead will be either of the timber crib type, 35 ft. square, or of the steel cylinder type, 35 ft. in diameter. The site of the work is from 2,000 to 2,500 ft. off shore, and it is exposed to storms from the north and northeast. Work in the open lake can usually be carried on for about seven months of each year—from Apr. 15 to Nov. 15. The depth of water in which the breakwater is to be built varies from 30 ft. at the outer end to about 21 ft. at the inner end.



Cross Section of Rubble Mound Breakwater at Conneaut Harbor, Ont.

BREAKWATER.

Figure 1 is a cross section of the breakwater, indicating the various sizes of stone used in its construction. Core "A" is to consist of quarry run stone of any size, free from excessive amounts of sand, dirt or other foreign matter. A limited amount of such foreign matter, not to exceed 10 per cent by weight of any scow load, will be allowed, provided it is so distributed that it will not endanger the stability of the work. Covering "E" of the slopes, from the lake bottom to elevation—15 ft. below mean lake level—is to be at least 6 ft. thick, measured at right angles to the outer face. Each stone in this portion of the structure must weigh at least 1,000 lbs., and at least 50 per cent by weight must weigh 1 ton or over. Covering "B" of the slopes, from elevation—15 ft. below mean lake level to mean lake level, must be at least 10 ft. thick, measured at right angles to the outer face. Each stone in this portion of the structure must weigh at least 3 tons, the largest stones, so far as practicable, to be used in the upper portion of the lake face. Core "C" is to consist of a mixture of sizes such as will insure dense construction, the minimum weight of the individual stones being 500 lbs., of which 50 per cent by weight must weigh 1 ton or over. Covering "D" of the top and the slopes above approximate mean lake level must consist of stones weighing generally not less than 3 tons each, but not more than 10 per cent by weight of this covering shall consist of stones weighing less than 3 tons. No stone shall be used in this covering the least dimension of which is less than 12 ins. The individual stones of covering "D" shall extend into the work at least 5 ft., except that when the top of the breakwater is formed by stones weighing 5 tons or more a thickness of not less than 3 ft. will be permitted. No stone shall be used in coverings "B" and "E" or core "C" whose greatest dimension is more than 3½ times its average thickness.

PIERHEAD.

A pierhead either of the timber crib type or of the steel cylinder type will be required, the United States reserving the right to include either type.

The timber crib type shall be 35x35 ft. x 33 ft. high, and shall be divided into pockets about 9 ft. square. The outer rows of pockets shall be capped with a concrete superstructure, and the crib shall be protected by a rubblestone embankment. The concrete in the outer pockets shall extend 7 ft. below the top of the crib, and on this there shall be built a concrete superstructure rising 12 ft. above mean lake level.

The steel cylinder type shall consist of two concentric steel cylinders filled in between them with reinforced concrete. The interior well shall be filled with stone capped with reinforced concrete, and the pierhead shall be protected with a rubblestone embankment. The pierhead shall be 35 ft. in external diameter and 42 ft. high. The diameter of the interior shell shall be 28 ft.

QUANTITIES OF MATERIALS.

The following are the approximate quantities of materials:

Rubble mound breakwater.	With timber crib type of pierhead, tons.	With steel cylinder type of pierhead, tons.
Core "A," below elev. — 15 ft.	31,900	32,400
Covering "E," including stone protection of pierhead	16,400	12,700
Covering "A," above elev. — 15 ft.	7,650	7,825
Covering "B"	15,800	16,100
Core "C"	9,720	9,930
*Entire breakwater, except covering "D"	81,470	78,955
*Covering "D"	9,300	9,500
*Timber crib pierhead	Lump sum	Lump sum
*Steel cylinder pierhead	Lump sum	Lump sum

*Items of bid.

Large New York Subway Contracts Approved.

Bids Opened for Wide Variety of Work This Month.

The largest number of rapid transit construction contracts ever adopted by the Public Service Commission for the First District, New York, at one time was approved on July 9, when seven different contracts were approved and as many advertisements for bids authorized. The contracts and the dates for opening bids are as follows:

Broadway subway, Manhattan: A four-track underground railroad extending under Broadway from 38th to 42d Sts., and under Seventh Ave. from 42d St. to 51st St. This line will be operated by the New York Municipal Railway Corporation (Brooklyn Rapid Transit), and this section is the last to be placed under contract. Bids for the construction of this section will be opened July 27.

Eastern Parkway subway, Brooklyn: A four-track underground railroad running under Eastern Parkway from Nostrand Ave. to Buffalo Ave. This is a part of the extension of the existing subway, and will be operated by the Interborough Rapid Transit Co. Bids will be opened July 27.

Nostrand Avenue subway, Brooklyn: A two-track underground railroad under Nostrand Ave. from Church Ave. to Flatbush Ave. The Nostrand Ave. line is a branch of the Eastern Parkway subway, and will be operated by the Interborough Rapid Transit Co. The first section, between Eastern Parkway and Church Ave., is already under contract. Bids for the second section will be opened July 28.

Track materials for use upon all lines of the Dual System not already provided for: Bids opened for supply of manganese rails July 27; for rail splice bars, anti-creepers and nut locks, July 28.

Station Finish: Bids for station finish on the Corona elevated railroad and the extension of the Queensboro subway in Queens will be opened Aug. 3; for station finish on the Astoria line in Queens Aug. 4. The Astoria and Corona lines are elevated railroads leased for operation to the Interborough Rapid Transit Co. with trackage rights to the New York Municipal Railway Corporation. The extension of the Queensboro subway is to connect the tunnel under the East River with the two former lines at the Queens end of the Queensboro Bridge. It will be operated by the Interborough Rapid Transit Co.

The bids recently opened and to be opened this month for track materials will constitute one of the largest orders of the present season. Bids for about 35,000 tons of open hearth rails were opened July 16, and between that date and Aug. 4 bids will be received for about 3,000 tons of rolled mangane e rails, over 1,000,000 tie plates, about 356,000 cu. yds. of broken stone ballast, and about 30,000,000 ft. of ties and timber. This material will be sufficient to equip about 230 miles of single track. The city-owned lines in the Dual System cover about 260 miles of single track, but the track materials for about 30 miles in the Fourth Ave. subway in Brooklyn and the Centre Street Loop subway in Manhattan have already been purchased.

Summer School of Scientific Management.—The Pennsylvania State College will conduct a Summer School of Scientific Management during the two weeks beginning August 9. This summer session is planned for the accommodation of works managers, superintendents, heads of cost, stores, purchasing, planning and production departments and members of such departments. The time is restricted to two weeks to meet the needs of employes whose vacation period is limited to that time. Fee, $15 for course.

The mornings of the session will be devoted to lectures and discussions on industrial organization and scientific management under the leadership of Prof. Hugo Diemer, head of the Department of Industrial Engineering at the Pennsylvania State College. Prof. Diemer has had charge of summer courses in the Industrial Organization and Scientific Management at the University of Chicago this summer. He has been superintendent of the National Motor Vehicle Co., organizing engineer for the Goodman Manufacturing Co., and has done advisory work in planning shops, organization, cost, stores, wage and production methods for such companies as Fairbanks-Morse Electric Co., the Western Gas Construction Co., the Cincinnati Milling Machine Co., Atlas Engine Works, International Harvester Works, Bullock Electric Co., Marion Iron and Brass Bed Co. and others. He has written several books and numerous magazine articles on organization and management.

The afternoons will be devoted to actual practice in applied methods of scientific management, in the making of time studies, tool lists, instruction cards, routing and scheduling under the direction of W. H. Tabor, of the Tabor Mfg. Co., which has been designated as having the most completely developed shop under scientific management in America. Applications for the course should be made at once to J. A. Moyer, Director, State College, Pa.

Bids Asked on Highway Work in Ohio.

Over 100 Miles of Roads to be Improved.

Total Cost of Work Approximately $1,139,100.

As briefly noted in our issue of last week, bids are being asked by the Ohio State Highway Department on 47 contracts for highway improvements. These contracts cover 102.31 miles of road work. Of this 40.36 miles are to be surfaced with waterbound macadam; 19.47 miles with brick; 9.32 miles with bituminous macadam, and 7.52 miles with brick. On four of the contracts, totaling 12.01 miles, the specifications call for bituminous surface treated macadam. Five of the contracts call for work for the Bureau of Maintenance and Repair, three of which specify surface treatment of H. O. and grit, one calls for 1.12 miles of brick paving on concrete base and one for surface treatment of H. T.-1 and grit. The work for which proposals are asked includes the constructing of bridges and culverts, grading of roadway and paving.

The total estimated cost of the proposed work is $1,139,134. The largest part of this, about $408,610, is for brick paving. The waterbound macadam is next, amounting to about $370,800; concrete, $145,731; bituminous macadam, $102,329. Details of the contracts are given in Table I.

Bids will be received on this work until 2 p. m., July 23, 1915, by Clinton Cowen, State Highway Commissioner, Columbus, Ohio.

TABLE I.—DETAILS OF HIGHWAY IMPROVEMENTS FOR LETTING JULY 23 BY STATE HIGHWAY COMMISSIONER OF OHIO.

County.	Road section.	Road.	Township.	Type.	Length, miles.	Width pavement, ft.	Width roadway, ft.	Estimated cost.
Allen	Sec. D	Lima-Spencerville	Amanda Spencer	Bituminous macadam[1]	3.11	16	26	$35,989
Ashland	Sec. J	Ashland-Loudonville	Vermillion	W. B. macadam[2]	3.58	16	26	45,727
Ashtabula	Sec. I	Hampden-Andover	Cherry Valley. Andover	Brick	2.81	10	26	37,248
Athens	Sec. G	Athens-McArthur	Alexandria	Brick	1.44	16	26	36,083
Belmont	Sec. M	Barnesville-Hendrysburg	Warren	Brick[3]	2.56	16	26	50,935
Champaign	Sec. M	Urbana-West Jefferson	Union	W. B. macadam	0.40	12	24	3,651
Crawford	Sec. I	Columbus-Sandusky	Holmes	Brick	2.29	16	28	46,976
Harrison	Sec. O	Steubenville-Cambridge	Green	W. B. macadam	2.05	12	26	18,885
Hardin	Sec. I	Ada-Forest	Liberty	W. B. macadam	1.48	16	26	12,395
Henry	Sec. D	Wauseon-Napoleon		Surface treated macadam—canceled. To be readvertised.				
Highland	Sec. K	Hillsboro-Greenfield	Madison	W. B. macadam	1.10	14	26	5,347
Highland	Sec. H	Milford-Hillsboro	Liberty	W. B. macadam	0.92	14	26	4,589
Highland	Sec. J	Cincinnati-Chillicothe	Madison	W. B. Macadam	1.28	14	26	7,997
Highland	Sec. L	Hillsboro-Washington C. H.	Penn	W. B. macadam	1.04	14	26	4,997
Highland	Sec. I	Hillsboro-Piketon-Waverly	Liberty	W. B. macadam	4.75	14	26	19,023
Huron	Sec. R	Mansfield-Norwalk	Fitchville	Concrete	1.96	10	26	28,415
Lawrence	Sec. G	Ohio River Road	Union	Bituminous macadam	1.92	16	26	22,061
Licking		Columbus-Millersburg		W. B. macadam—cancelled. To be readvertised.				
Mahoning	Sec. Q	Canfield-Poland	Canfield	W. B. macadam	1.34	14	24	11,351
Marion	Sec. J	Marion-Waldo	Waldo Pleasant	W. B. macadam	4.18	16	26	40,133
Marion	Sec. I	Marysville-Marion	Prospect	W. B. macadam	2.84	16	26	26,972
Meigs	Sec. L	Middleport-McArthur	Salisbury	Brick	1.00	14	26	17,282
Miami	Sec. D	Piqua-Urbana	Brown	Bituminous macadam	4.29	16	26	44,279
Monroe	Sec. I	Woodsfield-Marietta	Center	Brick	0.075	14	26	2,166
Montgomery	Sec. J	Cincinnati-Dayton	Van Buren	Brick[4]	2.42	14–16	27	71,729
Morgan	Sec. F	McConnellsville-Athens	Marion	W. B. macadam	2.84	14	26	48,520
Muskingum	Sec. L	Zanesville-Caldwell	Wayne	Bituminous surface treated macadam	2.00	16	26	26,988
Pickaway	Sec. J	Lancaster-Circleville	Circleville Washington	W. B. macadam	3.50	16	26	37,529
Pike	Sec. L	Jackson-Piketon	Beaver	W. B. macadam	1.85	14	26	15,633
Portage	Sec. P	Cleveland-East Liverpool	Edinburg	Concrete	3.15	12	..	30,388
Portage	Sec. O	Ravenna-Painesville	Ravenna	Concrete	2.41	12	26	27,403
Preble	Sec. F	Edon-Richmond	Jackson	Bituminous surface treated macadam	5.70	16–25	26	32,661
Scioto	Sec. I	Jackson-Portsmouth	Clay	Brick	2.00	16	26	43,985
Stark	Sec. H	Canton-Steubenville	Osnaburg	Brick	2.59	16	30	57,965
Trumbull	Sec. O	Warren-Sharon	Howland	Brick	1.44	16	26	29,043
Union	Sec. E	Urbana-Marysville	Paris Union	Concrete	4.27	16	26	59,525
Van Wert	Sec. D	Van Wert-Rockford	Pleasant	W. B. macadam	2.01	16	26	18,956
Vinton	Sec. I	McArthur-Logan	Swan	W. B. macadam and concrete	1.80	14	26	13,806
Vinton	Sec. J	Chillicothe-McArthur	Richland	Bituminous surface treated macadam	1.13	14	26	11,620
Williams	Sec. K	Bryan-Pioneer	Pulaski Jefferson	Surface treated macadam[5]	3.18	16	26	32,971
Wyandot	Sec. F	Upper Sandusky-Findlay	Crane Salem	W. B. macadam	3.90	16	26	35,284
Bureau of Maintenance and Repair:								
Medina	Secs. A, B, C and H	Cleveland-Wooster	Guilford Medina Brunswick Montville	H. O. and grit[7]	3.02	16	..	1,703
Muskingum	Sec. B	Zanesville-Dresden	Falls	Brick[6]	1.12	16	..	15,204
Preble	Sec. C	Hamilton-Eaton	Washington Jasper	H. O. and grit	2.53	16	..	2,400
Preble	Sec. B	Dayton-Indianapolis	Washington	H. O. and grit	2.00	16	..	1,877
Sandusky	Sec. A-1	Fremont-Port Clinton	Rice	H. T.-1 and grit	1.54	16	..	1,443

[1] All contracts include bridges, culverts and grading. [2] Waterbound macadam.

[3] Contract No. 2. (Contract No. 1 Main Market XXII, grading and roadbed only, estimated cost, $10,588.)

[4] Contract No. 1. (Contract No. 2 calls for grout pavement and dressing bermes, slopes and ditches, 2.42 miles; pavement 14 and 16 ft.; cost, $2,723.)

[5] Alternate bids will be received on paving with bituminous macadam; estimated cost, $38,047.

[6] Brick on concrete foundation.

The U. S. Geological Survey has just issued a guide book, Bulletin 612, describing the Overland Route from the Missouri River to the Pacific Coast. The book is freely illustrated with half-tone plates and a series of 29 accurate maps. Price $1.

St. Louis Items.

Mulvill Bros. of Alton, Ill., were awarded the contract for completing the Woodriver district levee near Woodriver, Ill. They are going to start on this job just as soon as the high water recedes. Wet weather the past two weeks has delayed them some on their extensive county road work near Potosi, Mo.

Articles of incorporation filed July 8th in Recorder Joy's office by the St. Louis Railway and Dock Co. is the preliminary step toward the construction of docks and terminal facilities in St. Louis on an extensive scale for the interchange of land and water freight transportation, according to W. J. Holbrook, one of the incorporators. The company proposes, the incorporation papers say, to build and operate a belt line 25 miles long on the river front from the Missouri River and Columbia Bottom road to the vicinity of Van Buren and Catalan streets in St. Louis. The incorporators of the new concern are H. F. Bell, who owns 245 shares, and W. J. Holbrook, John Hill, D. Arthur Bowman, John F. Moore and E. W. Banister, who own one share each. The capital stock is $25,000, composed of 250 shares of $100 each.

E. S. Heyser and A. J. Callahan of the Callahan Construction Co. were with us the other day. They are moving one of their drag lines on to 600,000 yards of work near McClure, Ill. Just finishing up a 1,250,000-yard job on a diversion channel at Greenville, Miss.

The contract to furnish steel for the east approach of the free bridge was awarded by the Board of Public Service on July 9th to the American Bridge Co. The board made the award after consulting with the engineers employed to design and construct the bridge, Boiler & Hodge of New York City. The contract for the steel aggregates $1,035,000. The American Bridge Co. submitted the lowest bid, 2,165 cents a pound, but the Pennsylvania Steel Co., which bid about $40,800 more, offered also to furnish equipment for the construction work. This company contended that the free use of this equipment would be equivalent to a bonus of about $50,000. President Kinsey of the Board of Public Service stated that after consulting with the engineers it was decided that the saving by the free use of the equipment offered by the Pennsylvania Co. would only amount to about $15,000. He also said that the board has been informed by the City Law Department that it could not consider any modification or qualification of the bids as submitted. The amount of steel to be used in constructing the eastern approach is estimated at 23,000 tons. It is understood that the American Bridge Co. intends to manufacture much of it at its St. Louis plant, 1014 South Vandeventer. It is estimated that this will mean the increase of the present force at the plant by from 150 to 200 men. The American Bridge Co. furnished the steel for the construction of the central spans of the free bridge. The Pennsylvania Co. furnished the steel for the McKinley Bridge, and now is engaged in constructing a bridge at Memphis, Tenn.

Geo. Reinecke is up and around again. Broke his arm about a month ago cranking a new machine.

Street improvements to cost $84,411 were recommended to the Board of Aldermen on July 9th by the Board of Public Service. These bills will be introduced in the board when it meets after its summer vacation on September 17. A bill for the construction of sewers in the North Rock Creek Joint

Sewer District also was recommended. The paving of the following sections of streets, with the following materials and at the following estimated costs, was recommended: Bernays Ave. from Florissant Ave. to Bircher St., asphalt, $30,944; Thekla Ave. from Euclid Ave. to King's Highway, asphalt, $7,219; Thekla Ave. from King's Highway to Bernays Ave., asphalt, $14,670; January Ave. from Arsenal St. to Columbia Ave., brick, $19,705; Kaiser St. from King's Highway west to the west line of Von Drehle's subdivision, Telford, $6,073; Waterman Ave. from Union Blvd. to Belt Ave., resurfacing brick pavement with asphalt, $5,800.

M. L. Windham came in from West Frankfort, Ill., to look over the big levee job to be let on July 12th across the river here.

A meeting of property owners along the St. Louis-Alton highway, near the village of Woodriver, has been called for Tuesday to consider the question of agreeing on changing the road so as to shorten its length from St. Louis to Alton by one mile. A decision is imperative at once, as the contractor for the state aid road being built out of Alton is ready to take up that part of his work.

The J. A. Ware Const. Co. expect to finish their steam shovel work on the Wabash R. R. near Maryville, Mo., in a few weeks and are in the market for more of this kind of work. Houser Bldg., St. Louis, Mo., will catch them.

Louis Rich has his outfit at work near Kirksville, Mo., building a coal spur.

Bids were opened by the East Side Levee and Sanitary District in their office in East St. Louis on July 12th for approximately 800,000 yards of embankment, 230 cu. yds. of reinforced concrete, and for installing 2 hand gates and 2 automatic gates.

Bidder.	Price, embankment, per yard.	Price, reinforced concrete.	2nd-hand gates, price, each.	2 automatic gates, price, each.
John B. Carter Co..	$0.52	$15.00	$250.00	$250.00
Walsh Const. Co....	.46½	10.00	300.00	250.00
John Marsch	.38¾	30.00	500.00	200.00
F. W. Kinser.......	.42	10.00	450.00	175.00
J. H. Flick Const. Co.	.45	10.00	300.00	190.00
J. A. Ware Const. Co.	.38.8	10.00	300.00	250.00
List & Gifford Const. Co.	.44½	19.00	750.00	150.00
Mason & Hanger Co.	.44	10.00	150.00	100.00
Gist Bros. Co.......	.36½	8.50	325.00	275.00
Yale & Reagan.....	.50	16.00	800.00	200.00
John Keeley	.36	7.50	250.00	250.00
H. H. Hall Const. Co.	.49	8.50	300.00	300.00

Side Lights of the East Side Levee Letting in East St. Louis on July 12th.

John Keeley of East St. Louis was low bidder.

Henry Albrecht's cafe was a busy place right after the letting.

Tom Walsh and Brother Daly got mixed up and started to take a car going to Bellville in place of back to St. Louis. Koenig put them on the right track.

L. B. Davis, who formerly was Superintendent of the East Side Levee & Sanitary District, was an interested spectator. Davis is now in the boarding and commissary business.

Bill List was touted as the fellow that had the work until after the bids were opened.

Capt. J. A. Ware was the youngest-looking old man in the bunch.

F. W. Kinser shouted across the room that Koenig was the only bald-headed man in the congregation, which is going some to be among a bunch of 50 or 75 enlightened and brainy contractors, that were at the opening of the bids. When Kinser drew Koenig's attention to the fact that he was the only bald-headed man in the crowd, Koenig got right back at him and said that it was a good sign that somebody in the crowd would be awarded the work.

Joe Flick was there, and later on came across the river. Did not feel so bad as the writer thought he would. Joe is busy right now trying to get railroad freight and passenger rates increased so that the railroad companies will get some money to do some new work with and help along the poor contractors.

John Marsch was there hid away back in the corner. We heard quite a few remarks that he was the fellow that would get the work. John was in the money, but is running still. Just a little bit too high.

A. P. Greensfelder, representing Fruin & Colnon, was there with his hair braided. Did not bid on this job. Don't know the reason why. Greensfelder promised to meet us at Koerner's on this side of the river after the letting, but he evidently forgot about the engagement, for we failed to find him there. Nevertheless, quite a few of our contractor friends are under obligations to him for giving them a ride across the bridge in his big machine.

Geo. Harrington of the Harrington Bros. is some chauffeur. You ought to have seen him come across the bridge with us. Skidding by trolley cars and missing the big transfer wagons by a whisker. George is a fellow that never drinks, so don't accuse him of getting reckless.

Baxter L. Brown, the noted engineer, was there with his pencil jotting down notes of the proceedings.

Wm. D. Foulke, Treasurer of the Western Wheel Scraper Co., came down from Aurora, Ill., to renew old acquaintances and make new ones.

The two big quarrymen of East St. Louis, E. A. McLean and Will Stolle, were there endeavoring to get rid of their quarry overburden at Falling Springs, Ill.

Geo. W. Gist was there smiling until they opened John Keeley's bid. Gist was the next lowest man. Of course, you know how a fellow feels when he loses out by half a cent.

Yale & Reagan of Chicago were represented by an up-to-date and practical gentleman. We must apologize for mislaying his card and hope he will send us another one so as we can give him due credit.

A. C. Esser, the hustling representative of the Western Wheel Scraper Co., was there and one of the first men to talk to Mr. Keeley after the meeting adjourned. We look for Mr. Esser to get a nice large order out of this job.

Jerry Lyman was not at the meeting. He was poisoned by ivy in looking over suitable places to get material.

Koenig was in the row that he always has in the theaters.

We are under many obligations to Geo. Smith, Chief Engineer of the Levee Board, for the many courtesies extended to the contractors.

F. Locke Tarlton, President of the East Side Levee & Sanitary District, was busy chewing gum when he wasn't reading off bids. The large crowd did not flustrate Locke much.

Quite a number of other good fellows at this letting, but space prevents mentioning them all in this issue.

J. A. Cordeal, who formerly was manager of the Western Wheel Scraper Co., left here for Buenos Aires, S. A. We are delighted to receive a cablegram from him stating that he arrived there safely on July 12th. The next place we look for the Western Wheel Scraper Co. to open an office will be in Mars.

J. W. McMurray and Roger Fabion were with us one day last week, praying for the river to fall so that they can resume work on their two revetment jobs north of the city.

A. B. Koenig.

PERSONALS

Mr. F. C. Richards, who was formerly employed as general superintendent of bridge construction for G. W. Ensign, contractor, at New Castle, Pa., has accepted a position with Byrne Bros. Dredging & Engineering Co., Chicago.

Mr. W. P. Danford has been appointed assistant state highway engineer for Oklahoma. Mr. Danford has been city engineer of Durant, Okla., for the past six years. He has been engaged in engineering work in Oklahoma for sixteen years.

Mr. Edward S. Rankin, sanitary engineer and head of the sewer department at Newark, N. J., has been elected secretary of the Joint Sewer Commission which is in charge of the joint outlet sewer for the municipalities of Summit, Millburn, South Orange, West Orange, Irvington and part of Newark.

Mr. Russell Huff, consulting engineer of the Packard Motor Car Co., is nominated for the presidency of the Society of Automobile Engineers, which includes the most able creative men of the motor industry. The nomination is equivalent to an election. Mr. Huff has been identified with Packard development since the enterprise was started in Warren, Ohio, sixteen years ago.

Mr. C. H. Wetter is superintendent and treasurer of the Tiffin, Ohio, water works, succeeding Mr. M. L. Scannell, who recently resigned after 37 years of service. Mr. Wetter has been superintendent of construction of the plant for the past year. During 1912 and 1913 he was superintendent of construction on the hydroelectric plant at Paterson, N. J. During the nine years preceding that he was superintendent of construction on a number of water works systems, including those at Wabash, Ind.; Lincoln, Ill.; Jackson, Miss.; Ft. Scott, Kans.; Delaware, O., and Warren, O.

Mr. E. A. Kingsley has been appointed paving engineer in charge of work in San Antonio, Texas, which will probably amount to about $3,000,000. Mr. Kingsley is a graduate of Purdue University, class of 1893. For a number of years his experience was gathered in the railway field and general engineering work. In 1904 he entered municipal work as city engineer of Little Rock, Ark. He retained that office until 1911, when he became county engineer of Pulaski County, Arkansas, of which Little Rock is the county seat. During 1913 he was state highway engineer of Arkansas. Since January, 1914, Mr. Kingsley has been in private practice, his work including Temple, Texas, roads, $700,000; paving in Paragould, Ark., amounting to $125,000; paving in Dermott, Ark., $30,000, and in Little Rock to the amount of $100,000.

CIVIL SERVICE NEWS

The Chicago Civil Service Commission announces an examination for the position of foreman for the garbage plant, to be held July 29. Salary, $1,500-$1,600.

The U. S. Civil Service Commission announces the following examination: Ordnance draftsman, U. S. Navy Yard, $3.28 to $5.04 per diem; Aug. 4-5.

INDUSTRIAL NOTES

The J. I. Case Threshing Machine Co. of Racine, Wis., has taken over the plant and equipment of the Perfection Road Machinery Co., of Galion, O., makers of Perfection road graders, drags and rooter plows. The product of this company has been sold exclusively by the Case company for several years. The Perfection plant will be moved from Galion to Racine, and the graders will be manufactured and sold as Case Graders.

The Diamond Power Specialty Co., Detroit, Mich., manufacturers of "soot blowers to suit every type of boiler," announce that Mr. Thomas J. McMaster has been appointed district manager for their western territory with headquarters at 809 Ashland Block, Chicago. Mr. McMaster has acted as sales engineer for a number of well-known concerns during the past 30 years. For three years he has devoted a large part of his time to the sale of Diamond Mechanical Soot Blowers, and will in the future give his entire time to Diamond interests.

RAILWAYS

PROSPECTIVE WORK.

Connecticut:

New Britain, Conn.—Council has granted petition of the Connecticut Co., W. R. Dunham, Jr., Engineer, for the extension of its line in Myrtle, Grove, Broad, Washington Sts., and Commonwealth Ave.

Georgia:

Macon, Ga.—The Central of Georgia Ry. is reported to have sold its issue of bonds, the proceeds of which are to be used in constructing the $1,000,000 terminal here. It is thought that actual construction work will be started by October 1.

Americus, Ga.—Council has granted the Georgia Lumber Co. a franchise to build a railway into the city from Byromville, to connect with the Atlanta, Birmingham & Atlanta Ry.

Missouri:

Jefferson City, Mo.—The St. Louis Railway & Dock Co. has been incorporated with a capital stock of $250,000 to construct and operate a terminal railroad in St. Louis county and city, to be aprpoximately 25 miles long. W. J. Holbrook and E. W. Bannister, both of St. Louis, are interested.

Ohio:

Cleveland, O.—Council has granted the Cleveland and Youngstown Ry. franchise for a freight terminal. This grant carries permission to vacate 40 streets in the downtown section.

Cleveland, O.—Council granted O. C. Barber, of Akron, a franchise for the construction of a freight subway to extend from the lake front to the upper valley of the Cuyahoga River.

Columbus, O.—The East Linden Electric Ry. has asked Council for franchises over two sections of the city.

Columbus, O.—The Chesapeake & Ohio Northern R. R. will, it is reported, file application with the State Utilities Commission for permission to issue the securities necessary to construct and equip its line. Engineering work is complete and right-of-way secured. Curtis-Ward Co., Bluefield, W. Va., has contract for foundations for concrete structures.

Toledo, O.—Council committee on railroads and telegraph approved the plan of the city's laying new street railway tracks on streets where repaving is being held up. City Engineer Herbert McKechnie will submit estimates of cost.

Cincinnati, O.—Surveys for a new interurban are to be made at once, according to reports from here. It is said the object is to furnish rapid transit facilities for the Cincinnati, Lawrenceburg & Aurora Traction Co. The line is to extend for six miles from Anderson's Ferry into the city, and the cost is estimated at $100,000 per mile. Stanley Shaffer is attorney for the proposed road.

Pennsylvania:

Scranton, Pa.—The Delaware & Hudson Co., Jas. MacMartin, Chief Engineer, Albany, N. Y., plans to abolish 16 grade crossings in this city at an estimated cost of $225,000. John I. Riegel, civil and mining engineer, has been retained to resurvey the line within the corporate limits.

Philadelphia, Pa.—Mayor Blankenburg has signed the ordinance empowering the Pennsylvania R. R. Co. to build an addition to its Overbrook classification freight yard this fall. The proposed work will cost between $6,000,000 and $7,000,000. Alex. C. Shand of Philadelphia is Chief Engineer.

Texas:

Dallas, Tex.—Plans are being perfected for the merging of the properties of the Texas Traction Co. and the Southern Traction Co., it is said. This is to be immediately followed by the construction of an extension of the latter company's line south from Waco to San Antonio, via Austin and a number of other towns.

Virginia:

Blackley, Va.—It has been announced here that the Louisville & Nashville will shortly commence construction work on an 18-mile line from Blackley to the headwaters of Rockhouse Creek. W. H. Courtenay, Louisville, Ky., Chief Engineer.

BIDS OPENED; CONTRACTS LET

Illinois:

Chicago, Ill.—The Baltimore & Ohio System has let a contract to James Stewart & Co., Westminster Bldg., city, for the construction of its Robey Street yard buildings to include an office building, storehouse and power plant. The contract will aggregate $250,000.

Ohio:

Ashland, O.—A contract is reported to have been awarded by John C. Lake of Big Prairie, for the construction of an extension of the Lorain, Ashland & Southern R. R. 1.2 miles from its present terminus at Custaloga to Big Prairie. Estimated cost, $10,000. The line is to be leased to the above company, of which J. Palmer Ramsey, Lorain, is chief engineer.

ROADS STREETS

BIDS ASKED

Alabama:

Huntsville, Ala.—City is asking competitive bids for resurfacing 10,000 sq. yds. of streets with mineral rubber, tarvia or asphalt. W. P. Monroe, Clerk.

California:

Sacramento, Cal.—Until 2 p. m., July 26, by State Highway Commission, for following highway work: Marin County, between Burdell and St. Vincent, about 4 miles to be graded; Monterey County, between Greenfield and Camphora, about 11.7 miles to be paved with Portland cement concrete; Santa Barbara County, between Gaviota Pass to Zaca Station, about 11.4 miles to be graded; San Luis Obispo County, between Atascadero Creek and Pablo Robles, about 10 miles to be paved with Portland cement concrete; Colusa County, through Arbuckle, about 0.3 mile, to be surfaced with asphalt 55 ft. wide. Austin B. Fletcher, Engineer.

Stockton, Cal.—City Clerk Pulich has advertised for bids for the construction of asphaltic concrete (2-in. wearing surface) pavement on 9 streets, estimated to cost $86,726.

Stockton, Cal.—Until 10 a. m., July 27, by George W. Pulich, City Clerk, for paving with asphalt concrete (Topeka specifications) portions of Weber and Minor Aves., Market, Commercial, Sonora, Church, Washington, Sutter and San Joaquin Sts.

Connecticut:

Hampton, Conn.—Until 3 p. m., July 26, by Fred S. Hall, Chairman Building Committee, for building wall, cement walk and grading ground around the grammar school.

Glastonbury, Conn.—Until 2 p. m., July 22, by Board of Selectmen, for building 4,500 ft. of macadam road on Naubuc Ave. Charles E. Goodrich, First Selectman.

Indiana:

Muncie, Ind.—Until 10 a. m., August 3, by Board of Public Works, for the construction of a combined cement curb and gutter, and for resurfacing sections of First St., Vine St. and Penn St. John R. Kelley, City Clerk.

Illinois:

Springfield, Ills.—Until 11 a. m., July 28, by State Highway Commission, for 3,560 lin. ft. concrete road in Kankakee County near Exline, to cost $6,047, and for 5,000 lin. ft. of concrete road in Kankakee Township near Momence, to cost $1,959.

Glen Ellyn, Ills.—Until July 30, by Board of Local Improvements, for the construction of 35,521 sq. yds. of reinforced cement concrete pavement, estimated to cost $80,185. George G. Nelson, Municipal Engineer.

Paris, Ill.—Until 2 p. m., July 31, by Commissioners of Highways of Hunter Township, Edgar County, for 3,960 lin. ft. of gravel road on the Baldwinsville-State Line road and for 5,280 ft. of gravel road on the Heelan Road. J. T. Morrisey is a commissioner.

Iowa:

Spencer, Ia.—Until July 27, by Council, for approximately two miles of street paving.

Spencer, Ia.—Until 8 p. m., July 27, by city, for approximately 70,000 sq. yds. of paving. Bids will be received on Natural Lake sheet asphalt, creosoted wood blocks and cement concrete. Certified check for $10,000. E. O'Keeffe, City Engineer.

Kansas:

Hutchinson, Kans.—Until July 23, by city, for 20,000 sq. yds. 3-in. vertical fiber brick pavement. G. L. McLane, City Engineer.

Louisiana:

Lake Charles, La.—Until 11 a. m., August 3, by E. C. House, Clerk Police Jury, for the construction of sections of a Lockport to Ged Highway; approximately 14 miles of earth road. Fred Shutts, Parish Engr.

New Orleans, La.—In addition to the 75,510 sq. yds. of standard paving now being advertised by the city (bids to be opened on July 20), bids are now asked until 11 a. m., Aug. 3, for the paving of additional streets with standard material. It is estimated that the drainage and paving work will approximate the expenditure of $1,500,000. A. G. Ricks is Commissioner of Public Finances. W. J. Hardee is City Engineer.

Maine:

Bangor, Me.—Until noon, July 22, by Board of Street Improvement, for the construction of a concrete retaining wall to contain about 356 cu. yds. on Spring St.

Minnesota:

Duluth, Minn.—Until 11 a. m., July 23, by Department of Public Works, for the improvement of 44th Ave. and 20th Ave.

Duluth, Minn.—Until 11 a. m., July 26, by Department of Public Works, for the improvement of Devonshire St. and Colorado St.

Redwood Falls, Minn.—Until 1 p. m., July 27, by L. P. Larson, County Auditor, for graveling about 2 miles on east end of the State Road No. 3; for graveling about 2½ miles on State Road No. 3 west of Morgan Village; for graveling about 5 miles on State Road No. 4 north and east of Vesta Village. and for graveling about 18 miles on State Road No. 6.

Missouri:

St. Louis, Mo.—Until noon, July 23,, by Board of Public Service, for lettings Nos. 132, 133, 134 135 and 136, calling for street improvements. William T. Findly, Sec.

Nebraska:

Omaha, Nebr.—Until 10 a. m., July 27, by Thomas J. Flynn, City Clerk, for improving 10 thoroughfares by repaving, curbing and guttering, etc.

Omaha, Nebr.—Until 10 a. m., Aug. 3, by Thomas J. Flynn, City Clerk, for 11 street improvements.

New Jersey:

Trenton, N. J.—Until 2:30 p. m., July 28, by Frank Thompson, City Clerk, for paving portions of following streets: Cooper, Fulton, Lamberton, So. Clinton Ave., Whitaker and Ardmore Ave. with bituminous concrete.

New York:

Albany, N. Y.—Until 1 p. m., August 3, by State Highway Commission, I. J. Morris, Sec., for 22 highway repair contracts.

Buffalo, N. Y.—Until 11 a. m., July 24, by Acting Commissioner of Public Works George H. Norton, for nine street improvement contracts calling for paving and repaving.

Endicott, N. Y.—Until 8 p. m., July 27, by Donald C. Morgan, Village Clerk, for the construction of pavements of brick, bitulithic or other materials in Park, Broad and Monroe Sts., Madison and Garfield Aves.

Ohio:

Norwalk, O.—Until 10:30 a. m., July 24, by Chas. E. Bloomer, County Auditor, for the improvement of the section line road from Hartland Station northerly, of a distance of about one mile; the Angling road in Town-

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

Volume XLIV. CHICAGO, ILL., JULY 28, 1915. Number 4.

Two Suggestive Clauses for Codes of Rules for Employes.

In its book of directions to employes recently published by the Illinois State Highway Department there occur two clauses which carry a lesson to both employes and directors of engineering organizations. In Section 35 the regulations say:

> Continuous employment over a considerable period of time, without the presentation of suggestions relating to a more efficient service will be interpreted by the Engineer as reflecting an attitude of indifference toward the work on the part of employes so concerned.
>
> Employes are not unduly encouraged to remain in the service of the Department when opportunities elsewhere are presented that appear to be for the betterment of their condition in life. Upon the request of any employe the Department stands willing and ready to issue personal recommendations that are fully commensurate with the capability of the particular employe concerned.

Successful managers of labor, whether it is mental or physical labor, tacitly recognize both of these doctrines in their appraisal and treatment of employes. It is perhaps also true that these managers are less accustomed to announce their policy than might be wise; they take it for granted that the employe understands. He does not always understand, indeed it may be questioned whether he does not generally misunderstand. It is particularly worth while, it seems to us, that the engineers of the Illinois Road Department should by formal publication make plain their attitude and policy.

In the first clause quoted the subordinate engineer and particularly the young engineer, will find a lesson that he cannot afford to forget throughout his professional life. To be alert in offering suggestions for greater efficiency of work does not mean that the chief engineer must be snowed under with untested or half-thought-out plans and ideas. It does not mean that a hypercritical attitude toward things as they are is to be adopted. Yet as a rule the experienced manager holds higher the employe who has frequently some improvement to suggest than he does the employe who sees nothing that can be bettered in what is proceeding all about him. The inventive employe will evolve many plans which the manager will know to be impractical and the manager knows that this will be the case, but occasionally the employe will conceive a new and good plan, and the manager knows this also. As the employe gains experience and knowledge his suggestions will be fewer in number, but there will be a far greater proportion of them that is useful. These statements are obvious and hackneyed, but it nevertheless will not do to overlook their truth. Withal, however, there must be kept fast the fact that the employe is at his work to work—to produce results with the means and by the methods at hand. Failing in this essential he is not liable to be effective as a reformer, nor will his plans for reform attract much consideration.

In the second clause quoted is included a useful minor rule of scientific management. The employe who is convinced that his services will be relinquished freely and with full acknowledgment of their value when opportunity for the betterment of his position and pay presents itself, is bound tighter to his manager than he can be in any other way.

Is the Big City Necessary?

There is no notion more incorrect than this that the great city is permanent. None of its component parts exists long. Its buildings, its streets, its transit, its sanitation works endure in part only from one generation to another. There is constant shifting of its business and industrial centers, even the character and magnitude of these change in time, and social life shifts its activities and habitation often and widely. All this is trite, it will be said; the city as a unit remains and is permanent. One may remark of Nineveh and Babylon in answer but such a retreat is not necessary. There are increasing indications that people are beginning to understand that the big city, the city great in population and area, is not as fit to serve the only purposes that a city can serve as are smaller aggregations of the units which collectively we name a city. Newly created industrial cities are becoming familiar in America and in England and commerce and industry are coming every year to closer agreement with sociology in their estimation of the advantages of the small city. Acceptance of the logical conclusion is perhaps distant, but this conclusion is beginning to be admitted.

People are fond of comparing the birth and growth of a city with the birth and growth of a living organism. It is perhaps not an unfair comparison. The biologist, be it noted in this comparison, recognizes that a living organism is not necessarily higher in the scale of being simply because it is larger and more complex. The simpler organism can exist under much more simple conditions and may therefore be quite as fit as a more complex organism which requires more complex conditions under which to survive and thrive. We shall see that this comparison is particularly true of the city. The small city of 200,000 people may be and is usually just as capable in all that a city affords its inhabitants as is the city of 2,000,000 people.

As engineers let us see how the engineering tasks of a city are affected by size. The engineering tasks of a city are primarily to provide transit, to supply, purify and distribute water, to provide sewerage and dispose of sewage, to secure sanitary housing, to pave and keep clean streets and roadways. The accomplishment of none of these tasks becomes a serious problem until the city area and population become large. Generally the larger the city is the more difficult and therefore costly are the solutions that must be resorted to, assuming that quality of service is maintained. In a word, all the engineering difficulties of a great city are due primarily to its size and not to any superiority of the service provided. Cities of 200,000 usually have as good water supply and as good sewerage as do cities of 2,000,000, their people get from home to work as quickly, their streets are as clean and well paved, their housing and sanitation are as good. Where, then, is the advantage of great size? Is it in educational advantages, opportunities for amusement or social life or religious activity? Everyone knows that in none of these things does the small city deny its inhabitants any material advantage had by the inhabitants of a large city. Why should cities vie with each other to attain size? Size, merely, makes a city no more fit to serve its inhabitants.

These remarks are introduced to call attention to the article, "The Reconstructed City," published in another section of this issue. With all that the author has to say of the superior living conditions of the small industrial city most readers will agree at once. The points that we wish to emphasize are those in which are mentioned the advantages of the small city, to manufacturers, in increased productive capacity. It is not an easy matter for the city manufacturer in New York or Chicago or Philadelphia to think that he can do business as well in a city of a tenth the population. There are some, perhaps, who cannot. How many are they? The article which we publish is bound to raise this question and many others that we large city dwellers have let lie undisturbed, being so occupied in works to make big city life comfortable and convenient that there is no place for thought whether big city life is really at all necessary or desirable.

The Illinois Structural Engineers' License Law.

The structural engineers' license law, which was passed at the last session of the Illinois legislature and was signed by Gov. Dunne on July 5, gives to structural engineers, as principals, the right to design certain structures denied them under the provisions of the architects' license law, in force in Illinois since July 1, 1897. In our issue of March 17, 1915, we published in full the provisions of the bill as originally presented. Due to the determined opposition of organized architects to the original bill certain modifications were agreed upon, and opposition to the bill was then officially withdrawn by the joint committee of the Illinois Chapter of the American Institute of Architects and the Illinois Society of Architects. The bill was then passed although a number of architects continued to oppose it.

There is some doubt as to when the act becomes effective, as it was signed by the Governor after July 1. Unless worded to the contrary an act passed by the legislature becomes effective on July 1 succeeding the date of passage. In this case the act was passed before July 1, but it was not signed by the Governor until July 5. Whether the act became effective July 1, 1915, or will be in effect July 1, 1916, depends upon whether or not in this case passage by the legislature was sufficient without the Governor's signature, in that the latter did not act upon it until after July 1.

The amended portions of the act refer principally to the definitions of structures and of structural engineers. This part of the act, as passed, is as follows:

> Structures within the meaning of the act shall be construed to mean all structures, other than buildings, having as essential features foundations, columns, girders, trusses, arches and beams, with or without other parts, and in which safe design and construction require that loads and stresses must be computed and the size and strength of parts must be determined by mathematical calculations based upon scientific principles and engineering data; and any person who shall be engaged as a principal in the designing and supervision of the construction of structures or the structural part of structures designed solely for the generation of electricity, or for the hoisting, cleaning, sizing or storing of coal, cement, sand, grain, gravel or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces, rolling

mills, gas producers and reservoirs, water works, sanitary works as applied to the purification of water or plants for waste and sewage disposal, or roundhouses for locomotives, railroad shops, pumping or power stations for drainage districts, or power houses, shall be considered as a structural engineer within the meaning of this act, and shall be entitled to the benefits of these provisions, even though such structures may come under the definition of "buildings" as defined in "An act to provide for the licensing of architects and regulating the practice of architecture, as a profession," in force July 1, 1897; provided, however, nothing contained in this act shall be construed to limit or abridge the rights, privileges and duties of architects licensed to practice under the provisions of said act, nor to modify, limit or repeal any of the provisions of said act; and provided, further, that nothing contained in this act shall prevent draftsmen, students, clerks of work, superintendents and other employes of those legally practicing as structural engineers under licenses, as herein provided, from acting under the instructions, control or supervision of their employers, or shall prevent the employment of superintendents of construction paid by the owner from acting under the control and direction of a licensed structural engineer who has prepared the drawings and specifications for the structure; and provided, further, that nothing contained in this act shall be construed to prevent any person, mechanic or builder from making plans or specifications, or supervising the construction, enlargement or alteration of any structure or building which is to be constructed by himself or his employes and for his own use.

It will be noted that the exact meaning of the above quoted paragraph is as difficult of interpretation as is the intent of *some* specifications. It is, however, clear that licensed structural engineers, as principals, will be permitted to design and supervise the construction of those structures which are essentially engineering in character, and this is really what is desired by engineers. It means that, as regards such structures, the engineer need no longer act in a subordinate capacity, but may deal directly with the owner; and this should prove decidedly to his advantage. Another decided benefit of the new act is that it permits an engineer and an architect to form a partnership, this privilege being denied the engineer under the operation of the architects' license law.

Although the act was fostered by the legislative committee of the Western Society of Engineers it should be noted that the broad question as to the general desirability of licensing engineers was not involved. The conditions existing in Illinois, due to the operation of the architects' license law, were particularly unfair to the engineer, and it was to correct this that the passage of a structural engineers' license law was desired.

Contract Construction of Public Works and Graft.

In his message introducing the report for 1914 of the Chicago Department of Public Works, Mr. Carter H. Harrison, late mayor, takes an unusually radical stand against contract construction of public works. His position is perhaps most exactly described in his own words. He says: "Years ago the conviction forced itself upon me that graft and corruption in municipal government were directly attributable to private ownership of public utilities and to the contract system of construction of public works." This statement will be recognized as unusual as well as extreme. The common arguments against contract construction are that it takes the contractor's profit from the public, that it endangers the quality of construction, that it is provocative of lawsuits, that it prevents changes in plans and that it substitutes outside for local labor. It is noted that Mr. Harrison lists none of these familiar arguments. His charge is that contract construction is one of two things to which graft and corruption in city government are attributable.

There is in all conscience enough graft connected with contract construction in American cities. Would the elimination of contract construction eliminate corruption including graft from city works? Corruption and graft are games which cannot be played except by collusion. The contractor cannot employ corruption and enjoy graft without the connivance or consent of an agent of the city. There must be two criminals in every transaction of the sort and only one of them can be the contractor. On every occasion where a contractor has practiced corruption and graft in Chicago or in any city there has been a city agent, venial through cupidity or fear, to aid him. Will elimination of contract construction remove the venial agent? Will it even remove from the agent temptation to become venial? Anyone who knows conditions knows that to both questions the answer is, no.

In what has just preceded we have mentally granted that in matters of corruption and graft in city works the contractor is the party of the first part—that he is invariably the corruptor. To one who knows even moderately well both contractors and city officials the claim is not particularly credible that the former always has the role of Mephistopheles and the latter always that of Faust in the drama Corruption and Graft in Contract Construction. There are contractors who will seek every occasion for dishonesty. There are more who under stress of a losing contract will resort to dishonest procedure for financial rescue. Generally men of the latter class would prefer to deal honestly, and of both classes there is not a large number in proportion to the number of contractors who do honest and good work and do it often at financial loss. Every engineer knows that there are contractors who do crooked work but he knows that they are the exception and if he is a just man he does not permit his experience of crooked dealing by the few to bring condemnation of the many who are not crooks. We are convinced that ex-mayor Harrison has no belief that the contracting business is inherently and persistently dishonest; he has merely mistaken a means for corruption and graft in constructing city works for the cause of corruption and graft. The real cause is far deeper and is much more complex.

In the course of his comment on contract construction Mr. Harrison, after announcing the construction of certain city tunnels by day labor and the installation of shops for manufacturing and repair work for city departments, says: "Under the day-labor system there will be no recurrence of 'shale rock' or 'foundry-casting' scandals." Again the ex-mayor assumes that a cause of scandal has been done away with when it is only one means of scandalous action that has been eliminated. If Mr. Harrison had read carefully the reports of the engineers of the Boston Finance Commission or even the reports of Chicago's own Merriam Commission he would not have been so certain that the day-labor system is inviolable by scandal. Also he would have observed that there may be faults with day-labor construction which are far more costly to the public than any direct stealings that come from grafting.

Except in isolated instances day labor construction of public works is more expensive than contract construction. It is not much less liable to scandal than is contract work. These are particularly true statements when made of the work done in large politics ridden cities like Chicago. Now day labor construction is no more a fundamental cause of high construction costs than is contract construction the fundamental cause of corruption and graft. The cause in both cases is in other things. It may very likely be that the day-labor tunnel construction to which Mr. Harrison refers will be a notable example of cheap and good construction but the fact that it is day labor construction does not make it certain. On the contrary the analyst of day labor cost records of city public works is wholly warranted in suspecting that the work will not be both notably cheap and good. So also in respect to the future products of the new city foundry and machine shops, the records of city manufacturing operations do not guarantee either cheapness or high quality though both may result from Chicago's experiment.

It would be comparatively easy to pile up facts and arguments exposing the fallacy of Mr. Harrison's stricture on contract construction. Enough has been said, however, to show that it is a piece of superficial reasoning which demands attention only because of its source. Engineers and contractors will not generally be led astray but many others may be and thus the way of engineer and the contractor be made harder to travel.

GENERAL

The Reconstructed City.

When an architect builds a factory, he lays down upon the table before him a list of the various things the factory is to do, and then proceeds from these known needs to create a structure which will best meet them. It seems peculiar that, despite our thousands of years of experience with cities, there has been so little attempt to apply large scale planning to the idea of the city as a functioning unit and lay it out accordingly. Is it any more desirable that a city should grow indefinitely large than that a man should grow indefinitely large? Perhaps most of us as little boys have wished the wish of fairies that we might be as big as a giant so that we might pick up certain undesirable persons and put them between our fingers and place them where they belonged. Is the world-wide desire of cities to grow big, big, big, any more sane? My answer is emphatically "no." A city is to perform certain functions, and when it is big enough to perform those, additional size is of no more value than an additional one hundred pounds is to a man who already weighs one hundred and eighty.

THE WORLD'S GREATEST TOWN PLANNER.

Mr. Ebenezer Howard, an Englishman, sat down and drew up the plans of an ideal city. He first analyzed the proposition. The city affords to its inhabitants the social opportunity of numbers, to the factory the labor market of numbers, but it tends inevitably to crowd. On the other hand, the advantages of the country are cheap sites and room to grow things in the yard and garden, room to play, fresh air, and nearness to food supplies, but lack of social and employment opportunity. Then having put these things down on the table, he proceeded to plan a city which swung around the cardinal principles of (1) having all the inhabitants so placed that they were so near their factories that they could walk to their jobs, (2) so near to open space that they could easily walk to the farms, fields, and playgrounds, yet (3) sufficiently numerous to make the labor supply for factories which produce. This after all is the object of the city. These ends can only be attained by having a definite size for the city. This means limitation of the population. Why have more if the city is big enough. His ideal plan of the city was circular with an open park in the center, around which were gathered the public buildings of which the city needed but one, or at most but few, such as the town library, town hall, theater, opera house, museums, etc. Then came some four or five circular streets of residence, with a wide avenue in the middle of them with a park space in the middle of it, with room for schoolhouses, churches, masonic buildings, and other semi-public structures. The last street was to be a row of factories with a belt line railroad behind them and beyond that open ground for garden plots and farm land.

NOTHING NEW ABOUT IT.

By the application of our well-established principles of building restrictions, crowding was kept out by limiting the size of lots to a certain minimum and then limiting the proportions of a lot that could be covered by a house. Thus Mr. Howard figured that the city would be full grown with about thirty-two thousand, more or less, depending upon the size of the families. After this city was full the other increased residence needs could be met by building another city nearby, just as we build the next suburban station on the railroad. In the ideal plan about six thousand acres are required for the citv, of which about half are left for farms, and the remaining in streets and city.

HOW IT WORKS.

The average American predicts failure for any such enterprise. However, England feels the city problem much more keenly than we do in this country, for it has had the industrial city longer, and in recruiting for armies, particularly for the Boer War, England has discovered with horror the physical degeneration which results with generations of city dwellers, with inadequate dwelling facilities, no gardens, no ground, no play facilities. After much hard work, Mr. Howard succeeded in forming a Garden City Association that raised enough subscriptions of cash to start, although they did not get the necessary one and one-half million dollars which they thought they should have. They bought about four thousand acres of farm land forty miles north of London in Hertfordshire on one of the great railroads and proceeded to set apart the central half of it for city, lay out streets and plan a factory town. Owing to the contour of the ground, there was no attempt to maintain the circular idea of the abstract plan, but all the principles were applied, namely, nearness of the man to his job, to the open country, to play space, and a roomy lot for each residence. It has succeeded. In nine years between 1904 and 1913 about thirty factories have moved to the place, which had a population of 8,000 and was steadily increasing. The crucial test, however, of its success is the balance sheet. It was financed by a group of individuals who were willing to put up some money, buy the land, and get their 5 per cent cumulative dividends eventually if it succeeded. It followed the usual English plan of giving long leases to land and letting tenants improve. This is the way many English cities are already built. The company bought at farm values and rented at low town values. Thus the cottager who buys a lease for a plot pays perhaps $10 a year for the lot, but as there are seven or eight such lots per acre, the income on the original purchase price of $200 is ample. Thus these leases which had been sold when the town was one-quarter grown caused the balance sheet for the year 1912 to show a profit. The financial plan provides that the promoters shall get 5 per cent, and after that further profits shall go to the city in improvements and reduction of taxes. One of the manufacturers told me he could foresee the time when the town would be without taxes, and then the manufacturers would come there "in droves."

ITS APPEAL TO THE MANUFACTURER.

I regard this attempt to eliminate the crowding evil from the manufacturing town as perhaps the most important single social experiment going on in Europe, for it is a statistical fact that no large city population anywhere is physically and numerically maintaining itself. In 1913, I spent several days in this city going through it very carefully to see how it appealed to the manufacturers. I had letters of introduction to the prophets of the place, but really I did not care how it appealed to the prophets, for I knew that in advance. I did not care how it appealed to the poets, the artists, the retired bankers, the maiden ladies living on snug incomes, nor the cranks, nor the merchants who sold to all these, nor even to the workers who made up the bulk of the population. The worker goes where there are jobs. The butcher, the baker, and the candle-stick maker come to serve him, so that the vital part of a city is the way it appeals to the man who promotes the primal industry, which is usually manufacturing. Therefore I interviewed the manufacturers of the place, making a special attempt to try to find those who were most distinctly what you would call of the practical turn of mind in contrast to the altruistic. Everywhere I found the same enthusiasm. I went to get their ideas, but first I must go and look at their plants. They all pointed out the great superiority of the plant on these two or three-acre cheap sites over the plants they had left in London, many of which were crowded, and so dark as to be lighted by gas, and so inadequate as to interfere with the best efficiency of work.

Perhaps the best interview was given by an automobile manufacturer who had been the hardest to persuade to come there, and who finally consented to do so for the following reasons as he stated them:

First. When a man bangs about in an omnibus for an hour and even more, morning and evening, going to and from work, as my men did, I figured it was wearing him out, and making him less efficient for his work. I also figured that the six-pence he had to pay for that finally came out of me.

Second. In London where there were lots of works, we found the men were becoming rovers, increasingly so. If a man did not like it in my works, he could move to the next. When he needed a little discipline, he would get mad and quit, and go to the next place where he would do the same thing and be none the better for the move. It cost us at least two pounds Sterling when a man quit. Now where there are less works of a kind up here, a man will listen to reason, is a little more dependent on his job, learns, and becomes a better worker.

Third. The building restrictions appeal to me. In London, if I wanted to put a stove pipe through a foundry shed roof, I had to draw up plans and specifications, apply to the board of building inspectors, pay a fee, and maybe wait thirty days for them to get around to it, and perhaps be refused. Here, if I want to do it, I go ahead and stick her out. My plant is so far from the next plant that it can catch fire and burn down if it wants to without much danger to others. In London a rubber plant came and stood alongside mine, and the underwriters put my insurance up 100 per cent. Here that cannot happen. I have signed a uniform contract with the company like every other manufacturer has, and I know just what they can do and what I can do.

I found out one thing that I never believed. I had heard, of course, lots of socialists and other people say that if a man had a nice new factory with plenty of light and air, and good recreation, he worked better, but, Lord, Mr. Smith, I never believed it. But it's a fact. I know, for I have brought men here from London, have brought the machines with them and the same men worked on the same machines at the same rate of pay with the same inspection and same bonus system, the same number of hours per week, making exactly the same brand of machine, and they turned out more work. It amounts to between 7 per cent and 8 per cent. That cuts down overhead charge, and what's more, the quality of the output is better. I can't give you that in percentage, but I have been running these works for fifteen years and I know. The stuff goes through better, and less material is spoiled.

When the work is over, the children come up to the factory gates to meet their fathers and they are home in ten minutes. You ought to see this place on Saturday afternoons. It is full of football games. Every works has a football team or two or sometimes three. All the teams play match games with each other in winter and cricket games in the summer.

It is not an uncommon thing to see a factory in the corner of a three-acre lot over which it may eventually grow. Meanwhile football goal posts indicate the use the ground is being put to. Owing to the fact that this land is had at a low lease per year, the works can easily afford to rent three acres of ground to expand on.

It is the most beautiful factory town I have ever seen, for the reason that every house has room enough for flowers in front and vegetables behind. At no place do they have lots more than twelve to the acre, which means that lots can be practically 20x200 ft, even in sections given over to the artisan. That makes provision for a small front yard, cottage site, little back yard, and 100 feet left for garden in the rear. A labor agitator with whom I had a long interview on Sunday told me he could pretty nearly tell how long a man had been there by looking at his garden. The first year after arriving from London, he did not do much. Then summer came, the neighbors began to hand vegetables across the line. The next year he made a start, and by the third year his garden began to be of some real value.

Inasmuch as the town is definitely planned, it has ample factory districts on railroad sidings, and there is on each side of this a large district given over to cottages for factory workers. This is reserved for factory workers, by building restrictions which insist that houses shall cost up to a certain minimum, but not beyond a certain maximum. That practically means artisans' cottages. Beyond that in both directions are larger lots, at higher rent with different building restrictions, which means middle class. On the highest ground still further away from the factories are yet larger and more expensive lots where factory owners and persons of some means have their beautiful homes. Near the station is the natural place for the shopping district, while immediately across from it is a seventy-acre playground, with several smaller ones of twelve, five, three, and one-half acres, etc., scattered about the place, which is, so far as I know, the only town of its size in the world that has public provision for simultaneous play of any large percentage of its population.

The limitation of population is provided for in building restrictions. Bv this means these facilities of accessibility and play space become permanent. Just beyond the factory district come the farm holdings. Perhaps Mr. Howard's dream of a town that combines the advantages of both city and country will come true. It has certainly made a good start.

The people of this town have almost unique opportunities for the development of health, muscle, character, and wealth through by-industry. There is a very considerable chance to duplicate the conditions of the artisan's life before the factories came. Think of the opportunities for boys and girls to garden, especially as the time for beginning factory labor is being postponed. This opportunity for wealth and solace and the additional ones offered by poultry are a boon to the old, and they are being used in Garden City. Back of a beautifully embowered yard lived a retired engine driver. Back of his cottage was one of the most productive bits of garden, 50x40 ft., that I have ever seen. If a family wishes to go at market gardening on the side, small holdings can be rented just beyond the town limit. It is not necessary to pay city lot rent. The land is not suburban, it is farm land, so denominated in the contract, and the contract is as tight as it could be made.

The health of the community as indicated by the appearance of the school children, and by vital statistics is unusually good.

THE NEEDLESS RECONSTRUCTION OF INDEFINITELY PLANNED CITIES.

The fact that this garden city is definitely planned saves it from the endless turmoil of reconstruction which a growing city encounters, owing to the fact that as the city grows, each part has a different use with every generation. Therefore each generation tears down what the previous generation built to last for many decades. Thus in Philadelphia and in New York the business section is invading the residence section, either using awkward old residences, or tearing down and building anew. This winter a block of splendid substantial houses worth many thousand dollars was torn away near the University of Pennsylvania to make room for another university building. That great university with 5,000 students on the campus has outdoor space for one football or baseball game at a time, leaving the other 99% per cent without the possibilities of outdoor athletics at that time. Thus the city has swamped itself, and its institutions, as all growing cities do where every building operation and every unit of growth is part of the heterogeneous individual effort. The supreme example of this waste is perhaps shown by the subway, that fearfully expensive kind of construction that never should have been. The suburbs of a growing city are successively swamped by new uses. Because the people are expecting in a short time to sell them for building purposes, the land is held for high prices and the chief occupation of the land that should be in crops is the support of "for sale" signs. Around Garden City is a belt of farms and playgrounds, which, owing to the fact that it is definitely set apart for these uses, has and can have no sale value, in which respects it resembles our parks.

The most significant part of the whole thing is that it has been done by the application of existing practices and existing laws with existing human science. Most attempts at social reconstruction have to await a conversion of the majority to a new point of view, and if the dreams of the socialist come true, we must also develop an entirely new system and type of business administration. In contrast to that millennial process, a garden city like Letchworth, England, can be built now in any well-chosen location. Any group of capitalists with constructive imagination and good business ability can start in and do it under existing law. As to its areal aspects—there is plenty of room along the Delaware River for all the industrial population now near it (and much more) to be so situated that they could avail themselves of all the principles involved in Garden City and have the best access to the harbor. They now have very poor access to it.

If our urban people lived in such cities as Garden City it would beyond a doubt reduce the cost of living, increase wealth through by-industry, increase pleasure through the possibilities of recreation, increase efficiency through increased health. The land speculator alone would lose—lose his present much too widespread opportunity to take something and give nothing in return. Something for nothing is a process that is variously regarded according to our social enlightenment.

ACKNOWLEDGMENT.

A paper by J. R. Smith, Wharton School of Finance and Commerce, University of Pennsylvania, in Annals of the American Academy of Political and Social Service.

Hardwoods of Borneo.—There are found in the island of Borneo several valuable hardwoods. The most useful is billian or ironwood, an extremely hard, and heavy timber, which is insect-proof. It is suitable for furniture making, dancing floors, inside finishing of railway cars, vehicles and other uses where high polish is desirable. Another wood as hard, but not so heavy, is russak or selangan batu, used for general building purposes, but preferred for posts and piles for wharves, beams for houses and all kinds of heavy frame work. Sirayah or redwood, a comparatively soft wood, is used for general building purposes where hardwood is not needed. It has been used for railway coaches. A dark red timber similar to mahogany, known as urat mata, is used for shipbuilding, masts and planks. It is very durable and impervious to ants and other insects. The supply of all of these timbers is plentiful and steps are being taken to develop the industry.

Comment on the Effect of Various Elements in Steel on Its Resistance to Corrosion.

(Staff Abstract.)

In our issue of June 30, 1915, we published the results of some tests made by Daniel M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., to determine the effect of various elements (notably copper) in steel on its resistance to corrosion, together with the conclusions of Mr. Buck, based mainly on these tests. Exception has been taken to some of these conclusions in a discussion of Mr. Buck's article by Allerton S. Cushman, consulting metallurgical engineer, Washington, D. C. We herewith give the results of some tests made by Mr. Cushman, together with an abstract of the discussion by this investigator. This discussion emphasizes the fact that there is not unanimity of opinion on this subject:

I have had, among many others, No. 26-gage samples of the most ordinary type of non-copper bearing Bessemer steel exposed under the atmospheric conditions of a densely populated mill town (which has not yet begun to combat the smoke problem) for 16 months before the first hole appeared in any of a large number of full sized corrugated sheets, in spite of the fact that some of my tests sheets had been left in the original black, while others, for comparative purposes, had first been pickled in acid in the usual way.

In order to supplement these atmospheric corrosion tests I adopted the expedient of exposing similar sheets of different types of metal to a more severe test. This was done by bending up the edges of flat non-corrugated sheets so as to make of them shallow pans. These pans were filled with coal slack cinders and exposed in a horizontal position so that the rains could descend upon them. The results are given in Table I. They are no more conclusive than Mr. Buck's tests. This point I wish to emphasize particularly. But it can be reasonably claimed that if the coppered basic steel was the best material amongst the great number of test pieces which I was investigating, they should have confirmed Mr. Buck's results. I give them here for what they are worth, in the belief that when independent engineers have had time and opportunity to thoroughly study these questions they will meet with a great preponderance of similar results.

TABLE I.—RESULTS OF CINDER PAN CORROSION TEST.

Sheet No.	Material.	Analysis Sul.	P.	C.	Mn.	Cu.	Ni.	Condition after 9 months' exposure.
85	Bessemer steel	.038	.094	.012	.36	.016	....	15 holes.
108	Basic coppered steel	.028	.008	.10	.19	.26	....	6 holes.
169	Pure basic open hearth iron	.020	.004	.012	.008	.032	....	Sound.
123	Pure basic open hearth iron	.029	.006	.012	.023	.024	....	1 hole.
127	Open hearth nickel alloy	.020	.007	.010	.037	.036	.16	5 holes.
126	Open hearth copper nickel alloy	.019	.009	.010	.015	.23	.26	6 holes.
170	Open hearth copper nickel alloy	.027	.006	.010	Trace.	.17	.20	Sound.
121	Open hearth high nickel alloy	.024	.004	.010	.015	.028	1.00	Sound.

I believe that the real reason of any improvement which may have occurred in the effort to introduce copper as a normal constituent of steel lies in the greater purity, better degasification, and decreased segregation of the modern material.

I feel it necessary as a metallurgist who has given a great many years to the study of the effect of the various impurities as they may or may not influence the resistance to corrosion of a typical metal to discuss Mr. Buck's statements under his separate headings.

CARBON.

Mr. Buck states that although there has been no attempt made to determine directly the carbon influence it seems that in the low ranges present the carbon has little influence, and that this is indicated by a study of the tables given in his paper (see ENGINEERING AND CONTRACTING of June 30, 1915).

As a matter of fact a great deal of work has been done by a number of metallurgists in this country and in Europe in the study of the effect of carbon on corrosion resistance. Some authorities hold that carbon, inasmuch as it will allow hardening, will act as a protection, provided it is combined with the iron and uniformly distributed. As a matter of fact, however, it rarely is perfectly combined with the iron and uniformly distributed, as the microscope readily shows, and segregation in the cooling of impure molten metal is always an important factor. In our own practice we believe carbon to be deleterious on account of the fact that it is more difficult to degasify properly the metal while carbon is still undergoing oxidation in the process of burning out I believe that Mr. Buck has followed a good example in limiting his carbon content from 0.02 to 0.14 per cent, with the accent on the minimum side.

MANGANESE.

Mr. Buck admits that some metallurgists hold the theory that a content of manganese is detrimental to steel in its corrosion resistance, but he does not agree with the theories advanced nor has he observed the slightest evidence of proof that such claims are justified. Nevertheless, he acknowledges that manganese combines with sulphur, forming manganese sulphide, which exists in isolated patches, but which he holds is at best only a feeble conductor of electricity and as such should stimulate corrosion to only a slight extent, if at all. He says that it is possible that these patches of manganese sulphide when they occur at the surface of the steel, or as they become exposed by the wasting of the steel, may become oxidized.

I submit that in the production of pure iron the manufacturers do not aim to make material containing patches, and it is this very patchwork condition which existed in the older, segregated, carelessly made steel which has had our most earnest effort in the overcoming. We believe that the consumers of this country are not in favor of patchwork metals, or metals containing patches of ingredients which may contribute to the wasting of the steel to however slight an extent. As a matter of fact corrosion is governed by a variable number of slight effects, all of which are important. Mr. Buck argues that this patchwork condition is due to the presence of sulphur and not to the presence of manganese. This is an ingenious truism such as the saying that it takes two to make a quarrel. I hold, however, that it is better to use the utmost endeavor to eliminate both the manganese and the sulphur, with the advantage on my side of the argument that it is an easier metallurgical accomplishment to effect the total elimination of manganese than the total elimination of sulphur. But Mr. Buck wants to eliminate sulphur to the highest degree possible, although he does not want to eliminate manganese.

In his comprehensive book "The Corrosion of Iron and Steel," Alfred Sang, on page 84, states:

> "Dr. Charles B. Dudley (for many years associated with the Pennsylvania Railroad) discovered some years ago that segregated manganese formed centers of corrosion, and it is a generally accepted fact that steels high in manganese are peculiarly liable to oxidation; if the proportion is small and uniformly distributed the effect is inconsiderable. The effect of manganese is corroborated by many reliable authorities."

Mr. Sang then proceeds to give a list of these authorities. It is true he points out that if the proportion is small and uniformly distributed the effect is inconsiderable, but Mr. Buck bears witness to the lack of uniform distribution within his range and deliberately admits a condition of isolated patchwork. To my mind no further argument seems necessary.

SULPHUR.

With regard to Mr. Buck's opinion about the influence of sulphur I am glad to say that I find myself for once in complete agreement with him, and feel no doubt that in his laudable drive against sulphur in the products under his charge he has been working in the right direction.

PHOSPHORUS.

With regard to phosphorus there is little accurate data as to its effect upon resistance to corrosion. In a paper delivered before this Institute some years ago I pointed out that nearly all the ancient irons which represent the survival of the fittest were remarkably pure with respect to every element with the single exception of phosphorus. However, I do not feel that any beneficial effect that it might possibly have has yet been proved in modern practice.

SILICON.

Mr. Buck claims that silicon present in the amount of 0.15 per cent and 0.30 per cent leads to a distinctly increased rate of corrosion.

I am not prepared to question the accuracy of this statement; it is in effect but one more argument for purity.

COPPER.

Mr. Buck states that it is quite generally conceded that if copper is properly added to molten steel to the amount of approximately 0.25 per cent the life of the steel under atmospheric conditions is greatly increased. This is, on its face, an incorrect statement. I do not concede it, and there are a great many investigators who have published in the technical press of the world who agree with me. In addition to this there is a great body of perfectly unbiased investigators who feel that the point has not yet been proven one way or the other. I do not hesitate to state that no such claim is justified on any basis of unbiased evidence. Mr. Buck says: "We have reached this conclusion from observations of copper-bearing steels after several years' exposure." I may reply to this that we have reached quite the opposite conclusion, and that we believe any improvement noted by Mr. Buck is due to a better degasification and less segregation than in the ordinary steels which he has been using for comparative purposes.

The statement that the rust formed on copper-bearing steel is dark brown, closely adherent and smooth, is only partially true. I have noted a number of test samples of copper-bearing steel which showed just such an excellent condition as Mr. Buck refers to, but on the other hand I have seen a great number of specimens of copper-bearing steel, especially those made in the acid processes, which show the limonite red, rough, loose and spongy character of rust to which Mr. Buck refers. Almost invariably the pure irons as free as it is possible to get them from copper show the dark brown, closely adherent, smooth surface which seems to be characteristic of all properly degasified basic open-hearth metal. Mr. Buck has stated that it is his belief that since copper is electro-negative to iron, when it is properly mixed and incorporated with it, it reduces the tendency to corrosion by lowering the difference of potential between the metal and the loosely adherent rust or oxide. If this is true, why, may I ask, does not silicon also in the amounts of from 0.15 to 0.30 per cent show a similar effect, since silicon is also a strongly electro-negative element? But as a matter of fact, as Mr. Buck claims, the addition of silicon in this range increases the tendency to corrosion. Such metallurgical arguments as these advanced by Mr. Buck cannot be accepted on their face, and when he sums up that the beneficial influence of copper in steel and iron is most marked under atmospheric conditions as well as under soil, water and other natural conditions, I must disagree with him, not only from the standpoint of the theories he has advanced, but also as the result of close application to the study of numerous carefully planned tests extending over a number of years.

I submit that, in spite of the fact that we are all forced into undertaking weather exposure tests of uncoated sheet metals, such tests are irrational inasmuch as no one uses any kind of iron or steel in an uncoated or unprotected condition, except in a few rare instances in which the conditions of service do not permit of protective coatings. If we are to make such irrational tests, however, I submit that the test pieces should not be pickled or sand-blasted or otherwise treated by special annealing or cold rolling, or by any other method, but should go on test as nearly as possible in the condition that a prospective customer would be likely to buy similar sheets. If any other method than this simplest one is followed a string of variables is introduced that could easily keep many of us so-called experts and our descendants arguing over the results until the crack of doom.

I submit also that 26 and 27-gage sheets are too thin to yield fair comparative results under varying weather exposure conditions. I have never been able to get even the cheapest and most ordinary steel sheets to rust through in the same length of time in which Mr. Buck's best analysis sheets failed, although I have had them out under very severe conditions of exposure. I am therefore led to the belief that the tests described are not conclusive.

At my original suggestion the Corrosion Committee A-5 of the American Society for Testing Materials is about to undertake a series of systematic weather exposure tests on large corrugated sheets of 16 and 22-gage iron and steel of all types now available in the open market. These sheets are not to be pickled and only a portion of the heavier gage are to be sand-blasted. Until these authoritative and unbiased tests can be reported on it is my belief that such sweeping claims as Mr. Buck has made in his paper are quite unjustified. My own opinion, based on what I consider the most reliable data yet available, is that in metals, as in food, purity is the safest criterion of excellence.

ACKNOWLEDGMENT.

The foregoing data were abstracted from the discussion of Daniel M. Buck's paper, "Recent Progression in Corrosion Resistance," presented before the recent meeting of the American Iron and Steel Institute, in New York.

BUILDINGS

Some Provisions of the Illinois License Law for Structural Engineers.

(Staff Abstract.)

In our issue of March 17, 1915, we published the provisions of a proposed act to provide for the licensing of structural engineers in Illinois. This act, somewhat modified, was passed at the last session of the Illinois legislature; but as it was not signed by Gov. Dunne until after July 1 there is some doubt as to whether the act becomes effective at once or does not take effect until July 1, 1916. The principal changes in the act as originally introduced refer to the definition of structures and structural engineers. These are defined in the act as passed, as follows:

> Structures within the meaning of the act shall be construed to mean all structures other than buildings, having as essential features foundations, columns, girders, trusses, arches and beams, with or without other parts, and in which safe design and construction require that loads and stresses must be computed and the size and strength of parts must be determined by mathematical calculations based upon scientific principles and engineering data.
>
> And any persons who shall be engaged as principals in the designing and supervision of the construction of structures or the structural part of structures designed solely for the generation of electricity, or for the hoisting, cleaning, sizing or storing of coal, cement, sand, grain, gravel or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces, rolling mills, gas producers and reservoirs, water works, sanitary works as applied to the purification of water or plants for waste and sewage disposal, or roundhouses for locomotives, railroad shops, pumping or power stations for drainage districts, or power houses, shall be considered as structural engineers within the meaning of this act, and shall be entitled to the benefits of these provisions, even though such structures may come under the definition of "buildings" as defined in an act to provide for the licensing of architects and regulating the practice of architecture, in force July 1, 1897.

The act provides that the Governor appoint a "State Board of Examiners of Structural Engineers," composed of five members, one to be a professor in the Civil Engineering Department of the University of Illinois, and the other structural engineers of recognized standing who have had not less than ten years' practical experience and who at the time of their appointment are practicing as structural engineers in the state. Two of the members are to hold office until Jan. 31, 1917, and the other three until Jan. 31, 1919.

LICENSE BY EXAMINATION.

At least two examinations are to be held each year for those desiring to practice structural engineering. Each applicant for an examination is required to pay a fee of $20 and to present an affidavit that he is at least 21 years of age. Each applicant must sustain a satisfactory examination in the design and construction of buildings and structures according to scientific principles and with reference to strength and safety, covering the strength and properties of various building materials and the principles of theoretical and applied mechanics. He must also show his ability to apply his knowledge to the ordinary requirements of structural engineering in such manner as to fairly and thoroughly test his competency to practice structural engineering. Each applicant shall show: (a) that at the time of taking effect of this act he was actually engaged in the practice of structural engineering in this state, and did not apply for a license under Section 5 of this act, in which case the applicant shall be entitled to an examination without regard to the number of years he has practiced; or (b) that within ten years next prior to his application he has practiced structural engineering in some state or territory of the United States, or in some foreign country, for not less than six years, during at least two full years of which period he shall have been in responsible charge of work, as principal or assistant; or (c) that within ten years next prior to his application he has pursued a course of study and training in the theory and practice of structural engineering for the period of not less than six years in the employ or under the supervision of one or more practicing structural engineers, during at least two full years of which he has been in charge of work in designing or construction. Applicants who have graduated from a college or school of engineering considered by the board to be in good standing and requiring a course of study of not less than four years, shall be credited two years upon the six-year period required above.

If the result of the examination be satisfactory to a majority of the Board, under its rules, the secretary shall, upon further payment of $30, issue a license to practice structural engineering in Illinois.

LICENSE WITHOUT EXAMINATION.

Section 5 provides that any person who shall by affidavit or other proof show to the satisfaction of the State Board of Examiners that he was a resident of and engaged in the practice of structural engineering in the state on the date of the taking effect of this act shall be entitled to a license without examination, provided such application shall be made within six months after the taking effect of this act. Upon the payment of a fee of $50 the secretary of the Board may issue to such a person a license to practice structural engineering.

Section 6 provides that the State Board of Examiners may in its discretion issue a license, without examination, upon payment of a fee of $50 to a structural engineer licensed under the laws of any other state or territory of the United tates, or any foreign country, provided it appears to the Board that in such state or country the license requirements are equal to those prescribed in this state.

The act further provides that no corporation shall be licensed to practice structural engineering, but it shall be lawful for them to furnish to others engineering plans, drawings and specifications for supervision of the construction of buildings and structures, provided the chief executive officer or managing agent in Illinois shall be a structural engineer licensed under this act. It shall be lawful for one or more licensed structural engineers to enter co-partnership with one or more architects licensed under the laws of Illinois for the practice of their profession.

EXEMPTIONS AND ANNUAL FEE.

This act shall not be regarded as applying to draftsmen, students, clerks of work, superintendents and other employes of structural engineers, so long as they work and act under the instructions, control, direction and supervision of their licensed employers; superintendents of construction of buildings and structures employed and paid by the owners, provided they act under the supervision and control of a licensed structural engineer; persons licensed to practice architecture in this state. Nothing contained in this act shall be construed to prevent any person from making plans and specifications for any building or structure that is to be constructed by himself or his employes, and for his own use.

It shall be the duty of the state building commissioner, or the building commissioner of any city, town or village, to issue permits for building construction to any owner or his agents upon filing of a true copy of the plans, drawings and specifications for the construction, and a certificate signed by the licensed structural engineer who executed them certifying under his seal that said plans and drawings are in accordance with the state building code, or the building code of such city, town or village, as the case may be.

Every licensed structural engineer in this state shall pay an annual fee of $10.

REVOCATION AND RESTATEMENT.

Any license may be revoked by a four-fifths vote of the State Board of Examiners for gross incompetency; or recklessness in the construction of buildings or other structures; or for fraudulently affixing his seal to plans or specifications; or for any dishonest practice or practices on the part of the order thereof; or for fraud in obtaining his license; or practicing without payment of the annual license renewal fee.

The board shall have power to entertain and grant for good cause petitions to vacate its orders revoking licenses and reinstate such petitioner to practice in this state, and to adopt rules and regulations governing the requirement and hearing of such petitions, provided that at least one year shall intervene between the date of the entry of the order revoking a license and the filing of such petitions in cases involving gross incompetency, recklessness, dishonest practices or fraud. Every petitioner shall pay a fee of $10 in advance. A majority vote of the board shall be sufficient to reinstate such petitioners to practice.

The Reinforced Concrete and Brick Roundhouse of the Buffalo, Rochester & Pittsburgh Ry., at Dubois, Pa.

(Staff Article.)

The roundhouse built for the Buffalo, Rochester & Pittsburgh Ry., at Dubois, Pa., is an interesting example showing the development which has taken place in roundhouse construction in recent years. The structure contains sixteen 103-ft. stalls, and is served by a 90-ft. deck turntable. With the exception of the doors and windows the roundhouse is of fireproof construction. The columns, girders, beams and roof slab are of reinforced concrete; the floors, pits and the wall and column foundations are of concrete; and the walls are of red brick. The structure is founded on wood piles, driven to refusal. An overhead electric crane of 15 tons capacity runs through the central bay of the house, from end to end, being used mainly for lifting engine parts. The house is heated by the fan system, the equipment being located in a small brick addition to the main structure, the air being forced through underground ducts into the engine pits. Lighting is effected by bull's eye reflectors and by clusters of lights. Each stall is furnished with connections for hot and cold water and with air and gas lines. The plant comprises a boiler washing system with a capacity of six engines in 24 hours. A concrete sump and an automatic electric centrifugal pump take care of the roof and pit drainage. Figure 1 is a foundation plan of the roundhouse indicating the general arrangement of the plant. The new structure is located directly opposite the old 16-story roundhouse, which is too small for large locomotives, but is still used for smaller engines. Both houses are served by one turntable.

STRUCTURAL FEATURES OF BUILDING.

In designing the roundhouse an allowable stress of 16,000 lbs. per square inch was used for the steel in tension and 500 lbs. per square inch for the concrete in compression. In addition to the roof loads the interior columns carry an electric crane.

Each stall has an over-all length of 105 ft. 0 in., and a width which varies from 15 ft. 1 5/16 in. between center lines of columns at the rear end to 32 ft. 4 9/16 ins. between centers of brick pilasters at the front end. Figure 2 is a longitudinal section of a typical stall, the section being taken along the center line of the track. The main roof beams are carried on reinforced concrete columns, except those which end at the front wall; these beams are supported on 17-in. brick pilasters. The thickness of the front brick wall, except at pilasters, is 13 ins., while the brick walls at the ends of the roundhouse have a thickness of 13 ins., except at the pilasters.

Engine and Drop Pits.—The engine pits have a length of 76 ft., a width of 4 ft., and a depth varying from 2 ft. 6 ins. at the center to 3 ft. at the ends (to provide for drainage). The rails rest on 8x12-in. creosoted yellow pine timbers, which are anchored to the concrete side walls with 7/8-in. bolts, 24 ins. long. The bottom of each pit is reinforced with old 80-lb. rails, in sections 8 ft. 6 ins. long, these rails being spaced 4 ft. on centers. Other details of the engine pits are shown in Figs. 2 and 3 (a).

Three of the stalls at one end of the roundhouse are provided with drop pits, as noted in Fig. 1. These pits are lighted with electric lamps, which are recessed in the concrete. Details of these drop pits are shown in Figs. 2 and 3 (b).

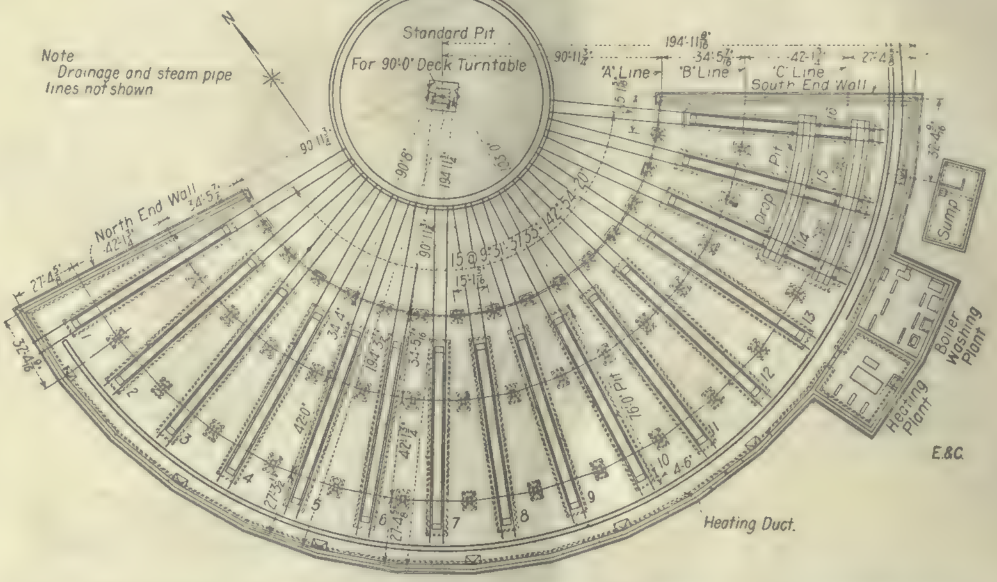


Fig. 1. Foundation Plan of Buffalo, Rochester and Pittsburgh Ry. Roundhouse at Dubois, Pa.

Floor of Roundhouse.—Between tracks the engine house floor consists of a 6-in. slab of 1:3:6 concrete, reinforced with No. 25 triangular mesh. This slab rests on an 8-in. layer of cinders. Figures 3 (a) and 6 show details of this floor. A 12-in. concrete slab spans the heating duct, which is along the outside wall of the roundhouse.

Footings and Pedestals.—The footings for the rear line of columns of the roundhouse are 5 ft. square and 2 ft. thick, each footing resting on four wood piles. Surmounting the footings are pedestals, 2 ft. square at the top, 4 ft. square at the base, and 6 ft. high.

The footings for the two interior lines of columns are 5 ft. x 7 ft. 6 ins. x 2 ft. high, and the pedestals are 4 ft. x 6 ft. 6 ins. at the base, 2 ft. 6 ins. x 3 ft. 6 ins. at the top, and 6 ft. high. The footings are reinforced in both directions with 1-in. twisted square bars spaced 6 ins. on centers, while the connection between the columns and pedestals is secured by means of 1-in. stub bars 4 ft. long, these bars projecting 2 ft. above the top of the pedestals. A 1:3:6 concrete is used in the pedestals and footings. Figure 4 gives the details of the foundations for the rear line of columns.

The foundation for the front brick wall, which is 5 ft. 3 ins. wide at the base, is supported on two lines of piles. These foundations extend 9 ft. 1 in. below the floor line. Figure 2 gives details of these foundations.

Roof.—Figure 5 is a roof plan of the two stalls at the west end of the roundhouse. This drawing, and that of Fig. 2, show the typical arrangement of the roof framing. The roof is of beam-and-slab construction. For the central bay the beams have a span of 42 ft. and are 4 ft. 9 ins. deep by 18 ins. wide; they support a roof slab 6 ins. thick. For the rear bay the beams have a span of 27 ft. 3½ ins., a depth of 2 ft. 10 ins., a width of 14 ins., and support a roof slab 5 ins. thick. For the front bay the beams have a span of 34 ft. 4 ins. and are 3 ft. 2 ins. deep by 16 ins. wide, the thickness of roof slab being 5 ins. Figure 6 shows details of the beams and roof slab which span the central bay and of the supporting reinforced concrete columns.

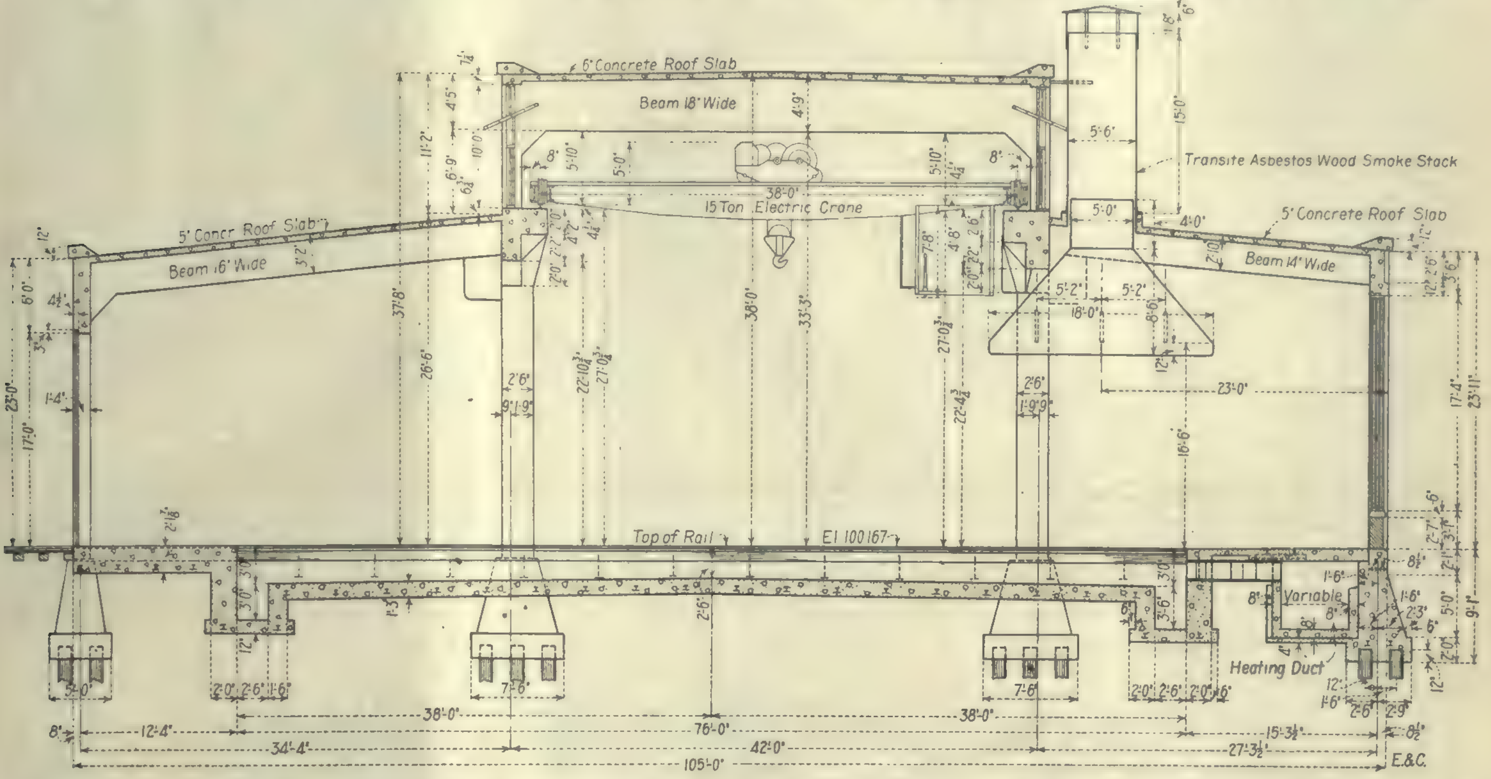
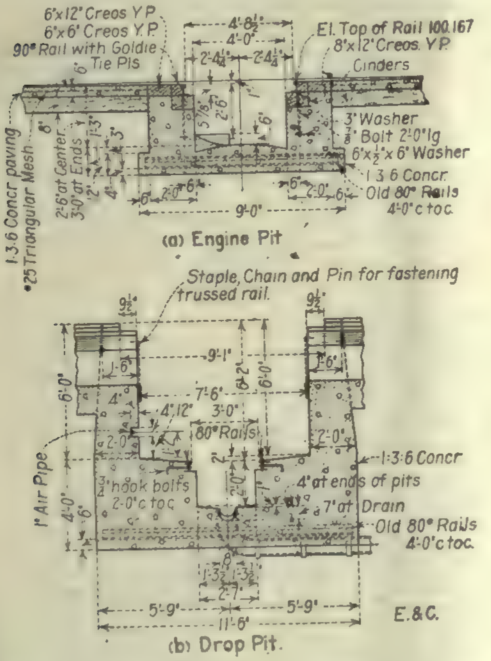


Fig. 2. Longitudinal Section of a Typical Stall of B. R. & P. Ry. Roundhouse at Dubois, Pa.



(a) Engine Pit

(b) Drop Pit.

Fig. 3. Cross Sections of Engine Pit and Drop Pit of B. R. & P. Ry. Roundhouse.

The roof slab was waterproofed as follows: The concrete was first coated with "J-M" asphalt concrete coating to form a bond between the concrete and the asphalt. Its surface was then mopped with "Ajax" asphalt cement, heated to flow freely, and while hot there were embedded in it three plies of No. 2 asbestos saturated "Ajax" felt, the entire surface between each ply being mopped with asphalt. The felts were so laid that 10½ ins. of each ply were exposed. The entire surface was then coated with "J-M" asphalt roof coating. It was specified the saturated asbestos felt should weigh not less than 14 lbs. per square, single thickness, and that there should be used not less than 60 lbs. of asphalt cement per 100 sq. ft. of roof surface.

Crane Girders.—To provide means of lifting heavy locomotive parts the central bay of the roundhouse is served by an electric crane having a span of 38 ft. and a capacity of 15 tons. The L-shaped concrete crane girders (for position see Fig. 2) carry 60-lb. rails, the latter being curved to conform to the curvature of the roundhouse. In addition, the crane girders support the ends of roof beams and are fitted with pipe and smoke jack hangers, as shown in Fig. 5. Girders G_2 have a length, center to center of columns, of 20 ft. 10 ins., while girders G_3 have a length of 27 ft. 10 ins. Figure 7 shows a plan, an elevation and a cross section of girder G_3. The rails are fastened to the concrete girder by means of U-bolts and rail clamps, as shown in the drawings. These L-shaped girders have a total width of 3 ft. 8 ins. and a total depth of 4 ft. 8 ins., the thickness of the horizontal flange being 2 ft. 6 ins. and that of the vertical flange 1 ft. 10 ins. The reinforcing details are clearly shown in the drawings.

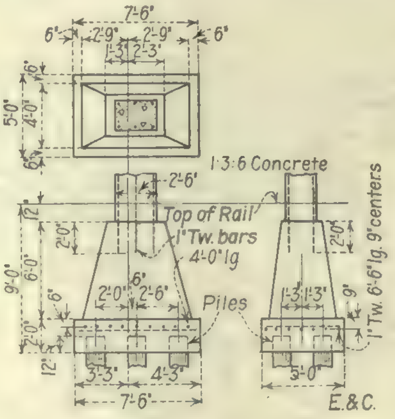


Fig. 4. Details of Typical Pedestal for Interior Lines of Columns of B. R. & P. Ry. Roundhouse.

Girders G_2 are somewhat similar to that shown in Fig. 7. These girders, however, have a total width of 3 ft. 8 ins. and a total depth of 4 ft. 2 ins. The horizontal flanges have a thickness of 2 ft., and the vertical flanges a thickness of 1 ft. 6 ins.

Columns.—The two rows of interior columns have a cross section of 1 ft. 10 ins. x 2 ft. 6 ins., and are heavily reinforced with vertical rods and with No. 0 wire hoops, closely spaced. The details of these columns are shown in Fig. 6.

The columns along the rear face of the roundhouse have a cross section of 16 ins x 18 ins. and are reinforced with four 1-in. square twisted bars and with No. 0 wire hoops spaced 12 ins. on centers.

Smoke Jacks.—The roundhouse is equipped with 19 smoke jacks, one in the front bay of each stall and one in each of the rear bays of the east three stalls. Figure 2 shows an elevation of a typical smoke jack and gives its position in the front bay. It will be noted that the center of the smoke jacks is 23 ft. from the outer face of the wall; those in the inner bays are also placed 23 ft. from the wall. The jacks are 8 ft. wide by 18 ft. long at the

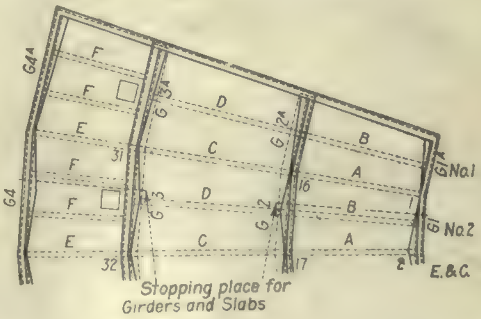


Fig. 5. Roof Framing Plan of Two End Stalls of B. R. & P. Ry. Roundhouse.

bottom and 5 ft. square at the top, with a smoke stack 5 ft. 6 ins. square extending 15 ft. above the roof. They are constructed of the Johns-Manville Co. ⅜-in. "Transite" asbestos wood.

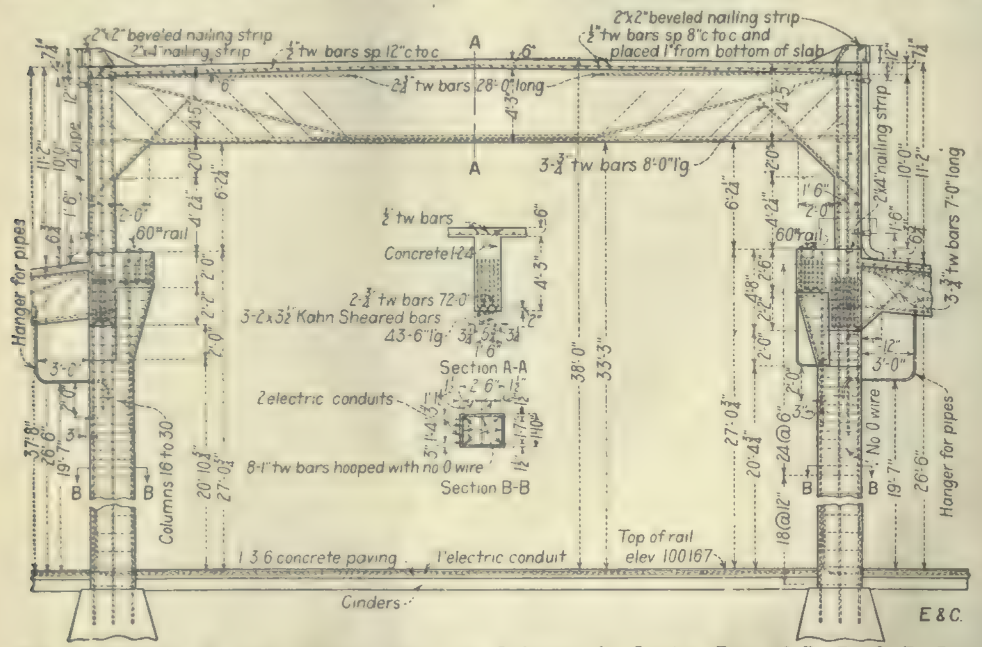


Fig. 6. Details of Roof Beam, Slab and Columns in Center Bay of B. R. & P. Ry. Roundhouse.

Doors and Windows.—Each stall is fitted with a double swinging engine door, and the west stall has an additional door in the outer wall, to permit engines to pass through this stall. Each section of these doors is 17 ft. 1½ ins. high by 6 ft. 11¾ ins. wide. The doors are constructed of white pine, the lower half consisting of 1¼ x 4-in. tongue-and-groove boards, laid diagonally, while the upper part consists of sash with 30 9 x 12-in. panes of glass. Six pairs of the engine doors are provided with "man" doors.

The front wall of each stall has a window area of 16 ft. 10 ins. x 21 ft. 6 ins., comprising 15 window units. The ends of the roundhouse are also fitted with windows. The windows in the rear brick walls are built in units, separate from the pilasters, so that in case of accidental collision of a locomotive with the brick wall the panel only will be damaged and the beams and girders of the roof will not be affected. The vertical area at each side of the central bay between the roof of the central bay and the roofs of the side bays are fitted with double transom sash 10 ft. high. The upper lines of sash are pivoted at the center to enable them to be swung.

CONSTRUCTION FEATURES.

Forms and Falsework.—Forms and falsework were made for four stalls, the forms being constructed of 2-in. plank. The system of forms and falsework used was completely detailed at the time the roundhouse was designed. Figure 8 is an elevation of the falsework showing the arrangement and size of each member used to support the forms. It was assumed in designing the forms that by the time the forms were placed for the fourth stall the concrete in the first stall would be set sufficiently to permit the removal of the forms from that stall to the fifth stall.

The forms for the roof slab were removed first by removing the supports from under the 2 x 10-in. joists (see Fig. 8), the roof boards being supported temporarily while these joists were being removed. The side forms for the beams and girders were then taken down by removing the bolts from the bracing. The bottom forms for the beams and girders were next removed by loosening the wedges gradually and taking down the sub-bents. After all of the forms were removed from the beams and girders the 8 x 16-in. timbers were removed from the top and bottom of the towers and the towers then moved sideways, placed on rollers, and rolled on 8 x 16-in. timbers through the adjoining stalls to their new location.

Concreting.—The specified concreting procedure for each stall was as follows (see also

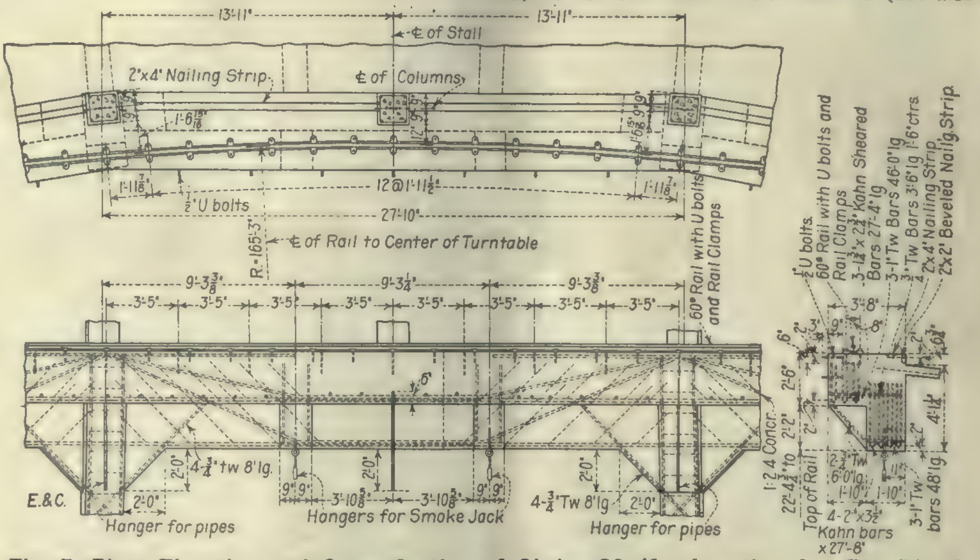


Fig. 7. Plan, Elevation and Cross Section of Girder G3 (for Location See Fig. 5.) of B. R. & P. Ry. Roundhouse.

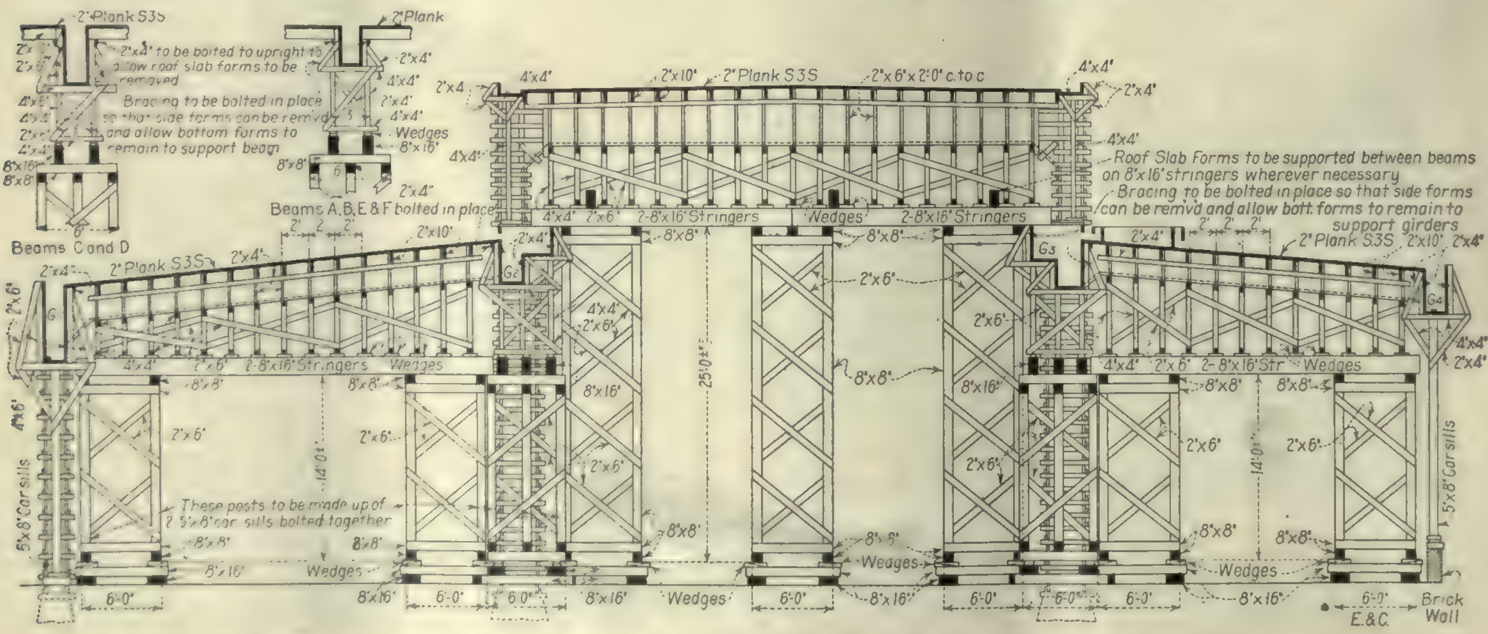

2" Plank S3S
2"x4" to be bolted to uprights to allow roof slab forms to be removed
Bracing to be bolted in place so that side forms can be removed and allow bottom forms to remain to support beam
8"x16"
8"x8"
Beams C and D
2" Plank
2"x4"
4"x4"
Wedges
8"x16"
Beams A, B, E & F bolted in place
2"x10"
2" Plank S3S
2"x6"x2'-0" c to c
4"x4"
2"x4"
Roof Slab Forms to be supported between beams on 8"x16" stringers wherever necessary
Bracing to be bolted in place so that side forms can be removd and allow bott. forms to remain to support girders
2-8"x16" Stringers
Wedges
G3
G4
G
25'-0½"
14'-0"
2"x6"
8"x8"
8"x16"
These posts to be made up of 2 5"x8" car sills bolted together
5"x8" Car sills
6'-0"
Brick Wall
E.&C.

Fig. 8 Details of Falsework and Forms for Typical Stall of B. R. & P. Ry. Roundhouse at Dubois, Pa.

Fig. 5): After reinforcement is placed pour continuously column No. 1 up to girders G_{1a} and G_1; also pour continuously columns Nos. 16 and 31 up to the bottom of the brackets on girders G_{2a}, G_2, G_{3a} and G_3. Then pour continuously girders G_{1a}, G_1, G_{2a} and G_2, up to the stopping point indicated in stall No. 2, and beams *B* and *A*, together with roof slabs from north end wall over beams *B* and *A* to the stopping point indicated in stall No. 2. Pour continuously girders G_{4a}, G_4, G_{3a} and G_3 up to indicated stopping point and the three beams *F* and beam *E* together with roof slab from north end wall over beams *F* and *E* to stopping point indicated.

The roof slabs are to be poured as a part of the supporting beams.

The forms for the upper part of columns Nos. 16 and 31, the sub-columns supporting beam *D* and beams *D* and *C*, together with the roof slab, should be in readiness to erect as soon as girders G_{2a} and G_{3a} are poured.

As soon as these forms are erected pour continuously sub-columns, beam *D*, upper part of columns No. 16 and 31, and beam *C*, together with roof slab from north end wall over beam *D* to a point on beam *C*, as noted in Fig. 5.

Side forms for columns, girders and beams and forms for roof slabs are to be removed in about one week after the concrete is placed, to allow free circulation of air, if the concrete is set sufficiently; and all forms may be removed after two weeks have elapsed if the concrete is found to be sufficiently set when inspected.

PERSONNEL.

The roundhouse was designed by the engineering department of the Buffalo, Rochester & Pittsburgh Ry., E. F. Robinson, chief engineer; W. F. Pond, office engineer, in conjunction with F. J. Harrison, superintendent of motive power and W. J. Knox, mechanical engineer. It was constructed by the railway company forces, under the supervision of G. H. Stewart, master mason.

Some Provisions of Revised Sections of the New York Building Code.

(Staff Article.)

On July 6 the Board of Aldermen of New York City adopted three important sections of the revised building code, these sections relating to masonry, fireproof construction, and reinforced concrete. As has been previously noted, the New York building code is being revised and adopted, section by section; it having been found that better results can be obtained by this procedure than by the framing and adoption of a code in its entirety.

The provisions of the section relating to walls differ considerably from those contained in the old code. As now revised the code permits the use in walls of hollow blocks of tile or concrete or equal terms (as to wall thickness) with brick. In buildings of skeleton construction hollow-block walls may be used for all heights, but in other types they are limited to buildings having heights not to exceed 40 ft. If used for exterior surface the blocks must be extra hard burned or veneered, or coated with a ¾-in. cement stucco on metal lath or studs. An important change permits the use of 12-in. curtain walls for the entire height of skeleton buildings. In residences the minimum thickness of both outside and inside walls is 8 ins.

As regards fireproofing, all types are admitted. A 2-in. thickness of covering is required, except at the edges of column brackets or lugs which may extend to within 1 in. of the surface of the fireproofing. No pipes or wires are permitted in the protective covering.

For floor and similar constructions a stress of 500 lbs. per square inch is permitted for stone concrete and tile, and 300 lbs. per square inch for cinder concrete. Partitions of tile or gypsum block 3 ins. thick, and those of solid cement or gypsum plaster 2 ins. thick, are allowed.

In reinforced concrete beams the stress is limited to 650 lbs. per square inch, and the direct compression to 500 lbs. per square inch; but over the supports of continuous beams the unit stress may be 15 per cent higher. In columns the allowable stress in the vertical steel is 7,500 lbs. per square inch and that in the concrete 500 lbs. per square inch; the added capacity per square inch of concrete for hooping is obtained by multiplying the percentage of hooping by 2¼ by its unit stress.

ROADS AND STREETS

Method of Striking Off Wide Concrete Street Pavements and Those Having a Varying Crown.

Contributed by H. Colin Campbell, 6536 Kenwood Avenue, Chicago, Illinois.

Sometimes a contractor is called upon to place concrete pavement on a short stretch of very wide pavement where the construction of a satisfactory strikeboard to span the full width would cost more than the size of the job warrants. An instance of this kind occurred at Chrismann, Ill., where the following method was successfully used, and the plan may be easily modified if necessary.

Assume the pavement to be either one or two-course construction, reinforced, and with steel-protected joints placed from 25 to 30 ft. apart. Figure 1 assumes the pavement completed to the joint at *AF*, the installation bar removed and mixer in the position *M*, work progressing in the direction shown by arrow *C*. At the points D and E, midway between the joint *AF* and the position of the next joint *BG*, stretch a string from curb to curb. Drive a row of 2x2-in. oak stakes of correct length (depending on the kind of subgrade) along the line *DE* and spaced 5 ft. apart, center to center. Drive these stakes with their top 2 ins. above the grade of the finished pavement as determined by the use of a set of three sighting T's. The amount that the top of the center T must be dropped in order to set the stakes at the proper elevation for each point can be calculated, or obtained by stretching a chalk line from end to end of one of the installation bars provided for the job, first measuring from the line to the center of the bar to see that its crown is correct and then measuring ordinates from the line to the bar every 5 ft. along the line. These ordinates plus 2 ins. must be subtracted from the amount of the crown and this remainder used as a guide to set each stake to the proper elevation. Set the two stakes next to the curb at *D* and *E* first, at the proper elevation, and use them to support the two plain sighting T's when setting each of the other T's in the line *DE*. Figure 2 suggests the construction for the center T, which will allow the top to be dropped the predetermined amount for setting each stake.

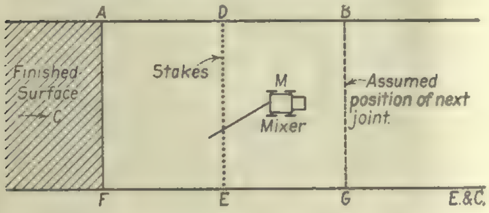


Fig. 1.

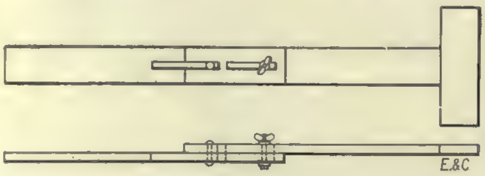


Fig. 2.

Having driven this line of stakes to the proper elevation, proceed to place the first course of concrete and reinforcement, carrying it several feet past the line of stakes toward *BG*. This first layer will, of course, be kept down below the tops of the stakes an amount equal to 2 ins. plus the thickness of the wearing course. If the workmen are not expert at leveling off the concrete it will be of advantage to drive as many stakes as are necessary in the area *ADEF* to be used simply as a guide to placing the concrete to the proper thickness. These of course can be pulled out as concrete is placed.

Across the top of the stakes in the line *DE* nail 2x4-in. lumber with the 4-in. side flat. It is preferable to use 2x4's of a length equal to one-half the width of the street, as the long pieces will curve more readily to the crown of the street than will shorter ones. A *lap* joint should be made over a stake to make close joints over which the strikeboard will ride.

Next commence placing the top course at one side of the pavement, say at *AD*, striking off, as placed, from *AD* to *FE*. Figure 3 shows the type of strikeboard which will be used. The operation of striking off is as follows: One man holds the strikeboard at the *B*-end (Fig. 1) and stands facing the joint *AF*, working the straightedge with both hands. Another man standing at the right of the joint *AF*, and facing the curb *AD*, works the straightedge with one hand. The straightedge is given a sawing motion, backward and forward, at the same time it is being moved ahead toward *FE*. As the workman at the *A*-end is always walking backward, his tracks in the concrete will be filled in by the material being struck off.

Two men spreading concrete from the bucket also keep the material correctly distributed in front of the straightedge and care must be exercised to see that there is always a small surplus heaped against the board, sufficient to fill in all low places. Note that as the "screed" is nailed to the top of the stakes, which are driven to 2 ins. above grade, its lower face is above the surface of the pavement and therefore does not tend to form a line of weakness in the pavement such as would be caused if it were allowed to be embedded with its top face level with the surface.

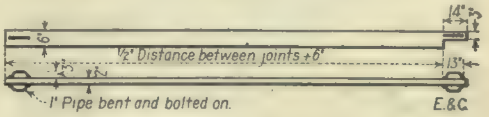


Fig. 3.

Assume that the area *ADEF* has not been struck off. Next place concrete to within 2 or 3 ft. of *BG*, then place the joint with its installing bar (joint having been prepared as noted below) and place concrete for the entire thickness of the pavement and reinforcement 2 or 3 ft. past the joint. Strip off the installing bar and strike off the pavement as before, reversing the strikeboard, end from end, resting the notched end on the "screed" and the other end on the joint, taking care to see that the footmarks of the men working the end of the board at *DE* are always filled up.

Very particular care should be exercised by the workmen to see that footmarks in the top surface are completely filled with good dense concrete and not with fine "soup" and water. If the latter happens there is a likelihood that a small stony pocket will be left in the surface at these places when the water evaporates. Even if this is not the case, the fine material at this spot will not wear as well as the remainder of the pavement and later may cause a hole to develop.

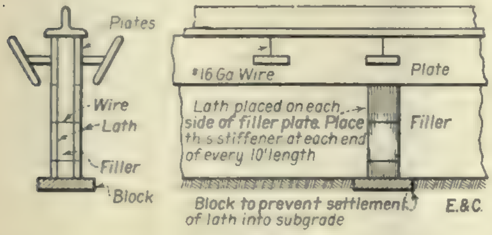

Plates
Wire
Lath
Filler
Block
#16 Ga Wire
Plate
Lath placed on each side of filler plate. Place th s stiffener at each end of every 10' length
Filler
Block to prevent settlement of lath into subgrade
E.&C.

Fig. 4.

After the section is struck off the "screed" and stakes are removed by a man working from a bridge, the holes are filled and the surface leveled off, if necessary, with a small straightedge about 5 ft. long.

If the width of the street and the size of the job do not warrant the construction of a bridge to span the whole street, 1x12-in. boards may be placed along the center line to support the ends of two bridges, each half the width of the street in length. These 1x12-in. boards should be cut to about 6-ft. lengths so that as the bridges are alternately moved ahead they can be removed and any marks left by them floated out at once.

Figure 4 shows a means of stiffening the felt filler of the joint at the center, ends, quarter points and other places if necessary, of the pavement, so that it will bear the weight of the strikeboard without sagging. The pieces of lath shown should be wired tightly to the felt and fit snugly up against the lower edge of the plates. In addition, the protection plates should, of course, be made to conform exactly to the proper crown of the pavement and should be wired together at the top edges with No. 16 gage malleable iron wire every 12 ins. along their length.

The above described method is applicable to any width of pavement. The method described below is applicable to pavements up to about 35 ft. in width, and is especially applicable to those pavements which are laid out with a variable crown; that is, pavements in which the crown increases from summits to inlets in order to provide for gutter drainage where the ground is flat and the center line of the pavement must be given a flat grade.

Before placing concrete a line of stakes is driven along the center line of the pavement 4x5 ft. apart with the top of the stakes 2 ins. above the top surface of the finished pavement. Concrete with reinforcement is then placed to approximately the proper thickness and a 2x4 lightly nailed to the top of the stakes as in the foregoing method described.

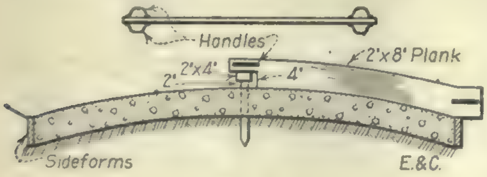


Fig. 5.

Figure 5 shows a strikeboard cut to conform to the pavement crown as noted below, for use if the pavement is not provided with curbs where the side form can be used to guide the outer end of the strikeboard and the 2x4 mentioned above is used to guide the inner end.

If curbs are provided and are such that the exposure of the curb face varies from summits to inlets, another guide strip placed at the gutter similar to the center guide strip as shown in Fig. 6 must be used. This strip must be set on a line parallel to the grade of the gutter. The strikeboard shown only strikes one-half of the pavement; two such strikes may be used or one used on each side of the pavement alternately. The strikeboard should be worked with a sawing motion.

For pavement with a variable crown having a maximum crown at inlets and a minimum crown at summits, the strikeboard should be cut to the average crown of the pavement. Runing the outer end of the strikeboard on the guide strip set parallel to the gutter grade will take care of the variable crown. Likewise the protection plates and installing bar for these pavements should be given the average crown. The installing bars and plates should be ordered in two sections, each section being of a length equal to one-half the width of the pavement. A connection for hinging the two half installing bars together is easily made by bolting a ½x1½x8-in. strap to one installing bar as shown in Fig. 7. The bars are connected after the joint is assembled in each and the bars placed in position by inserting a pin through the other bar. Enough space must be provided between bars at *A* to allow for setting the ends of each joint at the proper elevation.

Each installing bar is supported at the center by a device shown in Fig. 8, which can be made by any blacksmith at a small cost.

When ready to remove the installing bars, remove the nut and pull the frame, consisting of the two ½-in. bolts and cross bar. The clamp remains on the installing bar. The holes left by pulling the bolts are filled with concrete and floated over.

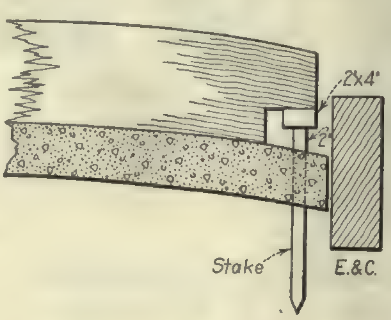


Fig. 6.

This method satisfactorily solves the problem of striking off a concrete pavement with a variable crown.

Patrol System of Road Maintenance and Repair in Pennsylvania.

(Contributed.)

State Highway Commissioner Cunningham has announced that on Aug. 1 the patrol system of maintenance would be established on State highway routes. Caretakers will be employed and each man will be assigned to a designated section of highway, for the maintenance and repair of which he will be held responsible. Altogether 190 men will be placed on this patrol work at the start and the territory covered will extend through 46 counties. These men will be paid at the rate of from 15 to 20 cts. an hour, depending upon the scale of wages for labor in their districts. This will mean an annual expenditure of $120,000 a year, which will figure down to a maintenance cost of $65 a mile a year for the state highways.

These patrol men will be directly under the County Superintendents. They will be required to make out a daily report of the number of hours they work and these reports will be collected by the County Superintendents, who will make out payrolls for the patrol men. As the County Superintendents have been supplied with light roadsters, as described further on, it will be possible for them to keep in close touch with these patrol men on the state highways and to ascertain whether or not the work is being done properly.

Each patrol man will be supplied with tools and equipment necessary for his work and each one will have a small red flag which he will be required to place in a conspicuous position on the road when, for any reason, he is required to leave the roadside during working hours. Hence, either the presence of the patrol man at work or of his flag, indicating temporary absence, will be noticeable during the working hours.

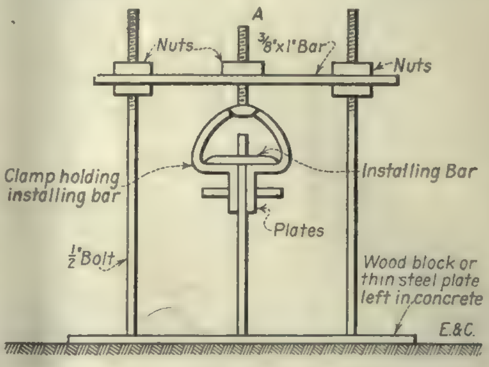

A
Nuts
3/8"x1" Bar
Nuts
Clamp holding installing bar
Installing Bar
Plates
1/2" Bolt
Wood block or thin steel plate left in concrete
E.&C.

Fig. 7.

Great care is being exercised in the selection of these patrol men and none but sober, honest and industrious men will be employed in these responsible positions. If it is found that the patrol men are neglecting their work, instant dismissal will follow.

The manner in which the caretakers will work is as follows: Along the side of the highway at frequent intervals will be placed small piles of stone chips and gravel, which will be used in patching holes as they are found in the roadway. Barrels, or drums, of bituminous material, containing approximately 45 gallons each, will be placed at intervals of from one-fourth to one-third of a mile along the roadside. When the caretaker finds a spot in the road which shows signs of wear, he will place the stones and bituminous material on it, tamping it down carefully and making the surface of the road smooth and even. The caretaker also will look after the edges of the road and will keep the berms clear of weeds and grass and will protect the shoulders of the road to prevent water from getting underneath. Each patrol man will be supplied with the following outfit: a small combination melting and pouring pot on wheels, a hand-pouring pot, an asphalt tamper, a wheel-barrow, a push brush, a pick, a short-handled and a long-handled shovel; a scythe and snath, a mattock, a rake, and a brush hook.

As these patrol men will be under the constant watch of the County Superintendent, it will be necessary for them to devote their entire time and attention to the territory to which they are assigned. It is the intention, ultimately, that no man shall have more than six miles of roadway to patrol and this only in sections where the character of the road is such that he can cover it easily and conveniently in a day. In mountainous districts, and in places where peculiar formations make the care of the road more onerous, the patrol distance will be diminished.

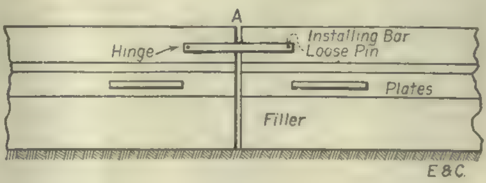


Fig. 8.

The following list of the general duties of the patrol men has been prepared by the State Highway Department and each man as he is engaged will be furnished with a copy of it and will have his duties explained to him in detail:

Keep drains and ditches open at all times.

Special attention must be given to defects in planking and condition of bridge floors.

Repair all defects in the surface of the road, maintaining same in a true and even condition.

Repair and whitewash guard rails.

Provide protection and red lights in cases of flood washouts, or other emergency conditions.

Remove brush from along the sides of the road, giving special attention to this condition at curves, approaches to railroad crossings, bridges, cross-roads, etc.

Keep the berms or shoulders of the road trimmed up, in that the surface water may be discharged freely from the road surface to the side ditches.

Remove all advertising signs from within the legal limits of the highway.

Paint and keep in first-class condition all department direction and warning signs.

Inspect culverts, head-walls, cribbing, retaining walls, etc., and report defects immediately to the superintendent.

Whitewash large rocks and the bases of poles on narrow sections of highway and at sharp curves (spring and fall); poles to be whitewashed to a height of six feet above ground.

All equipment, tools, and material placed in the charge of each caretaker must be accounted for by him at all times, and tools and equipment kept in thorough repair.

Economic and workmanlike results will be the most important factor recognized by the department.

Attention must be given to the entire section allotted to the caretaker, and work not confined to special and convenient portions.

Daily report postal card must be mailed every evening to the superintendent.

When working on the road, caretaker must have flag, which will be provided, displayed at all times near where work is being performed.

When conditions require additional help, team hire, or material of any character, permission must be first secured from the superintendent.

All additional help and team hire must be carried on foreman's daily report form, together with regular payroll form, etc.

All bills for material, etc., in amounts less than $10 must be covered by superintendent's purchase order; larger amounts by requisition of superintendent and department purchase order.

Caretakers are to be paid an hourly rate, and full value in service will be exacted for every dollar expended.

Caretakers must be courteous and considerate of the interests of the public at all times, and conduct themselves in a manner becoming representatives of the commonwealth.

Sobriety, honesty, industry, good character, and ability are the essentials required, and a failing in any of these will be met by dismissal.

The patrol system for the maintenance of highways is new in Pennsylvania but has been tried with great success in other states. Chief Engineer Uhler is an enthusiastic believer in this method. When he was Maintenance Engineer in the Maryland State Highway Department, prior to his employment by the city of Philadelphia as Assistant Engineer of Highways, Mr. Uhler inaugurated the patrol system in that state.

In connection with the patrol system the State Highway Department has inaugurated a system which will enable the County Superintendents to keep a closer watch on the work being done in their districts. By the dismissal of eighty general foremen, whose individual salaries were $85 a month and whose expenses averaged $15 a month, the sum of $8,000 a month is saved. These men worked for eight months in a year, consequently the total cost of their salaries and expenses to the State Highway Department was $64,000.

By the purchase of auto runabouts, with wagonette bodies, for the use of the County Superintendents, it will be possible for each superintendent to look after personally the work formerly done by the general foremen who have been dismissed. Ten runabouts have been purchased to test the efficacy of this plan and four of these ten have been delivered. They are equipped with the wagonette body which gives room to carry tools in the rear. The purchase price of each runabout is $440, with $25 added for freight, making the total cost to the Department $465. If, ultimately, 50 of these cars are purchased for the use of the superintendents, the total cost thereof will be $23,250, which, subtracted from the $64,000 saved in salaries and expenses of general foremen, leaves a balance in favor of the Department of $40,750.

Chief Engineer Uhler figures that the present traveling expenses of the County Superintendents, who, in many cases, are compelled to hire teams to take them over their districts, will more than pay for the operation and upkeep of the runabouts. But even more important than this is the increased efficiency of the working force which will be gained.

To prevent any possibility of the misuse of these cars and of others belonging to the State Highway Department, each car will be marked with a plate of white metal, embossed on which will be the coat of arms of the State with the words "Pennsylvania State Highway Department" in black enamel surrounding the shield.

The Cincinnati Pike is to be paved with brick for a distance of two and one-half miles from the Stroop Road to West Carrollton, O. The completion of this stretch will give a brick pavement from Dayton to West Carrollton.

A bill is to be introduced in the Georgia state legislature providing for the creation of a state highway commission, and will also advocate the construction of a number of state roads.

Diagram for Computing Quantity of Road Oil Required.

(Staff Abstract.)

The accompanying diagram is published by the Union Oil Co. of California. From it, knowing the gallons of oil per square yard required, one can read the gallons required per mile of road of widths from 10 to 30 ft. The method is: Follow the vertical line from "width of road" until it intersects the diagonal line from "gallons per square yard" and from the point of intersection follow the horizontal line to "gallons per mile."

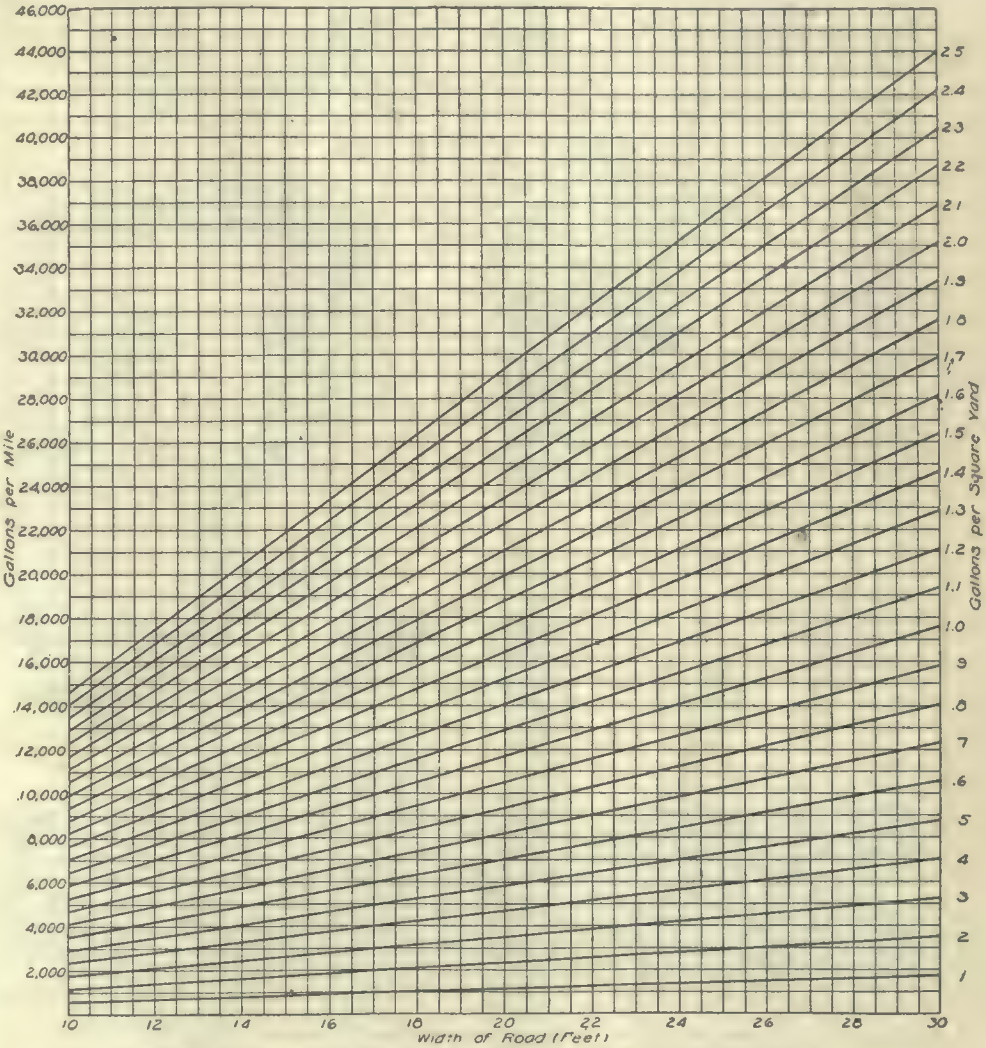


Fig. 1. Diagram for Computing Quantity of Road Oil Required.

Motion pictures showing the scenes along the Columbia River Highway are being made and soon will be shown all over the country. These films will be hand colored and are said to be part of a series of scenic reels to be made throughout the northwestern states.

Mortar Bed for Granite Block.—In the Borough of Manhattan, New York City, the use of a sand cushion for granite blocks has been abandoned. Under the 1915 specifications a mortar bed is used consisting of one part Portland cement to three parts sand, mixed almost dry. The blocks are just as readily brought to a proper surface by ramming as when the old sand cushion was used. The mortar hardens in a few weeks even under traffic. The great advantage of the mortar bed over the sand cushion is that surface water leaking through the joints of the blocks does not cause depressions in the surface, which was the case with the sand cushion, and the cost of maintenance is considerably reduced thereby. The above information is given by Eugene W. Stern, Chief Engineer, Commissioner of Public Works.

SEWERAGE AND SANITATION

Design Feature of New Sewerage System and Sewage Disposal Works for Cleburne, Texas.

Contributed by R. E. McDonnell, Consulting Engineer, Scarritt Bldg., Kansas City, Mo.

The city of Cleburne, Texas, is located in the north central part of the state, approximately 30 miles south of Fort Worth, and has a present estimated population of about 14,000. It is one of the principal division points on the Gulf, Colorado & Santa Fe R. R. With the exception of the railway roundhouse, car and repair shops, the city has no extensive manufacturing plants, but the surrounding country being an agricultural and grazing territory, it is quite an active trading center.

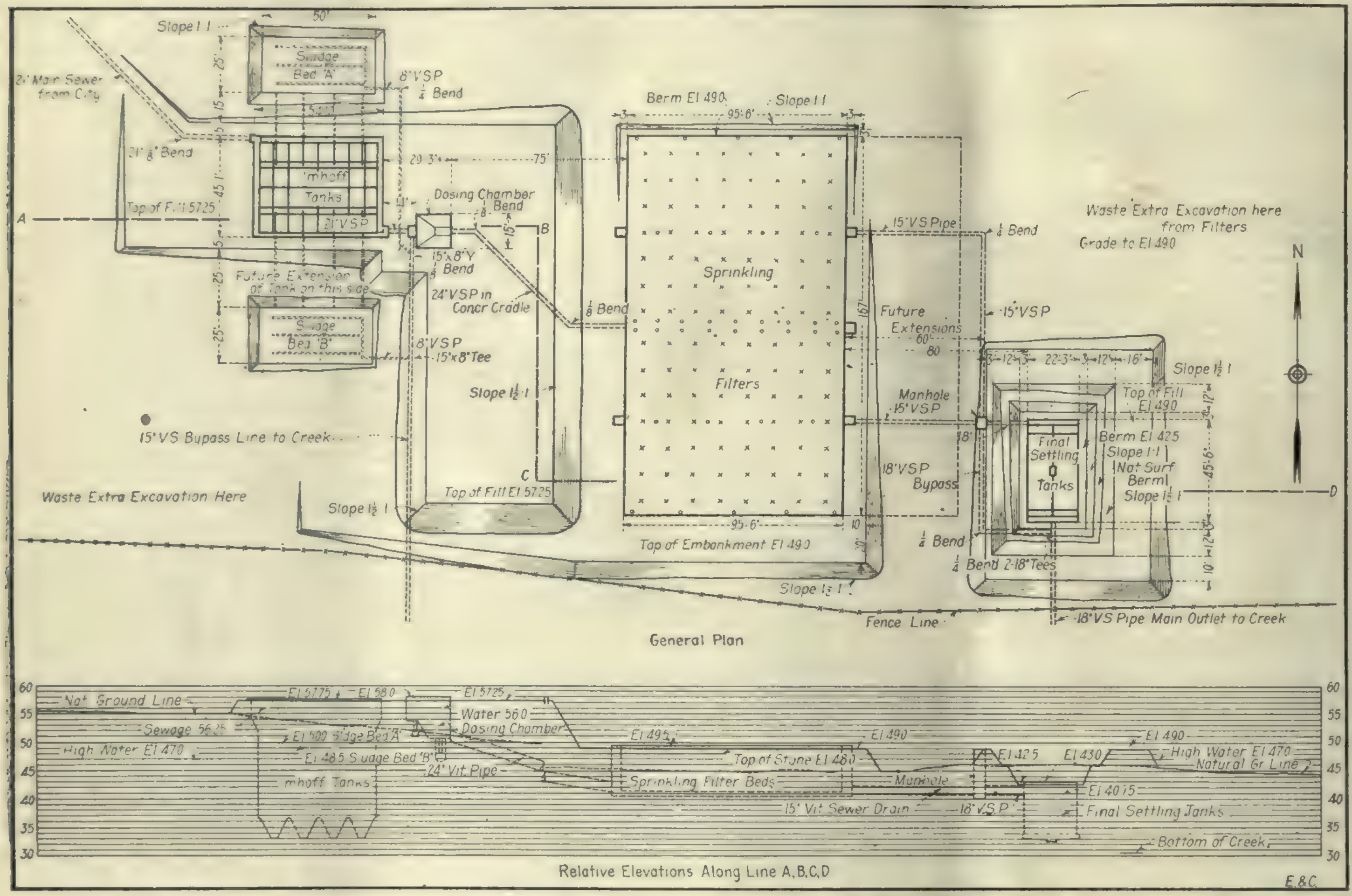


Fig. 1. General Layout and Diagrammatic Profile of New Sewage Disposal Plant at Cleburne, Texas.

Until about five years ago the city was far behind other cities of the same size in municipal improvements. Private corporations or individuals owned the water, light and sewer systems. The water works plant was in very poor condition, the supply insufficient, the mains too small and not serving the entire city, and as the plant was losing money not much could be done by the company toward making improvements and the necessary extensions required by the city's growth. About that time a progressive Mayor and City Council were elected and their first action was to employ consulting engineers to make an examination, inventory and appraisal of the water and sewerage systems and a report on the cost of new plans and improvements to the old. Bonds to the amount of $180,000 were voted and the water works plant was purchased at the engineer's appraised value of $129,000, and the balance of the bond issue was spent in increasing the water supply, pump station improvements and equipment and extensions to the mains. In the past three years the city has never been in danger of a shortage of water, the plant has been made to pay all operating expenses and the insurance key rate has been reduced over one-half.

In voting the water bonds the limit of bonded indebtedness, as provided by the special charter under which the city operated, was practically reached, and in order to proceed with the acquisition and extension of the sewer system, it was necessary to revise the charter to extend the limit of bonded indebtedness. As this required a special election and also a bill in the State Legislature, it has taken about two years to prepare for the sewerage system.

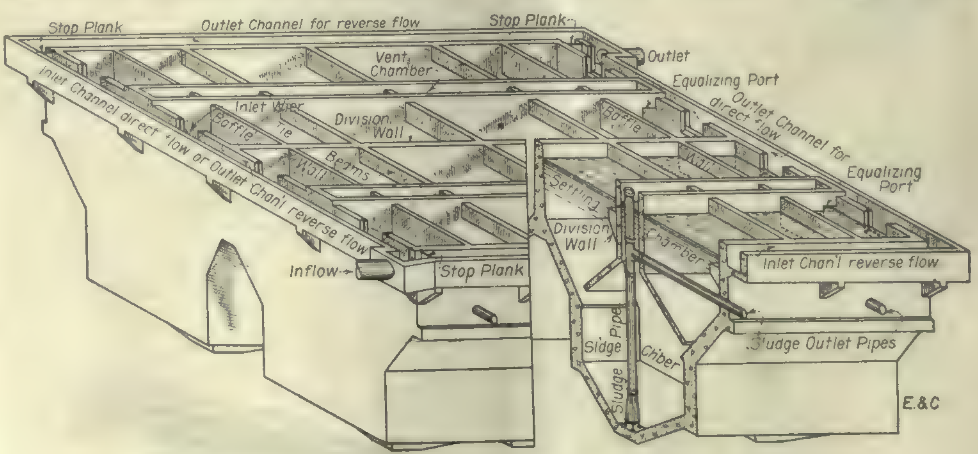


Fig. 2. Isometric View of Imhoff Tanks, Cleburne, Texas.

PRESENT SEWERAGE WORKS.

The present privately owned sewerage system consists of approximately 10.6 miles of vitrified sewer pipe, ranging in size from 4 to 15-in., having only 13 manholes, 2 flushtanks and about 50 lampholes and a disposal plant. The disposal plant consists of a Cameron septic tank for preliminary treatment, but on account of a tight clay soil over a rock formation, this was a failure. At present the effluent from the tank discharges directly into Buffalo Creek, a small stream with very little flow during dry weather and consequently the effluent does not have sufficient dilution below the outlet and the creek becomes very foul and obnoxious in the dry months. The plant is located on low ground along the creek and during rainy seasons is subject to overflow.

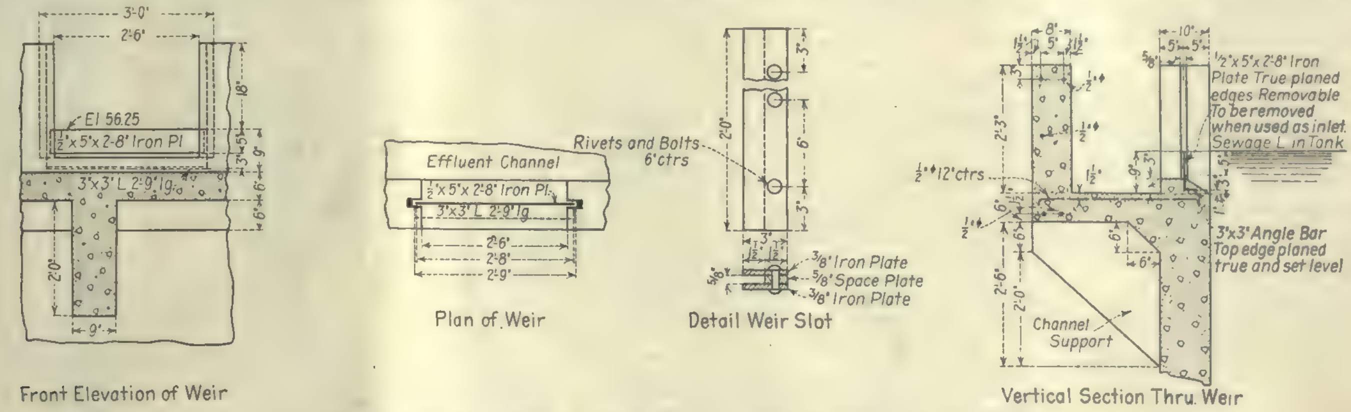


Fig. 3. Details of Weir Construction, Imhoff Tanks, Cleburne, Texas.

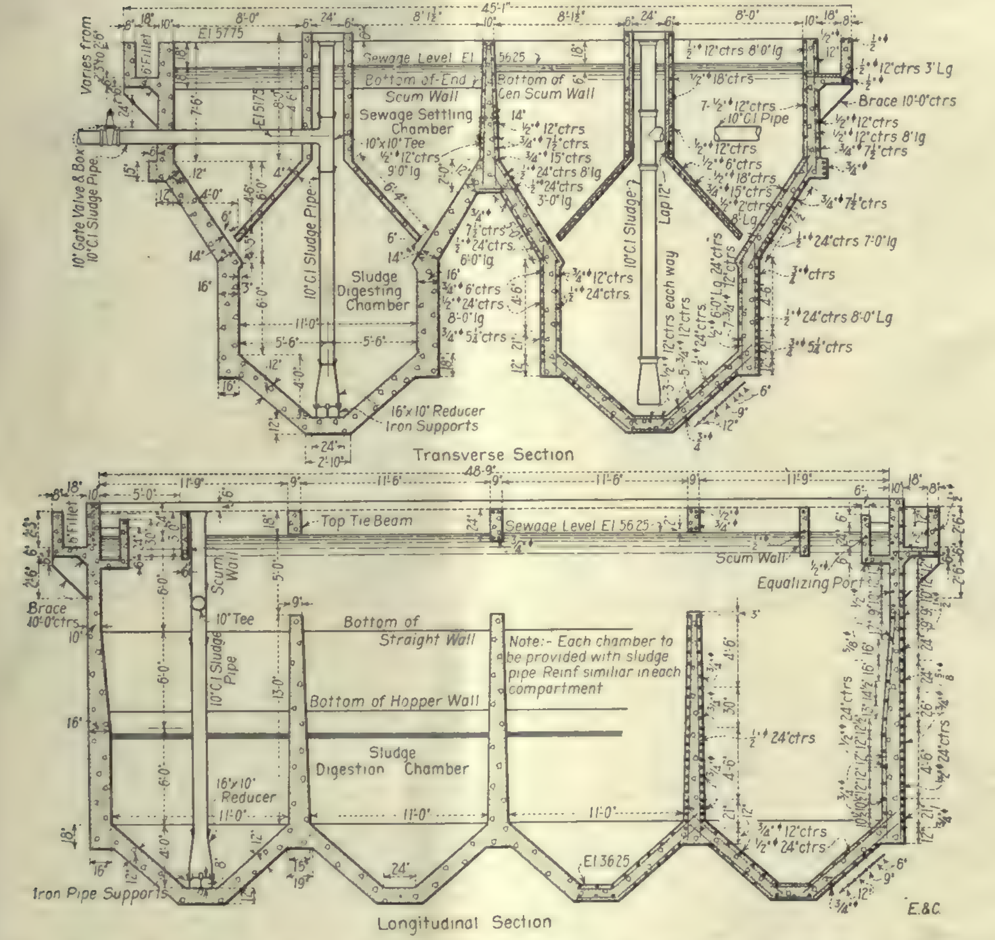


Fig. 4. Longitudinal and Transverse Sections Through Imhoff Tanks, Cleburne, Texas.

The sewer system proper was never planned on a comprehensive basis, having been constructed piecemeal. It consists chiefly of 4, 6 and 8-in. pipe, laid very shallow in many places with no provision for basement drainage and a large part with poor alignment and grade; very few manholes are provided in the system, and only two flushtanks, which are not now in use. A number of lines are without "Y" branches and as no regulations have been enforced as to manner of connection or usage, the lines have been cut into in a number of places for connections, cleaning out, etc., and one line, to which the gas plant is connected, is fouled badly with coal tar.

In appraising the old plant, those lines that could be incorporated and used in the new and more comprehensive system were given a value of the cost of reproduction minus the depreciation due to physical condition, and the lines that would have to be abandoned were allowed such salvage values as they might have, plus the value of the line as a revenue producer until a new line would parallel it and the old be replaced. The disposal plant, on account of its location and outfall lines, would have to be abandoned entirely and a number of lateral lines relaid deeper and larger especially to and through the business districts and in several other places where the depth and size would not have permitted extensions or drainage for existing basements. Inasmuch as there was such a large proportion of the system that the city would have to abandon or rebuild, the city and sewer company could not agree upon the amount for purchase of the old system. The city therefore voted $180,000 bonds for the construction of a complete new sewer system, including disposal plant.

NEW SEWERAGE SYSTEM.

The new sewer system has no special features as the general slope of the city from north to south is at about a 4/10 per cent grade. The main outfall sewer is a 21-in. vitrified clay pipe, laid on 1/10 per cent grade, giving a velocity of 2 ft. per second. No pipe less than 8 ins. in diameter is used and with a few exceptions 3/10 per cent grade is the minimum on the 8-in. lines. Manholes are provided at all changes of grade and in no case on the smaller lines are over 500 ft. apart. Through the business section the lines are deep enough to provide drainage for 8-ft. basements, but in the residence districts the average depth is approximately 5½ ft., as in this section of the country, with mild climates, very few of the residences are provided with basements over 4 or 4½ ft. deep below the ground surface. The excavation in the western half of the city will be in clay and limestone rock, but the eastern half has but very little rock excavation at the depths of the sewer lines. All of the lines lie practically above the normal ground water level.

The Texas Legislature passed a law in 1913 and amended it in 1915, requiring all cities, towns, corporations or individuals to purify all sewage before discharging into any stream or body of water that is used for farm, live stock, drinking and domestic purposes, and setting a date of January 1, 1917, as a limit, after which all offenders will be subject to fine. The State Board of Health

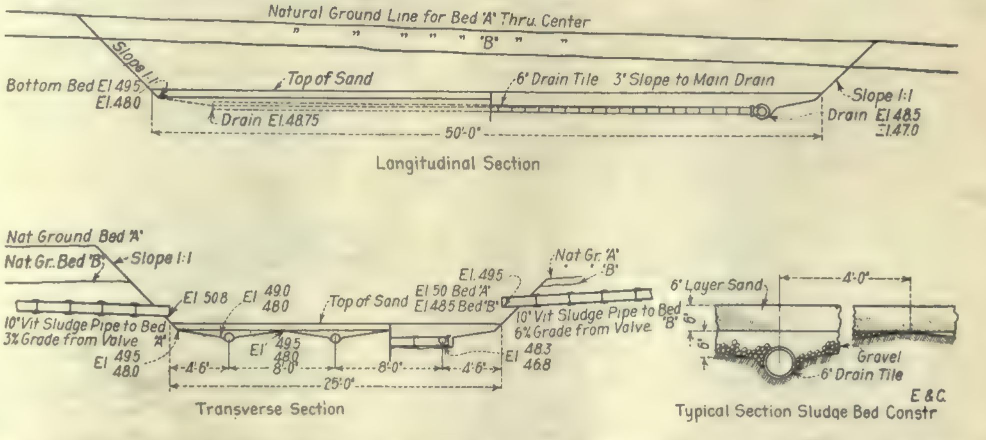


Fig. 5. Principal Sections of Sludge Drying Beds, Sewage Treatment Plant, Cleburne, Texas.

is authorized to make inspections and enforce the law and will, no doubt, rule in each individual case as to the degree of purification necessary.

NEW SEWAGE TREATMENT PLANT.

In view of the fact that the waters of Buffalo Creek are not used except for live stock watering purposes for a long distance below Cleburne, it was decided to install Imhoff tanks with sprinkling filters and final settling basins. From gagings and observations made on the flow in the present sewer system, and from the records of the daily water consumption, the plant was designed on a present basis of 800,000 gals. per day, with provision for extension and increase of 50 per cent of the original capacity, when necessary. The plant is shown in plan and in diagrammatic profile in Fig. 1.

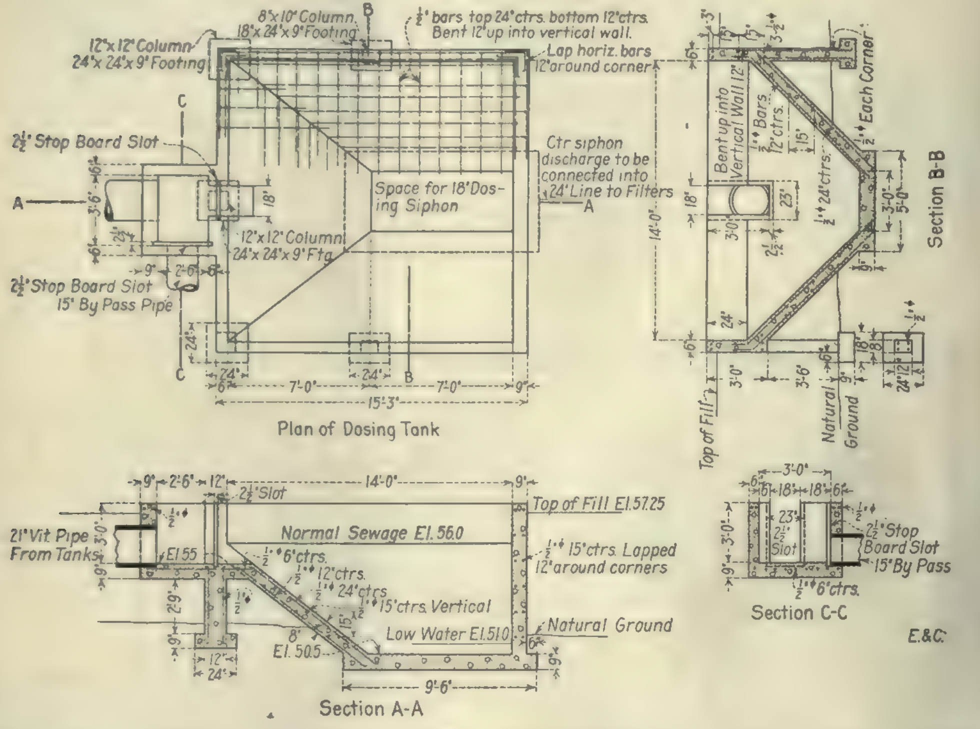

8"x10" Column, 18"x24"x9" Footing
½" bars top 24" ctrs. bottom 12" ctrs. Bent 12" up into vertical wall.
12"x12" Column 24"x24"x9" Footing
Lap horiz. bars 12" around corner
2½" Stop Board Slot
Ctr siphon discharge to be connected into 24" Line to Filters
Space for 18" Dosing Siphon
12"x12" Column 24"x24"x9" Ftg.
2½" Stop Board Slot
15" By Pass Pipe
15'-3"
Plan of Dosing Tank
Section B-B
Bent up into Vertical Wall 12"
Each Corner
Top of Fill
Natural Ground
21" Vit Pipe From Tanks
2½" Slot
14'-0"
Top of Fill El. 57.25
Normal Sewage El. 56.0
El 55
15" ctrs. Lapped 12" around corners
15" ctrs. Vertical
Low Water El. 51.0
El. 50.5
Natural Ground
Section A-A
2½" Stop Board Slot
15" By Pass
Section C-C
E.&C.

Fig. 6. Plan and Principal Sections of Dosing Tank of Sewage Treatment Plant at Cleburne, Texas.

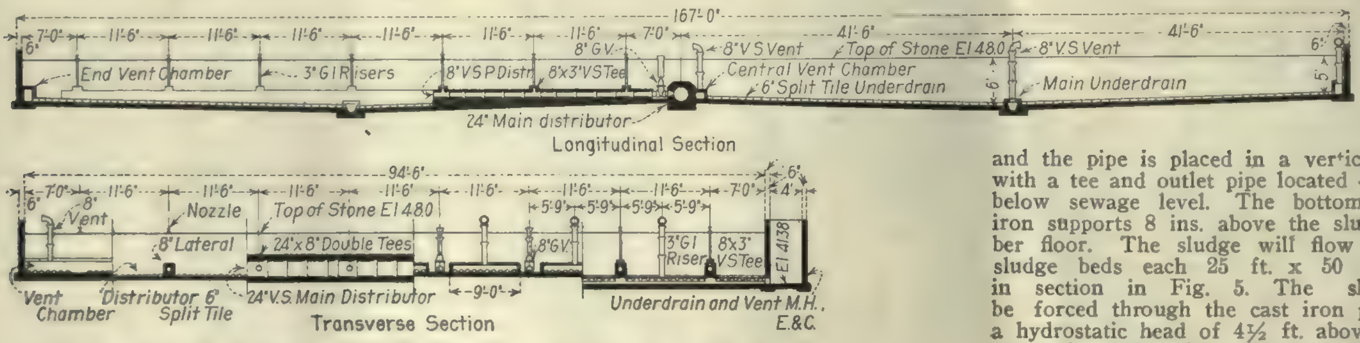


Fig. 7. Principal Sections of Sprinkling Filters, Cleburne, Texas.

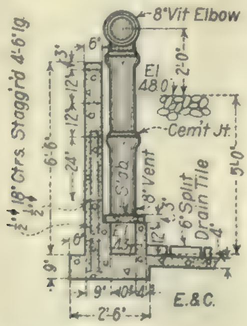


Fig. 8. Section of End Wall and Vent, Cleburne Sprinkling Filters.

Imhoff Settling Tanks.—The Imhoff tanks are divided into two separate units, so that one-half may be cut out of use at any time. The design of the tanks is shown clearly in Figs. 2 and 4. Each tank is 19 ft. 1 in. wide by 48 ft. 9 ins. long and 22 ft. deep from sewage elevation to bottom of sludge chamber. The capacity of the flow chambers is designed for a two-hour retention period, based on an hourly rate of 1/18 of the average daily flow. The sludge chambers have a combined capacity of about 8,000 cu. ft., or capable of holding sludge for 3½ months at maximum capacity.

The gas vent is formed by a continuation of the hopper walls and is 24 ins. wide, extending the full length of each tank, with walls extending 30 ins. above the normal sewage level. Equalizing ports are provided through the gas vents to prevent any flow of fresh sewage through the digestion chamber due to any difference in outlet weir elevation or unequal flow into the chambers.

The sewage enters the controlling channels at one corner and flows into the tanks through ports 30 ins. wide, two for each tank, and out similar ports provided with sharp crested weirs formed by removable iron plates. The ports used as inlets will have a depth of about 6 ins. below the sewage level, allowing free passage of floating particles. In reversing the flow, a 5-in. iron plate forming the outlet weir will be transferred to the opposite end, thus transforming the outlet to inlet ports and vice versa. The weir details are shown in Fig. 8. A concrete channel is carried around the outside of the tanks and provided with stop planks so arranged as to reverse the flow by adjustment of the planks and port openings. The tanks are provided with concrete scum walls, located 5 ft. from each end and extending 18 ins. below the sewage level.

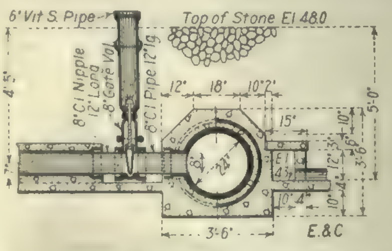


Fig. 9. Cross Section of Main Distributor, Cleburne Sprinkling Filters.

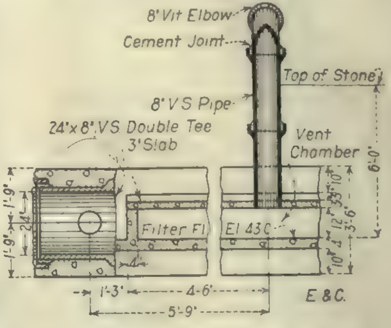


Fig. 10. Longitudinal Section Through Distributor and Vent, Cleburne Sprinkling Filters.

Each sludge chamber is provided with a 10-in. cast iron pipe for drawing off the decomposed sludge. The bottom of the pipe is enlarged by the use of a 16x10-in. increaser and the pipe is placed in a vertical position with a tee and outlet pipe located 4 ft. 6 ins. below sewage level. The bottom rests on iron supports 8 ins. above the sludge chamber floor. The sludge will flow upon two sludge beds each 25 ft. x 50 ft. shown in section in Fig. 5. The sludge will be forced through the cast iron pipe under a hydrostatic head of 4½ ft. above the center of the pipe, and will discharge into a 10-in. vitrified sewer pipe outside of the tanks. The vitrified pipe conveys the sludge by aid of the remaining pressure not used in friction and by gravity to the sludge beds, discharging about 1 ft. above the elevation of the top of the bed.

The sludge beds consist of a 6-in. layer of graded gravel over 6-in. tile under-drains spaced 8 ft. centers. Over the gravel will be placed a 6-in. layer of sand. The bottom of the beds will be graded to slope 6 ins. to-

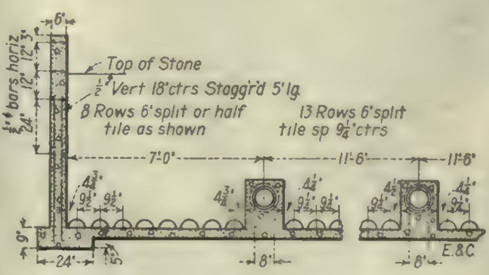

½" bars horiz. 12" ctrs.
Top of Stone
½" Vert. 18" ctrs. Stagg'rd 5' lg.
8 Rows 6" split or half tile as shown
13 Rows 6" split tile sp 9¼" ctrs
7'-0"
11'-6"
11'-6"
E.&C.

Fig. 11. Section of Side Wall and Floor, Cleburne Sprinkling Filters.

ward the under-drains. The sludge beds were designed to receive approximately 2,500 cu. ft. of sludge at one draw. As the climate is moderate, the sludge digestion will be fairly active the whole year, and it is intended to draw frequently, or as necessary, and consequently the sludge storage capacity and sludge bed capacity is not as large as they would be for a plant in a colder climate.

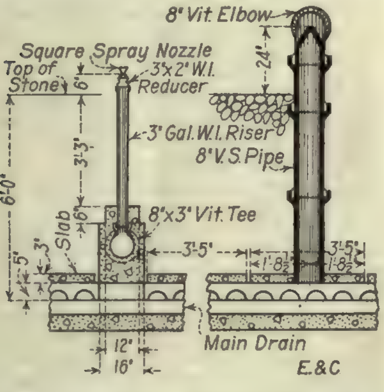


Fig. 12. Longitudinal Section Through Main Drain, Cleburne Sprinkling Filters.

The tank effluent flows into a tapered dosing tank, shown in Fig. 6, and is discharged by an 18-in. siphon to the filters. While operating under the rated capacity of the plant, the siphon will discharge about every six minutes.

The line from the dosing tank to the filters consists of a 24-in. vitrified pipe incased in a concrete cradle.

The sprinkling filter, as being constructed at present, covers an area of 362/1000 acres, or designed on a basis of 2,250,000 gals. per acre per day. The principal sections are shown in Fig. 7. The depth of the stone forming the filter medium averages 5½ ft. The floor of the beds consists of a 4-in. concrete slab on top of which are set 6-in. half-tile drains, 9½-in. centers, forming a false floor for the under-drainage system. The floor has a slope of 1 ft. to 40 ft. to the main outlet drains. The upper ends of the 6-in. half-tile are connected into a concrete box channel and the main outlet channel is similarly constructed with 8-in. vitrified pipe vents spaced at regular intervals. Eight-inch vitrified elbows are placed on top of the vent pipes and turned in direction of prevailing winds to secure better circulation of air through the under-drainage system. The end wall and vent are shown in Fig. 8.

The main distributor line consists of a 24-in. vitrified pipe encased in concrete extending through the center of the filter bed (see Figs 9 and 10). The lateral distributor lines are spaced at intervals of 11 ft. 6 ins. center to center and consist of 8-in. vitrified pipe, encased in concrete. At intervals of 11 ft. 6 ins., connected into 8-in. x 3-in. vitrified tees, are 3-in. galvanized riser pipes, which carry the nozzles. Nozzles of the square spray type are specified.

The outside walls of the filter beds are of concrete 6 ins. thick, and are not designed to be self-sustaining, but act as a division between the earth and filter rock (see Fig. 11). The specifications provide that the earth fill and filter rock shall be deposited at the same time, keeping the overturning forces counter balanced. Sections of the main drain are shown in Figs. 12 and 13. Provision has been made for extending the filter beds when the limit of capacity of the present installation has been reached.

The effluent from the filters will pass into a secondary settling tank of one-hour retention period before finally discharging into Buffalo Creek. The design of the secondary tank is shown by Fig. 14.

The relative elevations of the various components of the plant are as follows: Sewage level in Imhoff tanks, 56.25; high water in dosing tank, 56.00; low water, 51.0; top of filter stone, 48.0; outlet drain from filters, 41.1; sewage level in final settling tank, 40.75; ordinary water level in Buffalo Creek, 30.5; top of Sludge Bed "A", 50.0; top of Sludge Bed "B", 48.5.

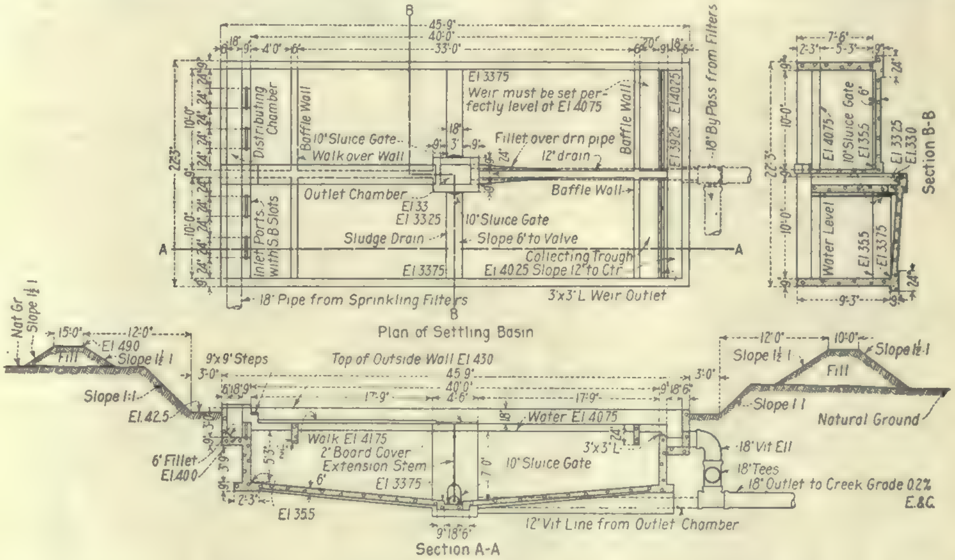


Fig. 14. Plans and Principal Sections of Secondary Settling Tank, Cleburne, Texas.

The waste excavation will be graded around the plant to an elevation of 49.0 to protect all parts from high water, which lasts but a very short time. High water mark is at an elevation of 47.0, but the water rarely reaches this elevation.

Provisions are made for by-passing the tank effluent and the filter bed effluent directly to the creek without passing through the other parts.

The improvements were started and made possible through the untiring efforts of Mayor C. W. Breech, who was well supported by a live, progressive Council. Bids were received on June 4, 1915, on 33½ miles of sewers and the disposal plant. Hamilton Brothers Construction Co. of Houston, Texas, were awarded the contract for the total construction work at $144,527.36, of which the disposal plant amounted to $28,194. Plans were prepared and the construction work will be supervised by Burns & McDonnell, Consulting Engineers, Kansas City, Mo., who also made the appraisal of the water and old sewer systems and plans of the water works improvements.

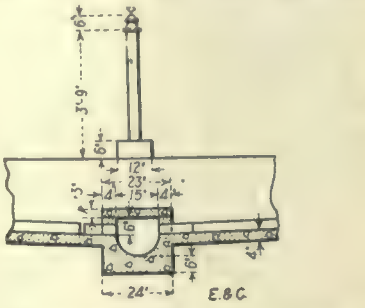


Fig. 13. Section of Main Drain, Cleburne Sprinkling Filters.

WATER WORKS

Methods Employed in Determining Hydraulic Elements of Unlined Water Tunnel at Rio Janeiro.

(Staff Abstract.)

The Perahy Tunnel of the Rio Janeiro Tramway, Light and Power Co., of Rio Janeiro, Brazil, is unlined and traverses hard gneiss. It is 5¼ miles long. For all practical purposes it may be considered unlined, although there is some concrete lining. However, there is less than 700 ft. of lining, no one section of which is longer than 70 ft. The lined portions are scattered throughout the length of the tunnel. The dimensions and theoretical properties of the tunnel are as follows: Area, 151.783 sq. ft.; length of wetted perimeter, 46.567; hydraulic radius, 3.259, n, .02 (assumed); C, 90.30; velocity, 7.87 ft. per second; capacity, 1,194 cu. ft. per second; slope, .002335. See Fig. 1. It was desired to determine the capacity of this tunnel, and also to determine the value of Kutter's coefficient "n" for such a tunnel. The present article gives the results of the investigations and tells how they were made.

A gaging station was made in the approach cut near the intake by suspending a cable bridge from bank to bank. A series of gagings were taken at this point with a No. 606 Gurley current meter, and a discharge curve plotted, see Fig. 2. The curve is a mean of 70 gagings. It will be seen that the curve is almost a straight line up to an elevation of 442.6, where it begins to curve rapidly until at 444 it is nearly level. This is due to the fact that above 442.1 the section is a semi-circle, and as the water rises above this point the wetted perimeter increases much faster than the cross-sectional area. As the water rises from 444 to 448 the additional head is evidently consumed in overcoming the retarding effects of cross currents, as the actual discharge increases but little. Beyond 448 the curve rises rather abruptly in almost a straight line.

By means of recording gages, a daily record of the tunnel flow was kept. Records were kept at the power house showing the rise and fall of the reservoir level, and the water consumed, as shown by the Venturi meters. Upon comparing the two records it appeared that too much was claimed for the tunnel, for on some days the flow of the lake basin proper appeared as a minus quantity, the tunnel flow alone being greater than the total inflow as shown by the power house records.

Upon discovering this discrepancy the engineers immediately set to work to locate it. The rating of the current meter was checked and found to be about 4 per cent too large. This was a step in the right direction, but there still remained a considerable difference. Attention was then directed to the Venturi meters placed in each of the eight penstocks leading from the valve house to the power house. For the purpose of checking these, a Francis weir was constructed in the old river channel a short distance below the power house. The weir was of the contracted type and had a notch 12 meters long by 1.3 meters deep. The capacity of the weir was approximately 30 second-meters. A curve showing the average velocity of approach for different heads was plotted, and then, using Francis' formula, a discharge curve was plotted. Hook-gage readings were taken at intervals of five minutes for a period of 24 hours and the flow, as determined by the weir, compared with that shown by the Venturi meters. Two 24 hr. runs were taken, in the first of which the difference was 1 per cent, and in the second, 2 per cent. In view of these results, and the fact that they agreed very favorably with the factory turbine rating, appearances were against the current meter.

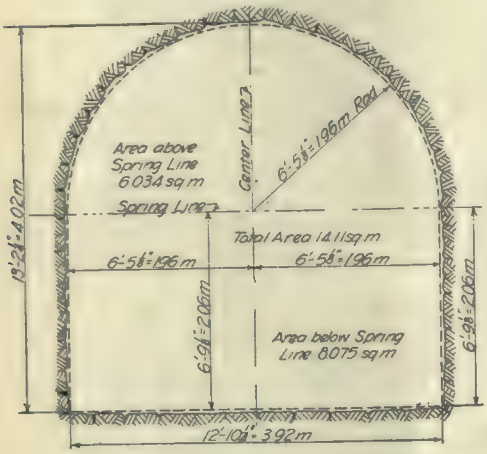


Fig. 1. Section of Unlined Perahy Tunnel in Non-disintegrating Rock, Rio Janiero, Brazil.

A gaging station was then made below the contracted weir, and another was located just a few feet above the crest of a suppressed weir which had been constructed a short distance below the outlet of the tunnel. The station below the contracted weir was located where the bottom was gravel and the banks solid rock, while the velocity of the water was 3 to 4 ft. per second. The location was not an ideal one, but would compare favorably with the average points selected for gagings in streams of like nature. The current meter here gave results 20 per cent to 25 per cent greater than the weir, the percentage of difference being practically the same for high heads on the weir as for low heads. The velocity of approach to the weir varied with the head, the maximum being about 2 ft. per second. At the other station above the suppressed weir where the channel was concrete lined, the current meter compared very well with the weir when the head and the velocity of approach were small, but gave greater results as the head and the velocity of approach increased. Where it is practicable to build the weir with the proper ratio between the maximum head and the distance from the crest to the ground on the upper side, the increase in head should not cause any error in the calculations, but in the case in question, the distance "G" was a trifle less than the maximum head. This distance decreased as the sand from the tunnel was gradually deposited there. Anticipating the deposit of this sand and silt, the weir was designed as a gate that could be raised to allow the sediment to be washed away. A well was built of concrete at one side of the channel and 7 ft. back from the crest. In this well was located the hook-gage and an automatic recording gage. Considerable difficulty was experienced in designing an entrance into the well, such that a negative head would not be produced by the velocity of the water. The mouth of the pipe leading to the well was finally placed just a little lower than the crest and at a distance of 16 ft. above it.

An attempt was made to measure the tunnel flow by the Saline Solution method, but the results were not very encouraging. This method has been successfully used in a few instances where the solution was introduced into the water above and allowed to pass through the turbines, thus insuring a thorough mix, but in open streams the solution does not seem to diffuse itself perfectly within a reasonable distance. In the case here considered, a 30 per cent solution was introduced at the crest of the suppressed weir by means of a row of ⅜-in. holes, bored 6 ins. apart in a 3-in. pipe. A uniform flow of about 3 liters (3 short quarts) per second was obtained by means of a 1-in. pipe passing through the top of an air tight tank, and extending to within a few inches of the bottom. When the 3-in. valve at the bottom of the tank was opened, the water would drop a little, forming a partial vacuum at the top, after which the flow was regulated by the bubbles of air entering the 1-in. pipe and rising through the water to fill the vacuum at the top.

Below the weir the water passed through a very rocky channel at a high velocity, which it seemed would be sufficient to thoroughly diffuse the solution. The results, however, seemed to prove otherwise. The method, so far as the titration of the samples was concerned, proved to be practical, but there was found to be a great difference between samples taken at the same points, as well as between those taken at different points.

The writer wishes to say in drawing conclusions from the above experiments, that he does not pose as an authority on these matters, but simply desires to state what seems to be the logical conclusions. (1) Venturi meters, when properly cared for, give good results: (2) Contracted weirs, when properly constructed—making the distance "G" at least twice the maximum head—give good results when the velocity of approach does not exceed 2 ft. per second; (3) suppressed weirs are best for low heads and low velocity of approach, and contracted weirs best for high heads and high velocities; (4) where it is impracticable to make "G" twice the maximum head, Bazin's formula applies best; (5) use Fteley & Stearns' formula for suppressed weirs having a high velocity of approach; (6) current meters give good results in smooth currents, but in rough channels, where there are many cross currents, results are too large; (7) Saline Solution method not adaptable to open streams.

In the measurements of water by any method, too great care cannot be exercised. Meters should be kept clean and oiled, and should be rated from time to time. Narrow troughs for rating meters should be avoided, as they are inaccurate for the higher velocities. In weir measurements, where there is a velocity of approach, care should be taken to get the correct head. As above stated, differences of 25 per cent were found between the weir and current meter measurements. This does not prove necessarily that the current meter is entirely unreliable, but serves to impress the fact that great care is necessary in selecting the place to make a gaging, and in the handling of the meter itself.

In view of the results obtained in the foregoing experiments, the value 0.020 which was used for the cofficient "*n*" in the designing of the tunnel, was much too small. It is impossible to arrive at a value which will fit all unlined tunnels, but the writer feels that if a value of .030 be used, and due care be exercised in keeping the bore true in line and section, the result will be reasonably close.

ACKNOWLEDGMENT.

This information is taken from an article by Mr. R. S. Wark in The Iowa Engineer for May, 1915.

Limits of Precision in Laying Submerged Water Mains.

(Staff Abstract.)

The question has been raised: how much deviation in line and grade is permitted in submerged pipe construction? This question is difficult to answer. In theory, the pipe should conform to the designated lines and grades, but in practice "it is different." Some information on this point is here given with reference to submerged pipe work in Portland, Ore. In ENGINEERING AND CONTRACTING of Dec. 9, 1914, an article was published entitled: Method and Cost of Constructing and Repairing Submerged Water Pipe Lines at Portland, Ore. The present article supplements the former one.

The 28-in. cast-iron, flexible-joint pipe, built in 1894, was laid in a trench excavated with a ladder-dredge which was supposed to excavate to a uniform depth below the surface of the water, the ladder being adjusted according to the gage showing the variation of water levels from the low-water line, which might occur from time to time. For laying the pipe, a timber cradle was constructed, one end of which rested on the pipe-laying barge and the other on the ground in the bottom of the excavated trench. This cradle was pulled from under the pipe as the pipe-laying barge was advanced, thus depositing the pipe in the trench along the line which the cradle followed, but it might or might not be exactly the alignment intended. That this pipe was not laid exactly to either line or grade as originally designed was shown by a survey made in 1902, when the question of lowering the pipe was under consideration. Soundings made at that time showed variations or depressions in grade amounting in places to as much as 2 ft., although no abrupt changes were noted.

In laying the 24-in. pipe, built in 1898, the same pipe-laying methods were adopted as had been used 4 years before, but, on account of the pipe being somewhat lighter, it is probable that a better alignment was secured.

In laying the 30-in. pipe, in 1910, and in relaying the 24-in. pipe, in 1913, a different method was adopted, the pipe being suspended from three boom derricks, and it was thus possible to line up the cables supporting the pipe and keep them in line until it was lowered to the bottom of the trench. By such means, the writer should sav, it is possible to deposit a pipe within a foot of the desired alignment, if the depth of water is not excessive. Any closer work than this he would not expect.

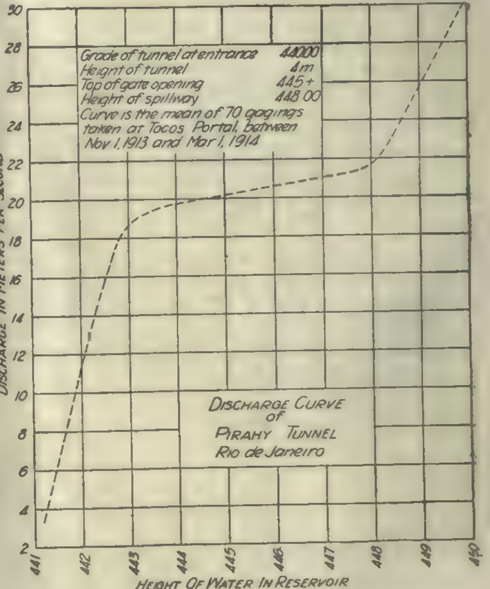


Fig. 2. Discharge Curve of Perahy Tunnel as Determined by Means of 70 Gagings With Current Meter.

ACKNOWLEDGMENT.

The foregoing information is from the dis-

cussion of the original paper before the American Society of Civil Engineers by Mr. D. D. Clarke, Engineer of the Portland Water Bureau, in Proc. Am. Soc. C. E., Vol. XLI, pp. 1195-1210.

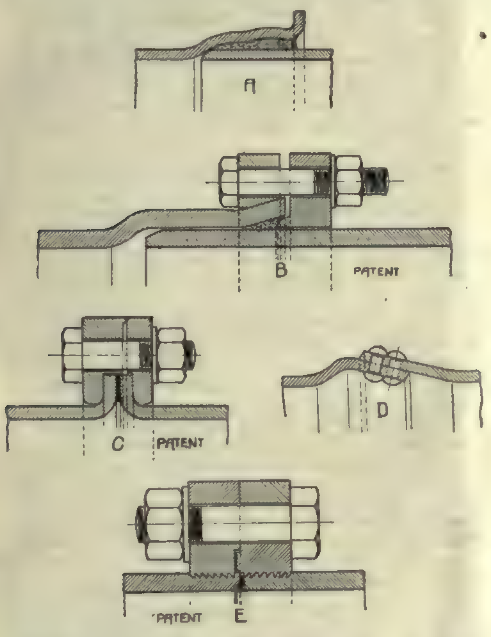
Joint Details in High-Head Pipe Lines —Data on Pipe Lines Throughout the World.

(Staff Abstract.)

The question of the proper type of pipe joint is a very important one in high-head hydraulic pipe lines. The accompanying cut shows five types of joint which have been successfully employed in various parts of the world. Table I gives data on these pipe lines.

Joint *"A"* is similar to the Matheson joint, as manufactured and used very extensively for gas lines, with the exception that the end of the pipe is belled out for reinforcement, while the Matheson joint is reinforced by an additional steel band shrunk over the end of the pipe.

Joint *"B"* could be described as a combination between the Matheson joint and the rubber packed coupling as used for plain end pipe. In this joint the belled out end of the pipe takes the place of the center ring, this pipe being further reinforced by the bolt flange, which is so manufactured as to come out close to the end of the pipe.



Design of Joints Successfully Used in High-Head Hydraulic Pipe Lines Throughout the World.

Joint *"C"* is very similar to the Van Stone joint, used so extensively in this country for steam lines and for the piping around the compressing station where the use of the rubber packed coupling would be impossible, and the screwed flange not as desirable. This type of joint is also used on piping the closer connections around a compressing station where the lay-out of the piping would not permit the use of a rubber packed coupling, due to the fact that the vibration due to the compressor and the uneven thrusts due to fittings could not be properly taken care of except with a solid connection. This joint, with the exception of the welded joint, I believe to be the best connection for station work, more especially when steel flanges are used, as it is exceptionally safe, durable and tight, and also has the advantage of being properly assembled with the minimum amount of labor.

Joint *"D"* is a riveted joint which allows the full area of the pipe at the joint without restrictions due to laps and rivets, and also permits greater ease in assembling than the straight pipe on account of it being, in shape, a modification of the bell and spigot joint.

Joint *"E"* is a unique screwed flange which depends on the thread and flanges only for the necessary tension and alignment (note the peculiar shape of thread, which is a modified form of the square thread), the joint being made tight by the shape of the recess cut in the pipe itself, the pressure of the fluid inside of the pipe forcing the soft ring gasket into the smaller end of the wedged shaped opening. The pipe and flanges are drawn up metal to metal.

Some idea of the pressures and conditions under which these joints are being used can be gained from Table I, which shows the location of the installation, the size and length of the pipe, the thickness of material, the pressure and the type of joint used. Special attention is called to a few of the sizes and pressures:

TABLE I.—DATA ON HYDRAULIC PIPE LINES THROUGHOUT THE WORLD.

Location.	No. of pipe lines.	Length of line, in feet.	Diameter, inches. Max.-Min.	Plate thickness, inches. Min.-Max.	Head, in feet.	Type of joint.
North America—						
Yukon	2	1,640-1,082	43	.688	.....	D
Armstrong	1	2,756	16-12	.236- .39	1,279	B
Jordan River	1	6,332	36-30	.314- .551	1,164	D
Vancouver	1	6,680	48	.496-1.125	1,214	D
Feather River	3	574	62	.393- .665	525	D
Feather River	1	509	25	.275- .314	525	D
Nevada	1	3,280	24	.236- .511	984	D
San Joaquin	1	2,362	40-34	.559- .866	1,411	D
San Joaquin	1	2,165	40-34	.559- .866	1,411	D
Los Angeles	3	1,975	84-54	.665-1.259	935	D-E
Mill Creek Kanon	1	1,811	26-20	.251- .437	755	C
Battle Creek	1	3,280	24-20	.629- .865	1,804	C
Utah	1	3,280	20-18	.511- .787	1,968	C
Arizona	1	2,526	36-32	.511- .665	1,017	D
Colorado	1	1,099	30-26	.255- .629	1,017	C
Woolfenden	1	971	22-20	.314- .433	919	C
Santiago Papasquiaro	1	99	30-27	.275	46	A
Fista Hermose	1	1,444	22	.236	484	B
Tux Pango	2	1,509	63-51	.393- .590	557	D
Tux Pango	1	1,509	18	.236- .275	557	B
San Luis Potosi	1	440	29-26	.275	82	A
Morelia	1	1,066	26-22	.236- .275	338	B
Queretaro	1	994	24	.236- .354	397	C
Mexico	1	1,837	16	.196- .433	1,148	C
Pachuca	1	2,198	25-21	.314- .590	1,279	B
Attotonilco	1	263	21-19	.275	76	A
Alameda	2	10,562	42-34	.314- .748	1,132	B
Necaxa	6	3,280	31	.393- .866	1,411	C
Necaxa	1	3,280	12	.236- .393	1,411	C
Oaxaca	1	2,132	20-16	.275	525	C
Honduras	1	2,362	14	.255- .374	1,312	C
South America—						
Valenzia	1	5,117	21-13	.236- .275	873	B
Morococha	1	296	18	.314	164	C
Valparaiso	2	1,887	28-17	.314- .551	886	C
Valdivia	2	4,986	13-11	.295- .314	721	B
Valdivia	1	4,592	18	.275- .314	721	B
Argentinien	1	1,181	25-2	.236- .275	177	B
Araxa	1	447	44-42	.275	36	B
Sorocaba	3	2,264	69-61	.393- .866	695	D
Genna	1	263	19-16	.236	180	A
Parangua	1	1,050	18-14	.236	295	B
Pretao	2	191	20	.236	56	B
Caconde	1	135	17	.236	54	B
Rio Pardo	1	328	47	.314	72	B
Santos	5	6,560	37-26	.393-1.259	2,099	B
Santos	1	302	50-44	.275	17	B
Jacare	1	574	24-20	.236- .275	207	B
Lavras	1	237	37-34	.393	535	A
Lavras	1	538	24-20	.236	105	D
Oliveira	1	181	24	.275	82	C
Agua	1	558	33	.275	240	B
Rio de Janeiro	6	2,132	37	.393- .866	951	C
Rio de Janeiro	1	2,132	12	.236- .314	951	C
Rio de Janeiro	1	125	25-24	.314	72	A
Rio de Janeiro	2	73	39	.314	33	D
Rio de Janeiro	1	1,968	34	.314- .551	721	B
Rio de Janeiro	1	1,972	26-22	.236	328	B
Rio de Janeiro	1	11,644	20-18	.275-1.023	3,037	B
Rio de Janeiro	1	135	20	.275	36	A
Rio de Janeiro	2	279	20	.275	147	A-C
Rio de Janeiro	1	394	18	.236	262	A
Rio de Janeiro	1	81	28	.314	65	A
Rio de Janeiro	1	1,394	39	.275	43	C
Rio de Janeiro	1	332	39	.275	23-16	D
Rio de Janeiro	1	351	67-63	.393	98	D
Rio de Janeiro	1	443	22-18	.236	49	C
Rio de Janeiro	1	53	24	.275	30	A
Rio de Janeiro	1	66	16	.236	49	C
Rio de Janeiro	1	263	31-28	.275	158	B
Almeria, Europe	1	2,460	16-13	.236- .314	820	..
Bildao, Europe	1	460	17	.393- .472	1,312	C
Island, Iceland	1	1,312	21-18	.236	158	A
Europe—						
Loch Leven	6	6,232	41	.393- .866	951	B
Isoverde	1	4,592	30	.393- .826	1,148	C
Blaschina	2	820	69	.866-1.377	852	B
Ticinetto	1	918	20	.236- .275	623	B
Arniberg	1	6,724	24-21	.354-1.181	2,798	A-B-E
Lugano	1	2,198	37	.275- .629	876	B
Robbia	1	2,460	31-30	.551-1.181	2,000	C-E
Gromo	1	1,247	26	.393- .590	1,050	C
Pantcharevo	1	328	55	.314- .393	164	C
Rjukanfos	10	2,296	79-49	.354- .984	972	D
Vadheim	1	1,375	28-20	.314- .433	1,050	B
Aasa	1	3,772	18-15	.275- .393	1,148	B
Tyko	1	591	26	.236	59	B
Tromso	1	1,903	25	.275- .433	656	B
Ketahoen, Asia	1	207	35-28	.314	138	A
Japan—						
Kumamoto	2	2,854	43-35	.314- .708	779	D-B
Besshi	1	4,182	35-26	.314-1.220	1,975	B-E
Kochi-Kecho	1	1,411	32-29	.314- .354	604	B
Tasmanien	2	3,936	33-30	.314- .708	1,125	B
Katsuragawa I	6	853	66-58	.314- .433	328	D
Katsuragawa I	1	853	24-20	.236- .275	328	B
Hakone	2	837	31-18	.314- .433	738	B
Katsuragawa I	6	755	73-65	.393- .629	404	D
Katsuragawa II	1	755	31-28	.275	404	B
Katsuragawa III	4	1,342	67-61	.393- .708	450	B
Kikko-Ashio	1	1,771	40-32	.314- .472	656	C
Hosso	1	2,165	48-40	.354- .708	689	E
Kinugawa	6	3,608	60-43	.393- .984	1,102	D-B
Kinugawa	1	3,608	28-20	.275- .472	1,102	B
Hitachi	1	640	60-51	.354- .551	541	C
Hokkaido	4	361	47	.393	420	B

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PIPE LINE AT RIO JANEIRO.

Length .... 11,644 ft.
Diameter .... 20 ins to 18 ins.
Thickness of walls .... 0.275 in. to 1.02 ins.
Hydraulic head .... 3,307 ft. = 1,300 lbs.
This line was laid with joint "B."

PIPE LINE AT LOS ANGELES.

Length .... 1,975 ft.
Diameter .... 84 ins. to 54 ins.
Thickness of walls .... 0.665 in. to 1.259 ins.
Hydraulic head .... 935 ft. = 400 lbs.
This line was laid with joints "D" and "E."

Besides calling attention to the various types of joint, Table I is of interest, as it shows the development of hydraulic power stations throughout the world.

ACKNOWLEDGMENT.

These data are taken from a discussion by Mr. L. C. Frohrieb, Secretary of the Federal Engineering Co. of Pittsburgh, as published in the Proceedings of the Engineers' Society of Western Pennsylvania for June, 1915.

Repairing Cracked Pump with Concrete and Sulphur.

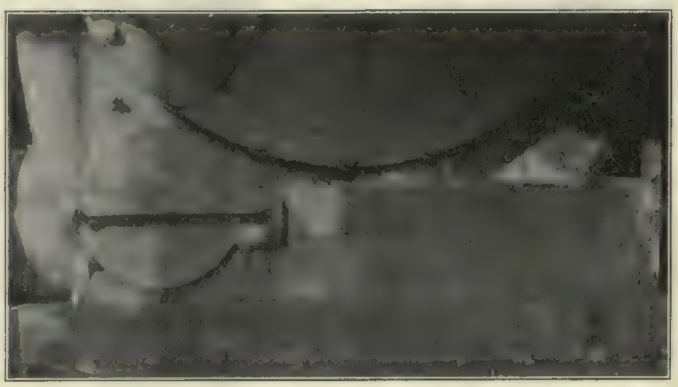
Contributed by W. G. Grace, Erie, Pa.

Rather a novel method was recently employed in the temporary repairs to a centrifugal pump casing on a hydraulic dredge in Erie Harbor. A crack had started in the lower part of the casing which was rapidly extending and showing an alarming tendency to break out. As any break in the pump would necessarily put the dredge out of commission, some temporary repairs were attempted.

A form of rough boards tight enough to hold the rich wet mixture used was placed around the affected parts, allowing plenty of overlap on all sides. In this was placed a wet mixture of 3½ cement: 1 sand. This was allowed to set for 24 hours, after which the pump was again started.

In about 4 days after the pump was started, the bond between the casing and the concrete became broken, due to the vibration and a small amount of leakage occurred. Sulphur was run into this crack between the concrete and casing and the leakage stopped at once. So far the repairs have been very effective, there being no leakage around the pump and the section that threatened to fall out has been held in place.

At the same time a Y in the discharge line which had been patched before, but had nearly worn through again, was given the same treatment and with even better results, as the vibration did not break the bond.



View of Concrete Patch on Cracked Casing of Centrifugal Pump. (No Leakage After Running Sulphur Between Concrete and Casing.)

Method of Grouting Leaky Bottom of Concrete Standpipe at Greenfield, Mass.

(Staff Abstract.)

The Rocky Mountain reservoir at Greenfield, Mass., is built wholly on ledge, a portion of it being excavated from the trap rock which occurs on the summit. A concrete floor, 6 ins. thick, was laid in alternate sections after the walls were completed. The roof is of groined arch construction, supported by 24-in. square concrete columns, spaced 17 ft. on centers. The capacity is 2,000,000 gals.

As stated, the bottom of the reservoir was entirely on trap rock, and was a 6-in. thickness of very rich concrete. The engineer was greatly surprised to find that the bottom leaked like a sieve; it was impossible to fill the reservoir with the pumps available, although it held only 20 ft. of water. The superintendent of water works then grouted the bottom and made it practically watertight.

The leakage was not due to defective concrete, as practically all the leakage detected was due to contraction of the floor slabs and wall sections, which were all poured in separate sections. The floor slabs were about 17 ft. square and the wall sections were not over 25 ft. in length.

The concrete was poured during the hottest summer weather, and the reservoir was filled about the first of November, when the water had a temperature of about 45° or 50° F. The work of repairs was done during the coldest winter weather, in order to allow the concrete to contract all that the colder water would make it.

The repairs were made by drilling holes in the concrete in the joints and inserting a short pipe nipple which was calked in with jute packing so that it would hold pressure. The discharge hose from a grout pump was then connected to the pipe and grout pumped in. In the walls a pressure as high as 100 lbs. per square inch was used. It was necessary, as the grout began to flow out of the joints, to calk them with jute packing in the same manner that the joints of a boat are calked.

In one or two cases, while repairing the floor, the grout appeared in joints about 50 ft. distant from the drill hole where it was being pumped in. As high pressure in repairing the floor was not used as with the walls, as there was danger of lifting the floor slabs. About one carload of cement was used. The leakage was reduced from about 400,000 gals. per day to practically nothing.

ACKNOWLEDGMENT.

This information is taken from discussions by Geo. F. Merrill, Superintendent of Water Works at Greenfield, Mass., and William S. Johnson, Consulting Engineer, Boston, before the New England Water Works Association, as reported in the Journal for June, 1915.

Growing Popularity of Leadite for Making Joints in Cast Iron Pipe Lines.

(Staff Abstract.)

Leadite, which contains about 50 per cent sulphur, has been used very successfully, within a few years, by water works men in making joints in cast iron pipe lines.

The material is melted and the joint is run just as a lead joint is, but with a gate about 6 ins. high, because the leadite is so much lighter that it requires a higher gate to fill the top of the joint. Leadite costs about twice as much per pound as lead, but being much lighter costs less per unit of volume; besides, it requires no calking. As a consequence a leadite joint costs about one-half as much as a lead joint. It requires some experience to make good joints with leadite, as it has its own individual peculiarities, and yet it is no more difficult to handle when understood than is lead. In many respects it is much easier to handle than lead. A small percentage of leadite joints will leak when first tested under pressure, but leakage usually stops within 24 hours, and if it does not a leadite joint is easily repaired. As a result of the economy in the use of leadite and its other good points, it is quite rapidly coming into favor as a material for making joints in cast iron water pipe.

ACKNOWLEDGMENT.

These comments on the use and characteristics of leadite were made by Mr. W. C. Hawley, Chief Engineer Pennsylvania Water Co., Wilkinsburg, Pa., before the Engineers' Society of Western Pennsylvania.

Cast Iron Water Mains Removed After 98 Years.—After remaining in service for 98 years a line of cast iron water pipe in Chestnut St., Philadelphia, is to be removed to make room for a larger main. This pipe was laid in 1817 as an experiment. It was one of the first lines laid to supersede the old bored-log mains. The pipe was imported from England. It is 4½ ins. in diameter and shows but slight effects from its long years of service. Other sections of cast iron pipe, laid about the same time, have recently been removed in favor of larger mains.

CURRENT NEWS

The Doings of the Week.

The general situation as regards business and finance maintains its favorable aspects. There was a well sustained volume of transactions in various commercial and industrial lines during the past week. Labor controversies in the east are in a fair way towards settlement. Bank clearings for the week ending July 22 showed an increase over the corresponding period of 1914. In the Metropolitan District of New York improvement was shown in the building material and financing markets. Structural steel contracts covering Metropolitan deliveries amounted to about 75,000 tons with about 80,000 tons additional ready to come out. An interesting feature of the week was the offering of $45,000,000 of Canadian Government notes in this country. This establishes a new precedent for Canadian financing in this market. In the construction field there has been little apparent slowing up of activities. In fact the number of big jobs reaching the call for bids stage is well up to the average of previous weeks. Eastern municipalities are doing considerable financing at present and the success of this will mean the undertaking of much construction. Several of the larger cities are now taking bids on large improvements. In Philadelphia alone, this work will involve the expenditure of many millions. In the steel trade further gains in production have been made. Many plants are now operating around 100 per cent capacity and some even have taken bids for new buildings to care for additional business. The Steel Corporation is operating at over 91 per cent of its ingot capacity and the Carnegie Steel Co. is working at about 95 per cent capacity. Negotiations for more than 400,000 tons of steel for war purposes are now underway. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending July 21 are as follows:

Finished Iron and Steel.

Per lb. to large buyers:	July 21, Cts.	July 11, Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.22½	1.22½
Iron bars, Pittsburgh	1.25	1.25
Iron bars, Chicago	1.20	1.20
Steel bars, Pittsburgh	1.25	1.25
Steel bars, New York	1.419	1.419
Tank plates, pittsburgh	1.25	1.20
Tank plates, New York	1.369	1.369
Beams, etc., Pittsburgh	1.25	1.25
Beams, etc., New York	1.419	1.419
Skelp, grooved steel, Pittsburgh	1.20	1.20
Skelp, sheared steel. Pittsburgh	1.25	1.25
Steel hoops, Pittsburgh	1.30	1.30

Sheets, Nails and Wire.

Per lb, to large buyers:		
Sheets, black, No. 28, P'gh	1.75	1.75
Galv. sheets, No. 28, P'gh	4.50	4.50
Wire nails, pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, Pittsburgh	1.40	1.40
Barb wire, galv. Pittsburgh	2.40	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.25 cts.

Railways—No development of importance in the railway construction field have occurred during the past week. There have been, however, some favorable features in the situation. According to a statement of the Interstate Commerce Commission railway earnings for the country for the first time showed an increase over last year. It is now expected that the Interstate Commerce Commission will render its decision before Aug. 1, in the western freight rate case. It is believed that the carriers will win their case and will thus secure about $10,000,000 increase. Rapid transit development for New York City and Philadelphia are offering about the only big construction jobs in the railway field at present. Post & McCord, Inc., 103 Park Ave., New York City, have been awarded a $877,000 contract for Section 1 of Route 49 of the duel system of New York City.

Roads and Streets—State and county highway work and street paving continue to furnish many construction opportunities. Many large jobs in these lines were awarded last week and much new work came up for bids. Laurel, Miss., let a $95,000 contract for asphalt, wood block and gravel pavement; Philadelphia, Pa., opened bids on street grading, repaving and resurfacing work, the total of the low proposal being $483,000. A $140,000 contract for grading and surfacing 35 miles of county roads was let at Longview, Tex.; Lakewood, O., awarded paving contracts totaling $69,000; Fairmont, Minn., let a $55,700 paving job; Norfolk, Neb., awarded a contract for 30,000 sq. yds. of concrete paving; Newport Township, Pa., let a $70,000 contract for paving with brick. Washington, California and Ohio awarded state highway contracts, the work in the latter commonwealth amounting to over $1,250,000. California will call for bids in a few days on 37 miles of state highway.

Bridges.—A number of fair sized bridge jobs reached the call for bids stage during the past week. The County Supervisors at Oroville, Cal., are asking proposals on eight bridges to cost $40,000; Philadelphia, Pa., is asking bids on four bridges, estimated to cost about $200,000. The California Highway Commission opened bids on two bridges, to cost $28,235 and $26,900 respectively. The County Court at Chattanooga, Tenn., has been authorized to sell $400,000 of bonds for the construction of a bridge over the Tennessee River. Westmoreland County, Pennsylvania, has taken steps for the building of a $225,000 bridge.

Drainage and Irrigation—A considerable amount of drainage work is in prospect, and several fair sized jobs already are being advertised. The County Auditor at Windom, Minn., is asking bids on a $108,000 judicial ditch; Grove Level Drainage District No. 1 of Maysville, Ga., opens bids on July 31 on ditch work requiring about 300,000 cu. yds. of excavation. County Commissioners of Manatee County, Florida, probably will let a $110,000 drainage job this fall. Project involves about 896,200 cu. yds. of drag line excavation and floating dredge work. Bids will be asked in about 30 days on the O'Nan public Ditch near Morganfield, Ky. This will require 622,000 cu. yds. of excavation.

Water Works and Sewerage—A fair amount of construction in both of these fields is being advertised for bids. St. Louis, Mo., opens proposals Aug. 13 for the reconstruction of the Compton Hill reservoir—a $400,000 job. Ilion, N. Y., is calling for bids for pipe line, diverting dam, etc. Syracuse, N. Y., is asking bids on a storm sewer to cost about $100,000. Dallas, Tex., opens bids Aug. 23 on three good sized sewerage projects; Philadelphia, Pa., is calling for bids on a $70,000 sewer contract, also for main and branch sewers to cost about $190,000 and $400,000 respectively.

Buildings and Rivers and Harbors—County Commissioners at Pittsburgh, Pa., have awarded contract at $193,965 for 6,500 tons of structural steel for new city and county building. School Commissioners of Indianapolis, Ind., opened bids for new public library building; lowest estimate amounted to $409,000. The Port Commission of New Orleans, La., awarded a $1,109,000 contract for wharf house and warehouse E for the cotton warehouse development. Charleston, S. C., let a $46,418 contract for constructing a creosoted timber wharf. Dock Commissioner of New York City awarded contract at $309,000 for 35th St. pier in Brooklyn. Bondurant Construction Co., Hickman, Ky., was awarded contract at Greenville, Miss., for $400,000 work of new levee and enlargement work.

Professional Unity.

We know of no better illustration of how the progressivism of yesterday becomes the conservatism of today than is afforded by the engineer's enlarged ideas of the functions of his profession and of his obligations to the community. The present thought on this point was admirably expressed by Charles Warren Hunt, Secretary of the American Society of Civil Engineers, in a recent talk before the San Francisco Association of Members of that Society. He spoke, in part, as follows:

> The time has come when engineers must realize the necessity for united action in all matters which affect the profession. There is no need of additional professional societies. What we need is united effort and the cultivation of a spirit of compromise which will subordinate narrow, individual views and foster and expand human and social elements in the profession. Why should not engineers of all kinds and types get together, and in so doing advertise in a perfectly proper and legitimate way, by educating the public to a better realization of what the profession accomplishes and what its services are worth?
>
> In the five national societies of civil, mining, mechanical, electrical and naval engineers there are approximately 30,000 trained minds, most of them pulling in different directions. Why should these able and keen-minded men allow other professions to outstrip theirs in matters which are not purely technical? Why should we not realize that in addition to being technically proficient we must be men of affairs, club men, civic men, broad men, whose influence in the body politic shall be recognized by all our fellow citizens?

Engineers for Engineering Work.

From this distance it appears that engineers are coming into their own in Philadelphia, at least. When Mayor Blankenburg came into power the Highway Bureau was in the hands of men who knew next to nothing at all about their work. At that time, among 1,000 employes, only one was a trained engineer. Under Mayor Blankenburg all this has been changed, and at the present time there are in this one bureau alone upwards of 200 men who have received technical training in the art and science of building and maintaining roads and pavements.

New Building Code for Pittsburgh.

A commission has been organized in Pittsburgh to draft a new building code as a result of the bill which passed the last state legislature giving the city practically "home rule" in regard to building laws. It is expected that the new code, which is to be carefully drawn, will give the city even a greater building boom than it has experienced during the last two or three years. Although the act under which the new commission is to operate does not become effective until the first of next year, work will be taken up by the commission at once, as it is hardly possible that they could have many concrete plans completed before that time.

Progress on Illinois Waterway

The Illinois waterway project which was enacted into law at the last session of the Illinois Legislature is moving along. Gov. Dunne has named three members of the commission. One member appointed is an engineer, Mr. Edward J. Kelly, who has been assistant chief engineer of the Sanitary District of Chicago. It is stated that the commission will be organized so that work may be begun on the waterway "immediately."

The Lighter Side of Engineering and Contracting

TALK about thoughtfulness! At one of the shafts for a waterworks tunnel the foreman has put up the following notice: "Please do not fall down this shaft."

An Impertinent Question.

UPON the completion of a certain railroad the contractor and chief engineer were riding over the line, seated on the back platform of the observation car. Said the chief engineer: "According to the plans and specifications the embankments should be 12 ft. wide." "Yes," said the contractor, "they are all that width." "Then," queried the engineer, "how do you explain the fact that the cross-ties, which are 8 ft. long, stick over the shoulders?" E. L., Buffalo, N. Y.

When Caught Without a Caterpillar Tractor, Try This.

NEWSPAPER joke-smiths who reside in that section of the country referred to by Benjamin Harrison as the rich fringe of the nation's robe, meaning the Atlantic sea-board, have a stock form of humor which consists, essentially, of poking fun at Kansas. Most of these jokes are merely provincial, a few are really humorous. For example: A Newark, N. J., paper tells how beer saved the 1915 Kansas wheat crop. The statement is made that no state in the Union is more fiercely hostile to the Demon Rum and all the lesser members of his family than is Kansas. Kansas is a dry state, we know, and was even back in 1910 when we worked out there. We know it was because we read articles written for eastern magazines of that period, by Gov. Stubbs, telling how prohibition prohibited in Kansas. But to go on with the narrative. The Newark paper states that heavy rains made it impossible to get into the ripe wheat fields with the regulation twine binder this year. The bull wheel mired down. A Cherokee farmer hit upon the idea of utilizing beer barrels for binder wheels. "Forthwith he secured two beer barrels, whence it is unnecessary and perhaps impertinent to inquire, and quickly fitted them to the axles of his binder, mounted the seat, clucked to his horses and proceeded to cut a wide swath through the ripened grain. Quickly the news spread and soon every confiscated beer keg in the county had been rescued from its depraved use and started upon a mission of saving bread for the farmers and putting money in the pockets of Kansas farmers. Hundreds more, empty of course, were ordered from outside the state and set gaily rolling to the music of the clicking blade. The wheat was saved and beer barrels saved it. And now the question arises, what would Kansas have done if all its neighbors had been as virtuous and as abstemious as is Kansas itself?"

Wasted Wealth.

Uncle Walt Mason, the rhyming crusader of Emporia, Kansas, and the United States, in one of his recent daily canters on Pegasus lamented the makeshift character of rural construction procedure in the following verse:

A man indignant waxes when he beholds the waste of coin he pays for taxes, all squandered or misplaced. Out on the western prairies the toiler's wealth is heaved at robins and canaries, and he, of course, is peeved. It goes for pewter bridges, which break beneath a load; it goes for plowing ridges and grading up the road. It goes for bum repairing of highway and of hill, and so we hear him swearing, the man who pays the bill. He seeks the county fathers, the men who spend the change, and vexes them and bothers their souls with questions strange. "Why don't you grade the ridges with permanent intent? Why don't you build us bridges of granite or cement? We all would be in clover if lasting roads were made, but over, still and over, you plow and scrape and grade, you make your culvert wooden and build your bridge of tin; contractors have a puddin' the strong box wading in." But useless is his kicking, the poor taxpaying man; the county dads are sticking to their old futile plan; still building bridges rotten and roads that wash away; all but the bills forgotten, the bills the workers pay.

Men Have Been Shot for Less Than This.

PROFESSIONALS say the oldest ones are best. Being willing to play straight tips we'll give this one a trial and tell the three oldest stories we know. A picture of Francis X. Bushman will be given to every one who laughs at one of them.

(1) Small boy to father: "Dad, is cofferdam swearing?" "No, son. Why?" "Well, you'd better give granny some medicine or she'll cofferdam head off!"

(2) A superintendent of water works was routed out of bed at 2 a. m. by the ringing of his telephone. A man had called up to say that his water service pipe had broken and flooded his basement, drowning an old hen and a brood of chicks. "What am I going to do?" queried the water taker. "Raise ducks," said the superintendent.

(3) A taxpayer was haranguing a group of his fellow citizens about the deplorable condition of the city's streets. "Why," he said, "we are always in the mud or dust here. The next town has pavements and we must have them, too. Now, can't we all put our heads together and make a nice wood block pavement for the court-house square?"

(The latter story appears to disclose some system in the use of creosote oil shampoos for falling hair so urgently commended by tonsorial artists.)

A PINFEATHERED engineer, fresh from college, where he had been prominent in Y. M. C. A. circles, got a job as inspector on a sewer job. The contractor was a bewhiskered behemoth who, in his earlier days, had worn a red flannel shirt and smoked "Giant." The first morning on the job the contractor offered the inspector a cigar. "I neither smoke, chew, drink nor swear," said the latter. "Well, then," said the contractor, "maybe I ought to slay you before you sin."

Why Railroad Men Go Crazy.

EMILIE LOW, at one time prominently connected with the Norfolk & Western Railroad in an engineering capacity, was talking recently about the difficulty of getting a certain class of railway employes to understand instructions. On one occasion Mr. Low was trying to explain the philosophy of a whistle and ring post to an extra man on the fireman's board. Feeling, finally, that the fireman had grasped the significance of the post and its markings, but wishing to make sure, Mr. Low asked him to interpret the instructions. The fireman said: "Now, Mr. Low, I can see how W stands for wring, but how R stands for whistle is more than I can figure out."

Another Reason for Adequate Drainage, Or Is It?

DURING a recent heavy rain in Chicago a large storm water sewer backed up into a police station where three transgressors were detained in cells located in the basement. One was incarcerated for larceny, another for being disorderly and the third for arguing too strenuously with his better half. As the water rose the prisoners followed suit. First they stood on the cots and then, monkeywise, climbed up the lattice work of the cell structures, where they clung chattering for assistance and reviling water and things generally. Their plight was the greater from their previously demonstrated inability to bail themselves out. At length the lockup keeper was moved to compassion and action. Acting on his own initiative he decided that drowning was more than they deserved, so he rescued them by means of a pair of hip boots and an improvised raft.

* * *

SKINNER MULVEY says: "I'm still a broth av a b'y and never dodge a shindy—with a man. But, I'd rather play leap frog over a buzz saw than trifle with a woman when she's mad."

DISTRIBUTES $990,000 FOR STATE ROAD WORK.

Illinois Highway Commission Names Amount to Be Used by Each of 102 Counties.

Available This Year.

The State Highway Commission of Illinois has distributed among the 102 counties of the state $990,000 to be used for the years 1915-16 in good roads work. The allotment is made in compliance with provisions of the good roads law. The amounts awarded to each county in the state follow:

Counties.	Allotment 1915-'16.	Counties.	Allotment 1915-'16.
Adams	$ 9,951	Livingston	$ 15,880
Alexander	10,390	Logan	10,936
Bond	4,334	Macon	16,683
Boone	5,805	Macoupin	11,027
Brown	2,799	Madison	15,469
Bureau	19,764	Marion	6,042
Calhoun	1,596	Marshall	6,118
Carroll	7,407	Mason	5,336
Cass	6,893	Massac	1,552
Champaign	20,676	McDonough	7,987
Christian	12,912	McHenry	12,956
Clark	5,446	McLean	24,196
Clay	3,487	Menard	3,657
Clinton	4,851	Mercer	9,085
Coles	8,905	Monroe	2,896
Cook	108,994	Montgomery	10,818
Crawford	4,904	Morgan	9,304
Cumberland	3,220	Moultrie	5,620
Dekalb	15,482	Ogle	12,949
De Witt	7,920	Peoria	21,744
Douglas	7,951	Perry	2,618
Dupage	11,266	Piatt	7,223
Edgar	13,529	Pike	8,664
Edwards	1,552	Pope	1,243
Effingham	3,904	Pulaski	1,987
Fayette	7,253	Putman	2,585
Ford	8,503	Randolph	3,615
Franklin	6,185	Richland	3,337
Fulton	11,811	Rock Island	6,285
Gallatin	2,267	Saline	8,462
Greene	7,049	Sangamon	17,010
Grundy	8,841	Schuyler	4,587
Hamilton	3,489	Scott	3,370
Hancock	9,719	Shelby	11,904
Hardin	661	Stark	5,097
Henderson	5,107	St. Clair	10,085
Henry	13,027	Stephenson	10,348
Iroquois	19,294	Tazewell	9,240
Jackson	7,880	Union	2,526
Jasper	4,052	Vermillion	29,482
Jefferson	5,124	Wabash	2,846
Jersey	3,808	Warren	9,069
Jo Daviess	6,285	Washington	4,356
Johnson	984	Wayne	5,844
Kane	23,582	White	4,531
Kankakee	10,394	Whiteside	13,741
Kendall	6,050	Will	17,772
Knox	11,624	Williamson	5,440
Lake	11,953	Winnebago	14,042
La Salle	28,384	Woodford	8,415
Lawrence	6,647		
Lee	10,461	Total	$990,000

Pan-American Road Congress.—The literary programme which is being prepared for the Pan-American Road Congress covers the entire range of subjects connected with the construction and maintenance of country roads and city streets. Among those who have already accepted assignments on the programme are the following:

G. P. Coleman, State Highway Commissioner of Virginia, "Convict Labor for Highway Work."

Wm. H. Connell, Chief, Bureau of Highways and Street Cleaning of Philadelphia, Pa., "Dust Suppression and Street Cleaning."

Geo. W. Cooley, State Engineer of Minnesota, "Road Drainage and Foundations."

A. W. Dean, Chief Engineer, Massachusetts Highway Commission, "Maintenance, Materials and Methods."

A. B. Fletcher, State Highway Engineer of California, "Organization and System in Highway Work."

W. S. Gearhart, State Engineer of Kansas, "Highway Bridges and Structures."

Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment of New York City, "Highway Indebtedness: Its Limitation and Regulation."

L. W. Page, Director, U. S. Office of Public Roads, "The History and Future of Highway Improvement."

Frank F. Rogers, State Highway Commissioner of Michigan, "Roadway Surfacings."

Prof. L. S. Smith, University of Wisconsin, "The Educational Field for Highway Departments."

Col. E. A. Stevens, State Commissioner of Public Roads of New Jersey, "The Essentials of Proper Laws for Highway Work."

W. D. Uhler, Chief Engineer, Pennsylvania State Highway Commission, "Resurfacing Old Roads."

Among those who will preside at the sessions of the congress are the following: Fairfax Harrison, President, Southern Railway Co.; W. A. McLean, Chief Engineer of Highways and Commissioner, Ontario Public Roads and Highways Commission; Col. W. D. Sohier, Chairman, Massachusetts Highway Commission; George W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn, New York City.

Large Tunnel Contract Awarded at Pittsburgh.

The contract for the construction of the Neeld tunnel to the South Hills was let yesterday to Booth & Flinn, Ltd., who were the lowest bidders with $1,347,018.50. This price is for the construction of the tunnel with monolithic concrete. There were seven bidders for the contract. Work will start at once, according to William Flinn, who represented the successful bidders, as only a few days will be necessary for the company to collect its machinery. Bids were received on several different methods of building the tunnel. On the recommendation of Engineer Neeld, brick masonry and block concrete were rejected and monolithic concrete accepted.

The other six bidders and their estimates on monolithic concrete were as follows: Bennett & Talbot Co., Greensburg, $1,737,895; H. S. Kirbaugh, Inc., New York city, $1,627,303.25; Arthur McMullen Co., Newark, N. J., $1,737,895; T. A. Gillespie Co., Pittsburgh, and Rheinhart & Dennis, Charlottesville, Va., bidding jointly with Robert Grace Contracting Co., Pittsburg, $1,380,878; John B. Carter Co., New York City, $1,627,303.25.

The tunnel will be 4,816 ft. in length and 33 ft. in width, and 17 ft. in height. The general bore will be made up of twin tunnels. On the inside of each tube the wagon and electric car service will be directed, while the wall sides of the tube will be given up to root traffic. It is expected that the work of completing the tunnel will consume about two years' time. A description of the proposed work appeared in our issue of June 23, 1915.

Texas Good Roads Association.—A joint meeting of the Texas Good Roads Association and County Judges' and Commissioners' Association is to be held at the Agricultural and Mechanical College of Texas, College Station, Texas, Aug. 5, 6 and 7. The program includes a number of inspection trips, moving pictures showing road construction methods, an exhibit of road machinery and materials, a demonstration of bituminous macadam and gravel roadways and concrete sidewalks, and papers and discussions on road laws, convict labor, highway legislation, maintenance, etc.

INDUSTRIAL NOTES

The Burd High Compression Ring Company, Rockford, Ill., is beginning the installation of machinery in an additional new factory building, containing 30,000 sq. ft. of floor space

Mr. George P. White has been promoted to the position of manager of the Philadelphia office of the Buffalo Steam Roller Co. This office has been removed to Room 404, Bulletin Building.

Mr. W. Spencer Robertson has been appointed secretary of the American Locomotive Co., 30 Church Street, New York City, succeeding Mr. C. B. Denny, resigned.

The Knox Motors Associates of Springfield, Mass., an association recently organized to act as sole distributors of the products of the Knox Motors Co., announce the appointment of C. F. Rouze as sales manager, succeeding Mr. H. F. Blanchard, resigned. Mr Rouze has been in charge of the branch office at Kansas City, Mo., since February, 1914.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examinations:

Marine engine draftsman for submarines; $5.04 per diem. Aug. 18-19.

Marine engine and boiler draftsman, $2.52 per diem; Aug. 18-19.

Junior drainage engineer, $960-$1,620 per annum; Aug. 18.

Senior drainage engineer, office of public roads, $2,220-$3,000 per annum; Aug. 17.

Drainage engineer; office of public roads, $1,800-$2,100 per annum; Aug. 17.

Junior Land Appraiser; $900 to $1,500 per annum; Aug. 18.

Senior Land Appraiser; $2,700-$3,600 per annum; Aug. 17.

PERSONALS

Mr. C. E. Drayer, a well-known engineer of Cleveland, Ohio, has been elected as secretary of the Cleveland Engineering Society.

Messrs. Seymour H. Phelan and Clarence P. Day announce the formation of a partnership under the firm name of Day and Phelan, for the general practice of surveying and civil and landscape engineering, with offices at Rooms 14-15, First National Bank Building, Santa Barbara, Cal.

Mr. T. H. Johnson, formerly assistant city engineer of Sioux City, Iowa, has been appointed city engineer to succeed Mr. Fred C. Smith, who recently resigned. Mr. Johnson entered the office of the city engineer of Sioux City immediately after leaving college in 1884. In 1892 he was elected city engineer. From 1895 to 1903 he was in private practice and promotion work. In 1903 he re-entered the city engineering office as first assistant engineer. Mr. Johnson is author of the Sioux City specifications for concrete pavement, and has also written a number of articles for technical papers and the general press relative to Sioux City concrete paving practice.

Mr. Charles H. Richards, engineering contractor, has opened an office at Van Nuys, Cal., for general engineering practice and contracting in irrigation work. Mr. Richards was formerly assistant superintendent and mining engineer for the Blue Bell Copper Co. in Arizona for two years. From 1905 to 1912 he was division engineer in charge of construction on 23 miles of the Los Angeles aqueduct. The following year he was assistant superintendent for the Pacific Gas & Electric Co., at San Francisco. During the years 1913 and 1914 he was resident engineer for the La Mesa Irrigation district, San Diego, Cal. For the past year he has been district engineer for the Los Angeles City Flood Control Commission.

Mr. Harold T. Power, 632 Call Building, San Francisco, Cal., has been appointed chief engineer for the State Water Commission of California. Mr. Power was superintendent and manager for the Hidden Treasure Gravel Mining Co. from 1896 to 1910. He installed a hydroelectric plant and underground electric haulage system on that property in 1897, which was the first underground installation of the kind in California. He had the superintendency of other mining properties during that period and also supervised the construction of canals, hydro-electric power development, distribution ditches, compressed air plant for the operation of underground machinery and similar engineering work. He has been a member of the California State Board of Control (water power), and the State Water Commission since April, 1911.

Mr. Edward J. Kelly, engineer of the Sanitary District of Chicago, has been appointed by Governor Dunne as a member of the Illinois Waterway Commission. Mr. Kelly, who is 39 years old and a native of Chicago has been with the Sanitary District for the past 22 years, except three years when he was with the U. S. Deep Waterway Survey under Alfred Noble, George Wisner and Major Raymond. Starting in as a rodman in the Sanitary District, Mr. Kelly has risen to the rank of assistant chief engineer, and is in charge of all engineering work. He had direct charge of the North Shore channel, for which $2,000,000 was expended on day labor, and $4,000,000 on contract work. He is now building the Calumet-Sag channel, at an estimated cost of $15,000,000. Mr. Kelly was in charge of the engineering work on the Illinois Waterway bill.

Mr. L. R. Jorgensen has severed his connection with the firm of F. G. Baum & Co., engineers of San Francisco, to open offices as consulting and designing electric hydraulic engineer at 1405 Chronicle Building, San Francisco. Mr. Jorgensen has been a member of the above firm since 1907 and has been engaged in hydroelectric work in various states and countries along the Pacific coast. Prior to 1907 Mr. Jorgensen was for one and a half years with the Pacific Gas & Electric Co. at San Francisco and for about the same time with the Southern California Edison Co. at Los Angeles on power plant and transmission line construction. During 1902 and 1903 he was with the General Electric Co. at Schenectady. Mr. Jorgensen has specialized in arch dams, and particularly in the construction of the constant angle arch dam, his own invention. He is at present engaged as consulting and supervising engineer on two multiple arch dams on Bush creek in eastern California.

Mr. H. A. Kipp, who has been connected with the office of drainage investigations, U. S. Department of Agriculture, for the past nine years, has resigned from his position as drainage engineer and has opened an office at Houston, Texas. Mr. Kipp has been connected with a large number of drainage projects in many parts of the United States, among which are the Everglades reclamation work in Florida, the St. Francis River bottoms reclamation in Arkansas, the Tuscumbia River, and Belzoni drainage projects in Mississippi, the Toisnot Swamp drainage project in North Carolina, and the planning of a system of drainage from the entire area of Jefferson County, Texas. Mr. Kipp will engage in general drainage engineering practice in the coastal plains of Texas, where there is a vast area of land that needs drainage. He is prepared to make surveys, plans, estimates and reports on any kind of drainage work, levee building, pumping, etc., in that section of the country. Mr. Kipp's office is Room 305, Southern Pacific Building, Houston, Texas.

Mr. Farley Gannett, who has been engineer of the Water Supply Commission of Pennsylvania for nearly ten years, has resigned to enter private practice, with headquarters in Harrisburg, Pa. Mr. Gannett intends to specialize in practice before state departments and commissions, including the Water Supply Commission, Public Service Commission and Health and Highway Departments, but is organizing a force to handle general practice as well. He has also organized a chemical and bacteriological laboratory to make analyses of water, sewage and trade wastes. Mr. Gannett is a graduate of Massachusetts Institute of Technology. He began work in 1902 for James H. Fuertes of the Board of Public Works. He helped design and build the Paxton creek interceptor, made the first survey for the Wildwood storage reservoir and park and was assistant engineer during the designing and construction of the filter plant at Philadelphia. In 1905 he was invited by the newly appointed Water Supply Commission of Pennsylvania to apply for the position of engineer to the commission and was appointed December 1, 1905. Mr. Gannett is president of the Engineers' Society of Pennsylvania, and has written many papers for engineering journals and addressed engineering societies and technical schools concerning hydraulic subjects.

Mr. Joachim G. Giaver, who for the past seventeen years has been chief engineer of structural design and foundations for D. H. Burnham & Co., announces that he has left that concern and opened offices for the practise of consulting engineering at 751 Railway Exchange Building, Chicago, where he intends to specialize in structural design, foundations and building engineering in general. Mr. Giaver graduated from Tecknical College at Trondjheim, Norway, coming to America in 1882. He was chief engineer for the Shiffler Bridge Co. of Pittsburgh, from 1883 to 1890, during which time he constructed the iron supporting frame for the Statue of Liberty in New York harbor. In 1892 he was assistant chief engineer for the World's Columbian Exposition at Chicago, and at that time designed the great three hinge arch in the Manufacturer's and Liberal Arts Building, which still holds the record as the largest building arch in the world. Mr. Giaver was the introducer of spandrel wind bracing in the modern steel frame building, and was the first to drive building foundations to rock in Chicago, Milwaukee and Detroit. Another innovation credited to him was the use of reinforced steel sheet piling as a retaining wall for building excavations in large cities. His latest tall building was the 40-story Equitable Life Building in New York City.

Joachim G. Giaver

OBITUARIES

Jonathan Clayton Forman, president of the Forman-Bassett Company of Cleveland, Ohio, died in that city July 6.

Robert Child Scott, secretary and treasurer of the Morris Machine Works, Baldwinsville, N. Y., died July 3.

Thomas Stephen Kean, general contractor of Cumberland, Md., died in that city July 12, aged 58. Mr. Kean was for four years superintendent of the city water works. He was one of the contractors who built the West Virginia Central & Pittsburgh Railway from Keyser to Cumberland. He was also one of the organizers of the Cedar Cliff Cement Co.

Frank R. Williamson, assistant engineer with the Sanitary District of Chicago for six years past, died in Chicago, July 11. Mr. Williamson was engaged in bascule bridge design and construction while with the Sanitary District, and prior to that was with the Scherzer Rolling Lift Bridge Co. He was a graduate of the University of Illinois, and a member of the American Society of Civil Engineers. His last work was in connection with the design and construction of the Jackson street trunnion bascule bridge in Chicago.

J. G. Scurry, civil engineer, died at his home in Seattle, July 14, aged 70. Mr. Scurry was one of the engineers who made the original location of the Southern Pacific Railway across the Mojave desert, and was one of the original locaters of the transcontinental line of the Union Pacific. He was chief engineer of the Seattle, Lake Shore & Eastern, afterwards part of the Northern Pacific, and also located the Columbia & Puget Sound railroad. He located the Alaska Central, recently taken over by the government.

Sir Sandford Fleming, civil engineer, scientist and public man, died July 22, at Halifax, N. S., aged 88. In the early '60s Sir Sandford did his first important work when he conducted a survey for the first link in a railway which would extend from the Atlantic to the Pacific within British territory. He was elected chancellor of Queens University in 1880 and was many times re-elected.

Henry S. Hawley, president of the Railroad Supply Co., of Chicago died July 22 at his summer home in Saunderstown, R. I., aged 64. Mr. Hawley was a noted railway contractor and promoter, having started in the bridge contracting and railway construction and promotion field in 1874. He was one of the promotors of the Chicago & Wisconsin, and for a time was president of the Chicago, Wisconsin & Minnesota Railroad. He was general agent and purchased right of way of a portion of the Chicago & Great Western Railroad, and on its completion became general agent in charge of traffic and leases. He was general agent for traffic in Chicago of the Chicago and Northern Pacific Railroad from 1890 to 1893, and became general agent and treasurer for the receivers of the same railroad from 1893 to 1897. He was general agent and treasurer of the reorganized company, the Chicago Terminal Transfer Railroad, from 1897 to 1899, and traffic manager and assistant secretary from 1899 to 1902. He became president and a director of the Railroad Supply Company of Chicago in 1902.

NEW CATALOGUES

GALVANIZED SHEETS.—Paper, 9¼x6¼ ins. 62 pp. American Sheet and Tin Plate Co., Frick Bldg., Pittsburgh, Pa.

Describes Apollo Best Bloom Galvanized Sheets for culverts, flumes, cellars, tanks, silos, roofing, siding and other forms of sheet metal work. Includes numerous photographs of actual applications and gives details as to service. Especially notes tests on copper bearing galvanized sheets.

SLACK CABLE EXCAVATORS.—Paper, 6x9 ins.; 28 pp. The Mansfield Engineering Co., 1011-14 Fletcher Savings and Trust Bldg., Indianapolis, Ind.

Pioneer excavating outfits are illustrated by a number of typical photographs and the slack cable system is explained by drawings. The advantages of the slack cable outfit and particulars of the Pioneer back dump bucket are described in detail. The cuts show the operation of these plants in varying conditions.

CATALOGUE REVIEWS

IRRIGATION BY PUMPING.—Paper, 6x9 ins.; 40 pp. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago.

In this booklet, which is entitled "Practical Irrigation by Pumping," are illustrated and briefly described a number of installations of Fairbanks, Morse pumping machinery now in actual operation on large irrigation projects throughout the West. The cuts are made from interesting photographs of operations under widely varying conditions, and the supplementary text and diagrams give a very good idea of the machinery used, the soil irrigated and crops raised. One of the larger plants described is located in the beet-raising district of Kansas. A 60-HP. Fairbanks, Morse oil engine belted to a centrifugal pump in this case delivers about 4,000,000 gals. of water per day. This book, Catalogue No. 114A, will be sent on request.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
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EDITORS

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A Notable Track Materials Order.

At almost any time and in these times particularly an order for track materials for 230 miles of single track railway is a sizable order. "Where," we hear the question, "is any 230-mile railway being built at the present time?" Well, we know of only one and that one is in New York City. The Dual Subway system now under construction by the city of New York has approximately 260 miles of single track and of this mileage some 230 miles must have rails, joints, ties, ballast, etc., delivered within the next eighteen months. This is the reason for this unusual order for these times or more correctly it is one reason. The other reason is that by placing a few big orders now at the prevailing low prices the city can save money and can have the materials delivered in installments directly to the contractors for track work and thus eliminate all storage and rehandling. Specifically the city has already received or is asking bids for 30,000 tons of open hearth 100-lb. steel rail, for 1,000,000 tie plates, for 30,000,000 ft. B. M. of cross-ties and timber, for 356,000 cu. yds. of broken stone and for 3,000 tons of rolled manganese steel rail. It is asserted that this is the largest contract for like materials ever made by an American municipality and one can readily believe that the assertion is true. Its magnitude, in any event, is great enough to present a rather impressive mental picture of the enormous expenditures being made in the eastern metropolis for rapid transit passenger service.

An Example of Competent Water Works Management.

An impressive illustration of the wisdom of choosing water superintendents on the basis of what they know about the water works business, or closely allied enterprises, comes to us from South Bend, Ind. In his annual message to the Common Council the Mayor of that city said:

> The clerical work in the water works office is now being executed very satisfactorily with three persons where formerly seven were employed. The report of the Water Department shows that a saving of nearly $8,000 has been made in the operation of the system and in the purchase of supplies, in some instances a saving amounting to 30 per cent of the prices formerly paid. The same methods have been used in watching for the best market prices as are used in the best regulated private industries.
>
> It has also been shown that your honorable body made no mistake in raising the salary of the superintendent of the water works so as to permit the employment of an experienced water works engineer.

The report shows that the pumpage for the two years was practically the same, being only about 317,000 gals. less in 1914 than in 1913, in a total of nearly two billion gallons. It should be noted, by the way, that reduction of total annual pumpage in a growing city is itself a substantial indication of improved management.

The significance of obtaining better prices in 1914 than in 1913 is open to debate. Obviously, though purchase may have been made with good judgment, many factors were operative in fixing unit prices in 1914 which were beyond the control of any individual. For that reason we shall pass over the substantial portion of the total saving of $8,000 which was due to the lower prices prevalent in 1914. However, there are other items the significance of which admits of but one interpretation, and that is better management. Thus we find that the saving in station labor was $1,500, and in office labor $1,362. Moreover, the total coal consumption was decreased 367 tons which, at $1.75 per ton, represents a saving of $642. The sum of the last three items is $3,504, a figure which certainly is far in excess of the difference between the salaries demanded by competent water works operators and operators of the class who are willing to take the job, because it is a job, at whatever it pays.

When one stops to consider the more common "leaks" in water works operation the value of competent management cannot be disputed successfully. Such leaks are found in the purchase of fuel and other supplies without specifications, the unwise selection of pumping station equipment, the retention in service of force mains of inadequate carrying capacity except at enormous frictional losses, the retention of flat rates, the toleration of "free" water and water wastage, the waste of coal due to improper methods of firing and the design and condition of the machinery.

Financial Courage in Individuals and Communities.

Of physical and moral courage we hear much. There is another form of courage, equally as important as the two forms mentioned, about which it is well to think occasionally. We refer to financial courage. Financial courage is one of the most important factors in individual, corporation, community and national success. The present is a most opportune time for giving brief consideration to this subject for evidence has been multiplying for some years past that the "go get it" spirit which characterized the American pioneers is somewhat in eclipse. In the business world our long protected industries are somewhat prone to ask government protection, large profits and a minimum of competition before going about their business in a whole-souled manner. This statement was as true before the war as it is today, so the war may be largely ignored in this discussion.

Financial courage is one of the most interesting attributes of man. Some men possess it to such a degree that they are always willing to plunge, while others who may be as brave as lions, physically, and Lincoln-like in their moral courage, are always pannicky in financial matters. Men of the latter class sometimes succeed if fortunately placed. Generally, though, the man who succeeds is the one who is willing to back his judgment with his money and occasionally cut loose from a sure thing. The same statements apply with unabated force and with equal truth to those artificial persons known as private business corporations.

We find the same conditions obtaining in municipal corporations. The tendency of some cities to get head over heels in debt is so strong that the bonding limit of cities has long been fixed by law. Again, some towns are so timid that they refuse to install public improvements on account of incurring indebtedness and the resulting increase in taxes.

As an example of a small town possessed of financial courage Essex, Iowa, may be mentioned. Essex has a population of 790 people, "but of such is the kingdom of Iowa." And of such, it may be added, are the other kingdoms in the Mississippi Valley. The entire world praised San Francisco for rebuilding a better city over its fire-swept ruins, but Essex did the same thing, very quietly, back in 1897 when about half of it burned down. Following its rebuilding it installed a water works system the original cost of which was $7,000. Additions have been made from time to time and all services are metered. The city is electrically lighted with "imported" current. About three years ago a $6,000 sewerage system was installed. All streets are graded and curbed with a view to paving later on. The people, it will be seen, long ago concluded that because they chanced and chose to live in this small village there was no reason for denying themselves the conveniences of modern life.

The authority for these facts is the present Mayor of the town, Mr. W. D. Gay. After giving proof of the financial courage of Essex, Mr. Gay addressed himself to officials of small towns lacking improvements as follows:

> You know that there are many small towns without lights, water or sewer service. Now, why? Honest, now, are you afraid, scared stiff, and at what? The cost? Strange, but true; yes, it's strange that a town council is afraid to be a party to bonding a good town to the extent of a few thousand dollars. Why, I know men, young men—boys, in fact, that are not one bit afraid to go into debt from $5,000 to $10,000 and pay 6 per cent for it. All on one pair of young shoulders—and they make good, too. Pay out and don't grumble. Then, why in the name of improvement is it that one can find towns, good towns of 800 energetic, hustling people, that are scared stiff when it comes to the point where they expect to issue bonds?

That Essex is not the only small town in Iowa having gumption enough to install improvements is shown by some figures given out by Lafayette Higgins, State Sanitary Engineer. Mr. Higgins states that the smallest Iowa town having a water works system has a population of 110. The population of the smallest town having water works and sewers is 357, and the smallest one with these improvements and also a sewage treatment plant has a population of 416. Apparently the spirit of the pioneers is not dead in Iowa.

We believe these figures will be serviceable to engineers who go about doing good by persuading small towns to install improvements. Incidentally, we hope we have suggested a line of thought which may help some of the larger cities to move out of the doldrums where they now lie becalmed.

Field Testing of Concrete.

In the past engineers and contractors have not been sufficiently concerned with the actual strength of the concrete entering into structures built under their direction. In general, they have been content to accept the results of laboratory tests of the cement and of a few samples of concrete, and have not given sufficient attention to the quality of the aggregates being furnished from time to time or to the methods used in mixing and placing the concrete. That the importance of these factors is being more generally realized is evidenced by the field tests which are being required on several important construction jobs now under way. That such tests are feasible and worth while can hardly be questioned, especially on jobs extending over a considerable period. The Massachusetts Institute of Technology buildings and the Welland ship canal are two important contracts on which field tests of concrete are required. In view of the fact that the engineers in charge of these projects have been compelled to originate their own methods of collecting samples of concrete and of testing these samples the following statements are pertinent:

On the Massachusetts Institute of Technology job two field samples are taken regularly on each section of the work at least four times a week for tests at 14 and 28 days, both samples being taken from the same batch. Wherever possible the samples are taken directly from place; but for beams, columns and girders, where this is impracticable, they are obtained from the barrow before placing. The concrete is shoveled into two 14-quart galvanized iron pails, remixed to eliminate any segregation of materials due to carrying from the work, and poured into iron molds embedded in moist sand. The maximum and minimum temperatures are recorded every day. For mass concrete, where the size of aggregate runs up to 2 or 2¼ ins., the samples are cast in 8x16-in. cylinders; but for the superstructure concrete, where the largest size of aggregate is not over 1½ ins., 6x6x12-in. prisms are cast. The bottom of each mold is formed of a ½-in. iron plate, and the concrete is tamped in the mold with a 6-in. ice chopper. Each sample is given one tamp on each face and four tamps at 90° in the center. The time given to dumping into the molds and tamping does not exceed five minutes. Just previous to the initial set the top surfaces are carefully troweled with a plasterer's trowel to obtain a uniform bearing in the compression machine. After 48 hours the blocks are removed from the sand, taken from the molds, and reburied in moist sand until the day before they are tested. The following results of some tests made on this work are of interest: The average compressive strength of the 1:2:4 concrete at 14 days was 1,640 lbs. per square inch, while that of the 1:1½:3 concrete at the same age was 2,008 lbs. per square inch. At 28 days the average compressive strength of the 1:2:4 concrete was 2,110 lbs. per square inch and that of the 1:1½:3 concrete at the same age 2,520 lbs. per square inch—each value being the average of about 90 specimens. It is thus seen that the average increase in strength from 14 to 28 days for the 1:2:4 concrete was 23 per cent, while for the 1:1½:3 concrete this increase was 25 per cent.

The value of this system of sampling and testing was shown at the beginning of the job. Some of the test specimens of the 1:2:4 concrete gave low values, and the method of handling the concrete was changed at once, with the result that subsequent specimens gave proper strengths. The importance of making periodic tests of the aggregates was realized by the engineers in charge of this work, and an inspector was sent to the sand bank at regular intervals to obtain samples, which were sent to the laboratory for testing.

In building the concrete structures of the Welland ship canal it is required that field samples of concrete be taken during the progress of the work. These samples are made into beams 4¾ ins. wide, 3½ ins. deep, and 3 ft. long, for testing at specified ages. This work is being done at the field office of each section, the tests being made on a special machine designed for the purpose. This machine, which can be constructed at a low cost, has given satisfactory results.

On contracts which extend over a considerable period, field testing is a logical procedure, and we believe it will soon come into general use. The necessity of determining the quality of the concrete which is going into a structure has long been felt, and field testing will do much to insure a more thorough testing of the aggregates as well as better mixing and placing methods. The formulation of a satisfactory set of instructions is essential to the general adoption of field testing, and it is gratifying to note that a sub-committee of the American Society for Testing Materials has been assigned this work.

WATER WORKS

The Valuation of Water Works Properties.

IV. Appraisal of Reservoir Site Value.

By Halbert P. Gillette.

The value of reservoir sites is commonly underestimated by appraisers. The ordinary method is to ascertain the acreage of the site and apply a price per acre at which surrounding land may be purchased. The surrounding land, however, is seldom well adapted for reservoir purposes, its topography being such that a reservoir built upon it would be excessively costly.

Land, it should be remembered, is usable for many purposes, and for no two purposes is its value identical. Thus, an acre of land may have one value for farm use, another value for pasturage, another for residence purposes, another for a manufacturing site, another for quarry or mining use, and so on. There are many factors that enter into the problem of land valuation, such as:

1. The character of the soil.
2. The availability of water for various purposes.
3. The topography or contour of the surface.
4. The character of material beneath the surface.
5. The contour and location of subsurface material.
6. The distance to "market."

In land used for engineering purposes, both topography and subsurface character are usually very important factors. This is particularly true of land used for a reservoir site.

The courts, of course, have ruled that land condemned for public use may have special value for special purposes, such as railway right of way, bridge sites, reservoir sites, etc. If this special-use value is higher than the ordinary use value, the courts hold that the higher price must be paid for it. While there are as yet few court decisions relating to land valuation for ratemaking, it is apparent that the same principles are being applied by the highest courts in the appraisal of land for ratemaking as in the appraisal of land condemned for public use. This was well brought out in the recent decision of the San Joaquin and Kings River Canal and Irrigation Co. case, in which the U. S. Supreme Court held that water rights must be assigned a value for ratemaking even as for condemnation.

In short, land must be appraised at its *highest* value for any use to which it may be applied. The problem then resolves itself into finding a proper method of attack.

The most general rule for land valuation is this:

The value of land is the capitalized profit derivable from its use.

When the land is part of a large plant, it is often difficult to ascertain how much of the total profit is assignable to the land and how much to the rest of the plant. It may even seem impossible to solve such a problem, and the seeming impossibility has doubtless led many appraisers to abandon scientific analysis and adopt pure guesswork. But deeper consideration of the general nature of valuation problems yields a method that is always applicable. I call it the alternative plant method. It may be briefly stated thus:

The value of any part of a plant is equal to the capitalized cost of its most economic alternative, provided the sum of the values of all the parts thus calculated equals the value of the whole, which is the capitalized profit derived from the entire plant.

By "capitalized cost" is meant the total annual cost (operating expenses plus fixed charges) divided by the rate of normal interest return on similar properties. Thus, if the operating expenses (including depreciation and taxes) are $10,000 yearly and if the interest charges are $22,000, the total annual cost is $32,000. If 8 per cent is the normal rate of return (allowing for risks) on such properties, then the capitalized cost is $32,000 ÷ 8% = $400,000.

Now to an application: Suppose a reservoir site is owned at the top of a hill, and that it covers 10 acres. What is the site worth? The appraiser must first seek the next available, or alternative, site for a reservoir. He finds, let us say, in another part of the city a suitable hill, but it is occupied by residences. He finds that to purchase 10 acres of this hill with the residences upon it will cost, say, $25,000 per acre. This high cost drives him to seek another alternative, which, let us say is a suitable piece of suburban land two miles farther from the pumping station than the existing reservoir. He finds that this land can be bought for $1,500 an acre, and that the added 2 miles of pipe line will cost $50,000. He estimates the maintenance and depreciation of the pipe line at $800 annually, which capitalized at 8 per cent is $10,000. He finds that this alternative site will involve more rock excavation than the existing site, to the extent of, say, $20,000. Summing up, he has:

10 acres at $1,500	$15,060
2 miles of pipe line	50.000
Capitalized maintenance, etc.	10,000
Extra excavation	20,000
Total	$95,000

It is of course necessary to estimate a pipe large enough to keep down the friction head to a point no greater than with the shorter existing pipe line. To the above $95,000 are to be added the capitalized increased cost of any other operating expenses, resulting from going to the alternative site, such, for example, as increased taxes on the larger investment. If there are no other increased operating expenses, then the $95,000 represents the *value* of the existing reservoir site, provided no cheaper alternative can be found than the one above given.

In the case of reservoirs, there is always available an alternative that does not involve the purchase of much land, namely a standpipe. But in calculating the cost of a standpipe it is important not to overlook two items, namely the added cost of pumping and the added risk of damage to the city from fires. The fire risk is usually so much greater with standpipe service as to become the deciding factor if there is any reservoir site available.

An adequate reservoir requires but one day "shift" of the pump crew, whereas a standpipe necessitates a night "shift" if there is to be adequate fire protection in a city or even in a large village. In addition, the intermittent pumping that a standpipe occasions calls both for larger mains and larger pumps to provide for the larger peak loads.

The standpipe itself requires maintenance (painting, etc.), to which must be added the maintenance and depreciation charges on the larger pumps and mains. All these added annual costs must be capitalized and added to the first cost of the standpipe equipment, to get the total capitalized cost. The difference between the total capitalized cost of the alternative standpipe plant (due allowance being made also for increased fire risk) and the total capitalized cost of the existing reservoir (exclusive of its site) is the *value* of the existing reservoir site, provided a standpipe system is cheaper than any other reservoir system.

Engineers who are accustomed to solving economic problems will find nothing unsound in the general method above outlined. Yet it is a curious fact that not a few engineers have opposed this method of appraising reservoir sites, mainly on the ground that it involves "capitalizing a natural advantage," which is repugnant to their ideas of fundamental justice." If asked to define "fundamental justice," they are confronted with a greater problem than the valuation of a water works. They often contend that land devoted to public use should not be valued by the same standards that prevail when it is used for private ends. If such a premise is granted, no standard whatever is left by which to value any land. Moreover, they find themselves in conflict with the highest courts.

Land and its entities—coal, gas, water, stone, etc.—pass into private hands by due process of law. It is not the function of an appraiser to set up a theory that disregards the facts. He may believe, with Henry George, that all land should be so taxed as to confiscate its value, or he may go only part way with George and hold that, when owned by a "public utility," land values should be confiscated by the public. But until laws are so framed as to make such confiscation legal, a public utility appraiser is duty bound to appraise land and its entities precisely as he would appraise them were they his own individual property.

Thus far I have assumed that an alternative reservoir site could be economically supplied with water from the same source as the existing reservoir receives its supply. Often this can not be done, in which event the cost of securing a new supply of water enters the problem. Then, of course, the value of the water rights (which is to be discussed in the next article of this series) becomes interwoven with the value of the reservoir site.

Natural reservoirs, such as ponds and lakes, are often owned by water works companies. The problem of valuing such natural sites is much the same as that of valuing artificial reservoir sites. Questions of title to the bed of the lake or pond may then enter. Usually, however, the right to use the water is vested in the company, so it is not particularly concerned as to the title to the lake or pond bed. Moreover, title to the margin of the lake or pond, or at least the essential part of the margin, is in possession of the company. Title to the land at the outlet, where a dam has been or can be built, gives sufficient legal control, provided the right exists to flood lands by raising the lake level. The dam site then may be regarded as possessing a value of its own.

In comparing two reservoir sites for the purpose of arriving at relative values, it should not be forgotten that a liberal allowance for contingencies should be made in estimating the cost of a proposed reservoir and its site. Often it happens that a seemingly good site—judged by surface appearance,—or even by borings is very poor. The ground may not hold water without expensive lining. A case in point is the recently built Cedar River reservoir of the Seattle municipal electric lighting system. The dam rests on a glacial drift deposit, which is so porous that it has been thus far impossible to fill the reservoir. Lining is out of the question because of the great area. The depth to bed rock probably prohibits construction of a cut-off wall. In short, there is strong likelihood that a very expensive dam and reservoir site may never prove useful. Facts such as these must be given weight in valuing an existing reservoir whose usefulness has been demonstrated.

A large reservoir is usually worth more than a small reservoir, particularly because of its greater insurance value in case of a conflagration. Hence it is often not fair to estimate the value of a lake reservoir by the "alternative method" when the alternative is a small artificial reservoir, unless an allowance is made for the greater fire risk. This is particularly true where the water to the small reservoir must flow through several miles of pipe or conduit. Then if a flood washes out some of the supply line, an entire city may be placed in jeopardy.

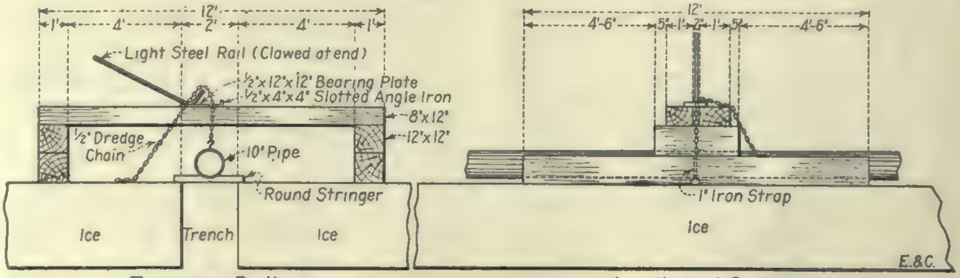
In the condemnation of the Syracuse water works (1891) the engineers representing the company claimed that the most rational method of ascertaining the value of the reservoir was to multiply its capacity in million gallons by the average cost of other similar reservoirs per million gallons. Such a method might give an approximation to the cost of the reservoir but would be no criterion of the value of the reservoir site. The method was advocated because of the absence of records as to amount of excavation, etc., involved in building the reservoir. It will be noted that the alternative reservoir method, which I have outlined, can be used to secure the combined value of an existing reservoir and its site; for that combined value is the total capitalized cost of the alternative reservoir and site minus the capitalized expense of operating the existing reservoir. This method gives an economically correct answer, whereas the Syracuse method gives only a crude approximation that may be quite erroneous.

In the next article of this series I shall discuss a subject closely related to reservoir site values, namely, water right values.

Method Employed in Lowering Water Intake Pipe Through Ice at Gilbert, Minn.

Contributed by A. Cohn, Assistant City Engineer, Gilbert, Minn.

A somewhat novel method was employed in lowering the water supply intake pipe into the waters of Cedar Island Lake, at Gilbert, Minn., last winter. The city is installing a filtration plant and it was thought best to lower the raw water intake during the winter. The work was started during February and after much sounding the right depth of water was found at about 800 ft. from shore.



Transverse Section

Longitudinal Section

Sketches Illustrating Method of Lowering Water Intake Pipe at Gilbert, Minn.

The ice was about 3 ft. thick. A trench was cut through the ice to a uniform width of 2 ft. The pipe was rolled to the edge of the trench. A staging, such as illustrated herewith, was erected every 35 ft., round stringers were placed cross-wise of the trench and the pipe was rolled upon them.

The pipe employed is 10 ins. in diameter and is coated with a Matheson coating. It came in 20 ft. lengths with screw joints, and a flange joint every 100 ft. A circular band of 1 in. strap iron was passed around the pipe at each staging and the lowering chain was engaged in a hook at the upper part of this band. The chain was pulled taut and slipped in the slot of the angle iron shown in the sketch.

Owing to the fact that two windblowers were attached at the off-shore end of the pipe a tripod and a 5-ton block and chain were erected over that end, and two snub ropes were also used to keep the windblowers perpendicular. Three men were used at each staging, one to work the angle iron and the other to operate the lever.

The night before the pipe was lowered the stringers were removed and the pipe was allowed to fill with water so that it would go down when the chains were slackened. The next morning the lowering began. A foreman stood at one end of the line with a megaphone and, at the word from him, each man at an angle iron allowed the chain to slip down two links. In this way the entire pipe line was lowered at the same time and it was not given a chance to sag. The shore end had to go down about 2 ft. while the off-shore end had to go down about 30 ft. As the shore end went down the chains slackened as the pipe reached the bottom and sunk into it. In three hours from the beginning of the lowering operations every chain was unfastened and pulled up. The pipe sunk about 1 ft. into the sandy bottom within two weeks after it was lowered.

Pros and Cons of Private Ownership of Water Meters.

(Staff Abstract.)

Probably the majority of water works managers advocate the public ownership of water meters or, as it is generally put, "the department should own the meters." However, the private ownership of meters finds a strong and able defender in the person of George Houston, water commissioner of Kalamazoo, Mich. Meters have been privately owned in Kalamazoo for years and the water takers of that city prefer, as a rule, to own their meters. Mr. Houston states his views on the subject of meter ownership substantially as follows:

Some contend that it is best for the municipality to retain the ownership of meters, for the reason that it gives the city full control in the care and inspection of them, which it could not have were they owned by the consumer.

We do not agree with those who hold this view, as experience has taught us that it makes no difference along this line whether the city or the individual owns the meter. As fully 90 per cent of the meters in use in our city are privately owned, we feel as though we are quite well posted on the subject.

When we first began the installation of meters we thought best that the city own them, but we soon found that people were very careless about protecting them, particularly against frost, and as we were put to a great deal of trouble as well as expense by reason of such carelessness, we set about to find some way out of the difficulty.

We finally hit upon the plan of giving the individual the privilege of either buying a meter outright or renting it. If he buys it he gets it at cost, and if he rents it he is charged an annual rental of 25 per cent of the cost of the meter and the setting of it, but is given credit for 40 per cent of all rents paid, which will pay for a meter in full in ten years. This, as you will probably conclude, is a modest way of forcing the people to own meters, but it has worked out nicely with us.

In handling matters in this way we have never had to make an appropriation for the purchase of meters except the first one of $4,000. The moneys received from rentals and the sale of meters have enabled us to keep the wheels revolving and to have a supply on hand at all times; and as we buy meters only as we need them, they are generally disposed of before the bill comes due.

We have never had any more trouble in exercising full control over privately owned meters than we have over those owned by the city, and we find that persons who own their meters, as a rule, take more pains in the setting and care of them than do those who rent them. I presume that it might be well to state that we do not rent meters that are above 1½ ins. in size, but require them to be paid for when installed, and so do not have any large, expensive meters on hand.

The city repairs the meters, charging cost for the parts and also for the time of the man making the repairs.

We have two methods of collecting for repair of meters. The city does not take off any meters that have been damaged by freezing; we require the property owner or some one for him—it may be the plumber or anyone else—to bring the meter to the office. Our men then repair the meter and we make out a bill and attach it to the meter, and some one has to pay that bill before the meter goes out. In other cases when repairs are made, the meters are put back into service and a report of the time and material is made to the office. We add that to the next outgoing bill and it has to be paid at the same time the bill is paid for water, regardless of whether the bill is being paid by the renter or by the owner of the property. If the renter pays the meter rental, if he is under obligation to pay the water bill, he usually collects or deducts the amount paid for the meter repairs from the next rental paid for the property.

The city reserves the right to furnish all meters. We have for a good many years had three different styles of meters from which consumers can make selections, so that no single kind is adopted as the standard meter.

ARGUMENTS FAVORING PUBLIC OWNERSHIP OF METERS.

The arguments favoring public ownership of meters or, in case of private ownership of the water works, the ownership of meters by the water company, are well stated in the following:

Ownership by the City.—Mr. Henry P. Bohman, Superintendent of Water Works at Milwaukee, Wis., states the arguments favoring ownership by the city as follows:

Milwaukee has about 161,000 meters in service, all of which are owned by the consumer. I wish to go on record that meters should be owned by the city; our experience has proved that to be the correct position to take. We have about 35 different makes of meters in service, good, bad and indifferent; whereas if the Department had had the selection of the meters, we would have confined ourselves to about two or three good types. The meters are furnished by the plumbers, who charge anywhere from $10 to $20 whereas if the Department owned the meters we would buy in large quantities and furnish them for $5 or $6. Indirectly that would be of benefit to every consumer. We have 35 meter readers who read the meters monthly and report as to how they are registering. If they are not registering properly, the next step is to take out the meter, sending a written notice to the consumer and asking him to sign the notice to have the meter repaired. The consumer has ten days to sign and send in that notice. In the meantime the meter is waiting in the shop. After the expiration of ten days it is repaired, and then it necessitates a second trip to replace that identical meter. Meanwhile the water registrar is advised that the meter has been taken off and replaced, and then the account is averaged. That is a simple proposition in the ordinary residence, but out of our total revenue one-half is paid by 100 consumers. It is very difficult to find a proper method of averaging the account when the customer is using from $25,000 to $75,000 worth of water a year. The fact that the gas and electric utilities furnish meters is pretty good evidence, I think, that the water department and companies should follow suit.

Ownership by the Water Company.—Mr. C. W. Wiles, Secretary of the Delaware Water Co., of Delaware, Ohio, states the arguments favoring the ownership of water meters by private water companies, as follows:

I have had experience both ways. We have about 90 per cent of our meters owned by the company and 10 per cent owned by individuals. I believe in the ownership of the meters by the company, for if a meter has been running five or six years and the books show that it has been dropping behind, that meter ought to come out. We took out over 40 this spring, because we thought they had been running longer than they were likely to run correctly. We found that 75 per cent or 80 per cent of those meters had been running slow, so we took them out without asking anybody's permission. We simply recorded on our books that the meter had been changed and another meter put in there. If the meter were taken out without putting another in its place, it would be necessary to estimate the consumption until replaced. One advantage of the company's owning the meter is that there is no controversy then over its ownership or repairs.

ACKNOWLEDGMENT.

This discussion of meter ownership occurred at the latest annual meeting of the American Water Works Association.

Prescribed Water Works Operating Methods in West Virginia.

The West Virginia Commission is the latest of the State Public Service Commissions to promulgate a set of rules and regulations for the government of electric, water and gas utilities. These rules were adopted July 15 and became effective Aug. 1, 1915. The present article gives the essential portions of the rules laid down to govern water works operation. The general stipulation is made that all existing construction dangerous to life or property should be changed to conform to suitable standards so as to obviate such danger as far as possible.

OPERATION AND MAINTENANCE.

Maintenance of Plant, Equipment and Facilities.—(a) Every utility furnishing, distributing, and selling water must have and maintain its entire plant and system in such condition as will enable it to furnish safe, proper and adequate service.

(b) Every utility must make an annual systematic inspection of its plant, equipment and facilities during May or June, and keep a record of results of such inspections for filing with the Commissioner by June 30.

Plant to Be in Accordance with Best Practice.—The construction of buildings, machinery, pumping and filtering plant of the utility shall be in accordance with the best modern practice.

Standard Practice.—The distribution system, including: (a) Water mains, (b) Fire hydrants, (c) Service pipes, (d) Valve boxes, (e) Meters, (f) Meter boxes, must be constructed and maintained in accordance with the best modern practice.

METERS.

Method of Measuring Service.—(a) The Commission recommends that all utilities shall install meters when demanded by consumers, except for fire hydrants and sprinkling and flushing streets of municipalities. Meters shall be furnished and installed at the expense of the utility, which shall also put in all service pipes from the main to the property line at its own expense. Any appliances furnished at the expense of the utility shall remain its property and may be removed by it at any time after the discontinuance of the service.

NOTE: The Commission believes that the fairest way of measuring the value of water is by meter; but, owing to the conditions prevailing in West Virginia, it does not see its way clear at the present time to adopt a rule requiring all water to be sold by meter. Water utilities, however, will take notice that it is the intention of the Commission to adopt such rule, and bring about metered service as soon and as rapidly as is practicable; and it invites the hearty co-operation of the utilities in bringing about this method, as soon as may be.

Location of Meters.—(a) It is recommended that all meters hereafter installed not on the consumer's premises should be located in a meter box between the curb box and the property line, and all meters hereafter installed on consumer's premises should be located if possible in the cellar as near as posible to the entrance of the service, and not subject to freezing.

(b) The meter should be easily accessible for reading and in such location that the visits of the meter reader or testers will not cause annoyance to the consumer. When a number of meters are placed in the same premises, every meter should be tagged so as to indicate the particular part of the building or premises served by said meter.

Meter Testing Facilities and Equipment.—(a) Facilities and Equipment. Every utility furnishing metered water service shall, unless specifically excused by the Commission, provide for and have available such meter testing shop and instruments and other equipment and facilities as may be necessary to make the tests required by these rules or other orders of the Commission. Such equipment and facilities shall be satisfactory to and approved by the Commission and shall be available at all reasonable times for the inspection and use of any authorized representative of the Commission.

(b) Working Standards. All testing instruments and other equipment shall at all times be accompanied by a certificate giving the date when it was last certified and adjusted and signed by the proper authority. These certificates when superseded, shall be kept on file in the office of the utility.

Accuracy Requirements for Water Meters.—No water meter that has an error in registration of more than 2 per cent fast or slow shall be placed in service. Whenever on installation, periodic or any other test, a meter is found to exceed these limits, it must be adjusted so as to register correctly to within 2 per cent fast or slow.

Place and Method of Testing.—(a) Every water meter, before installation on any consumer's premises, shall be tested for accuracy of registration by a competent meterman, employed by the public service corporation, whose selection has been approved by the Commission, and who has taken the oath of office required of all employes of the Commission.

(b) After all necessary repairs, adjustments and final tests have been made so that the meter registers accurately to within 2 per cent the meter shall be sealed and tagged with seals and date tags furnished by the Public Service Commission.

(c) The results of all tests and adjustments and data sufficient to allow checking of test calculations shall be recorded by the meter man in duplicate on blanks furnished by the Public Service Commission and the original test record so obtained shall be filed with the Commission within 30 days after making the test. All seals, date tags, and meter test blanks used shall be charged to, and paid for by, the utility at their actual cost and carriage. Every utility shall provide and use such copper sealing wire as the Commission may prescribe.

(d) All tests on water meters provided for in these rules shall be made in the meter testing shop of the utility, unless specifically permitted by the Commission to make tests on the consumer's premises.

Periodic Tests.—Every domestic meter shall be tested at least once every four years. All meters subject to heavy duty shall be tested at least once every two years.

Request Tests.—Every utility furnishing metered water service shall make a test of any water meter upon request of the consumer provided the consumer does not request such test more frequently than once in 12 months. If said meter shall be found to register not more than 2 per cent fast the consumer shall pay a fee of 50 cts. to the utility. A report giving the result of each request test shall be made to the consumer and to the Public

Service Commission, and the complete original record shall be kept on file in the office of the utility for at least three years.

Complaint Tests.—Upon formal written application to the Public Service Commission by any consumer a test shall be made upon the consumer's meter by an inspector of the Commission. A report giving the results of the test shall be made to the consumer and the utility, and a complete record of the test shall be kept in the office of the Chief Inspector of the Commission. If the said meter shall be found to register not more than 2 per cent fast the cost of such inspection shall be borne by the consumer, but if the meter shall be found to register incorrectly to the consumer's prejudice, more than 2 per cent, the cost of such inspection shall be borne by the utility. All inspections shall be made as soon as practicable. The charges fixed by the Commission for making such tests are as follows:

Outlet 1 in. or less	$1.50
Outlet 2 ins. and over 1 in	2.00
Outlet 3 ins. and over 2 ins	2.75
Outlet 4 ins. and over 3 ins	3.50

For meter having an outlet greater than 4 ins. in diameter, the Commission will adjust a special fee upon receipt of complete specifications.

INFORMATION TO CONSUMERS.

Information as to Reading of Meters.—Every utility supplying metered service shall adopt some method of informing its consumers how water meters are read either by printing on bills a description of the method of reading meters, by distributing booklets or folders describing the method, or by notice to the effect that the method will be explained on application.

Meter Reading on Bills.—Bills rendered periodically by every utility supplying metered service shall show the readings of the meter at the beginning and end of the time for which bill is rendered, the dates on which the readings were taken, the amount of water supplied and the price per unit.

Information as to Kinds of Service.—Every utility shall place on every bill a description of the kind of water furnished, whether filtered or unfiltered, and whether treated for bacteria or untreated. Where one class of service is available to only a part of the district served, this should be stated with every application. Where service is available only at certain times of day or night, full information must be readily available to all prospective consumers or their representatives.

Filing of Rate Schedules, Rules, and Regulations.—Copies of all schedules of rates for service, charges for service connections and extensions of lines, and of all rules and regulations covering the relations of consumers and utility shall be filed by every utility in the office of the Commission. All such schedules, rules and regulations, as filed with the Commission, shall be on file in the office of the utility, and shall be open to the inspection of the public.

Standard Pressure.—Every utility furnishing, distributing, and selling water shall maintain a standard pressure at the main level of the business district of the town or city where service is rendered, or at a point to be designated by the Commission.

Pressure Surveys and Records.—Every utility shall provide itself with one or more portable indicating pressure gages and every utility with more than 500 consumers shall have one or more graphic recording pressure gages, these instruments to be of a type and capacity suited to the pressure of the system.

All utilities shall make a sufficient number of pressure surveys to indicate the service furnished and to satisfy the Commission of its compliance with the pressure requirements.

All utilities having graphic recording gages shall keep at least one of these gages in continuous service at the plant, office, or on some consumer's premises. All pressure records are to be kept open for public inspection.

Tests of Healthfulness and Quality of Water, and Records.—Every utility furnishing water shall take a sample monthly, or as often as the State Department of Health may desire, from the source of supply or any point in the service designated by the said State Department of Health or by the Public Service Commission, in accordance with the rules for sampling as prescribed by the State Department of Health, and shall forward same to the testing laboratory of said department for analysis. Such test and analysis shall be made free of charge. The result of such tests shall be recorded in triplicate, one copy to be furnished to the Public Service Commission, a second copy to the utility and the original copy to be kept by the State Department of Health.

Every utility supplying water to a town or city of 5,000 inhabitants or more shall provide and use a suitable testing equipment for making proper tests for bacillus coli and other bacteria and tests for turbidity and quantity of matter in suspension, whereby the water furnished by it to consumers shall be tested at least once a week and at such other times and whenever required by the State Department of Health, and the results of such tests shall be recorded in triplicate, the original to be sent to the State Department of Health, a copy to the Public Service Commission and a copy to be retained on file by the utility.

Utilities shall furnish, at their own expense, such containers for samples of water as shall be prescribed by said State Department of Health for the purpose aforesaid.

Posting of Law, Rates, Rules and Regulations of Utility and Commission.—Every utility shall provide a suitable table or desk in the outside office, near the cashier's window, to which shall be kept securely fastened by a suitable chain the following:

(1) A copy of the rates, forms of contracts, and the rules and regulations of the utility, applying to the territory served from that office.

(2) A copy of the law of the state governing public utilities.

(3) A copy of the rules and regulations adopted by the Public Service Commission governing public service utilities.

(4) A suitable placard in large type shall be placed above the said desk or table, notifying the public that a copy of the law, and the rules and regulations and rates of the utility and rules and regulations of the Public Service Commission, are here kept for their information.

RECORDS.

Station Water Meters.—On or before July 1, 1916, every utility supplying water to a town or city of 10,000 inhabitants or more shall install such graphic recording water meters or other meters and graphic pressure instruments as may be necessary to obtain an accurate daily and monthly record of the amount of water pumped at every plant, together with the maximum demand and duration thereof.

Station Records and Interruption of Service.—Every utility shall keep a record of:

(1) The time of starting and shutting down power station equipment.

(2) The continuous pressure and amount of water furnished, as required in these rules.

(3) All interruptions of service upon the entire system or major division of the system, including in such record the time, duration, and cause of each interruption.

Records of Complaints as to Service.—Every utility shall keep a record of all complaints received at its office in regard to service, which record shall include the name and address of the consumer, the date, nature of complaint and the action taken. This record shall be available for inspection at any time within one year by any representative of the Commission.

Refunds.—Whenever a meter in service is found upon periodic, request, or complaint test, to be more than 2 per cent fast the utility shall refund to the consumer such a percentage of the amount of the bills for a period equal to the entire time elapsed since the last previous report test, but in no case to exceed 3 months, as the meter is found to be in error at the time of the test, provided, however, that the Commission may relieve the utility from this requirement in any particular case to any extent that the facts may appear justly to require.

Similiarly, when a meter is found to be more than 2 per cent slow, the utility may make application to the Commission for authority to render a bill to the consumer for water supplied, during a period equal to the entire time elapsed since the last previous test, not covered by bills previously rendered; but said application shall be made only in cases of substantial importance, and should be accompanied by a statement of all the facts in the case.

Deposits.—Any utility may require from any consumer or applicant a minimum cash deposit of $2.50 or other guaranty of an amount not to exceed the estimated 60-day bill of the consumer, where bills are rendered monthly or for an amount not to exceed the estimated four months' bill of such consumer where the bills are rendered quarterly. Interest on all cash deposits at the rate of 6 per cent per annum, payable upon the return of the deposit, shall be paid by the utility to every consumer making such deposit, for the time such deposit was held by the utility.

Accidents.—(a) Every utility shall keep a record of every accident happening in, or about, or in connection with the operation of its plants, stations, property, and equipment, whereby any person shall have been killed, or seriously injured, or any property other than the utilities damaged or destroyed, with a full statement of the cause of such accident, and the precautions taken to prevent similar accidents in the future, and shall at once make full report thereof to the Commission on blanks furnished by the Commission to be paid for by the utilities.

(b) It is required that all possible care will be exercised by each utility to reduce the life hazard (1) to which employes are subjected in working in stations and substations and underground lines, (2) to which the general public may be subjected by the presence of transmission mains, open ditches in the public streets, and ways.

It is also expected that every utility will so conduct its affairs as to cause the least possible danger or loss to other public utilities which make use of the public streets and roads.

ACKNOWLEDGMENT.

For the foregoing information we are indebted to Mr. J. K. Anderson, Chief Engineer of the Public Service Commission of West Virginia.

Cost of Automobile Maintenance, Brookline Water Works.—Mr. Fayette F. Forbes, Superintendent of Water Works at Brookline, Mass., reports that the automobile truck and two runabout cars now in use by his department have given excellent service and have greatly facilitated the work of the department. They are a great help and convenience in the general conduct of the routine business as well as in answering emergency calls. The three vehicles were in daily use throughout 1914 at a cost for maintenance of less than $1,000.

Lorain Electrolysis Case.—On Aug. 4, 1913, the city of Lorain, O., passed an ordinance "to protect the lives and property of citizens from the damages due to stray electric currents from the local single-trolley, grounded return circuit street railway system." One of the local street railways secured a temporary injunction, alleging in substance that this ordinance was confiscatory and impossible of operation. After engineers representing the gas, telephone and street railway interests made an elaborate electrolysis survey in Lorain, and had several conferences on the subject, the Common Pleas Court, on June 12, 1915, ruled that the allegations of the petition were untrue and found in favor of the city. The court ruled further that the electrolysis ordinance was good and valid, reasonable and just, and within the powers delegated to the city.

BRIDGES

The Chesapeake & Ohio Northern Railway Bridge Over the Ohio River at Sciotoville, Ohio.

(Staff Article.)

The new bridge of the Chesapeake & Ohio Northern Ry. over the Ohio River, at Sciotoville, O., forms a part of the new line of the Chesapeake & Ohio Ry. now being built to connect the main line of the latter in Kentucky with the Hocking Valley R. R., at Columbus, O. The bridge is a noteworthy structure in that it will contain two 775-ft. riveted through spans, built with the trusses continuous over the center support. The total length of the structure as designed is 3,435 ft., consisting, in addition to the two main 775-ft. river spans, of approaches on the Ohio and Kentucky sides having lengths of 822 ft. 6 ins. and 1,062 ft. 6 ins., respectively (see Fig. 1). These approaches comprise two 152-ft. 6-in. deck truss spans and a series of deck plate girder spans on concrete piers and abutments, these spans varying from 67 ft. 6 ins. to 110 ft. in length. The river spans are double track, but the approach spans are single track, although the piers and abutments provide for the future addition of a second track. The vertical clearance for navigation at high water is 40 ft., while at low water this clearance is 106 ft. 6 ins.

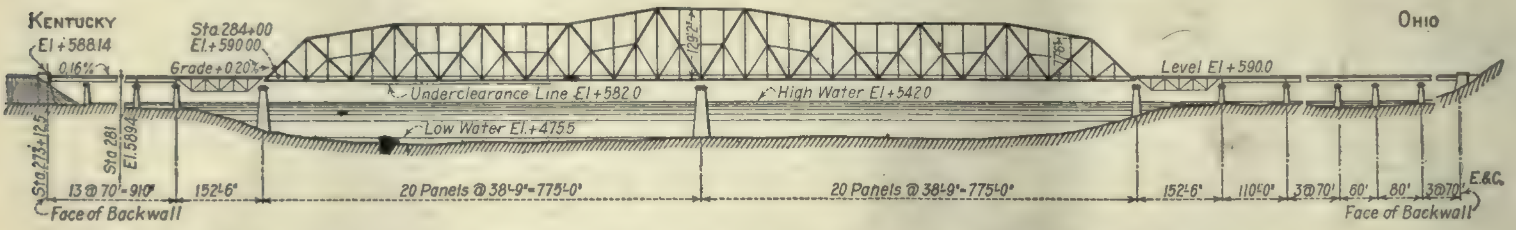


Fig. 1. General Elevation of Chesapeake & Ohio Northern Ry. Bridge Over Ohio River at Sciotoville, O.

At the bridge site the river curves sharply, its channel being near the inner or Kentucky side. At high-water stage, however, the traffic shifts to the Ohio side. This shifting of traffic made it desirable to have two large openings, which were fixed by the War Department at 750 ft., necessitating a spacing of piers of 775 ft. on centers. A comparison of various designs, consisting of simple spans, cantilever trusses, and continuous trusses, showed a decided economy for the design in which continuous trusses were used; this design also presents a better appearance, due to its symmetry. Conditions were especially favorable for the use of continuous spans, as rock is found at a depth of about 10 ft below low-water level. The bridge was designed for Cooper's E-60 loading on each track, with impact allowance according to Lindenthal's formula,

$$I = \frac{L^2}{D+L} \times \frac{1{,}200 + \dfrac{a}{n}}{600 + 4\,a}$$

in which,

a is the length of train behind the tender, and n = number of tracks loaded.

The secondary and erection stresses received special consideration, due to the use of rigid gusset plate connections. Open-hearth structural steel of from 62,000 to 70,000 lbs. per square inch ultimate strength is being used, for which the allowable tensile stress is 20,000 lbs. per square inch, and the allowable compression stress 20,000 reduced according to the length of the number.

The wind, lateral and braking forces assumed for the design were:

Wind along top chord, 800 lbs. per linear foot of bridge.

Wind along bottom chord, 700 lbs. per linear foot of bridge.

Wind on train, 500 lbs. per linear foot of bridge.

Lateral force from train, 10 per cent of live load (E —60) on one track.

Braking force, 1,000 lbs. per linear foot of bridge on one track, or 670 lbs. per linear foot of one truss.

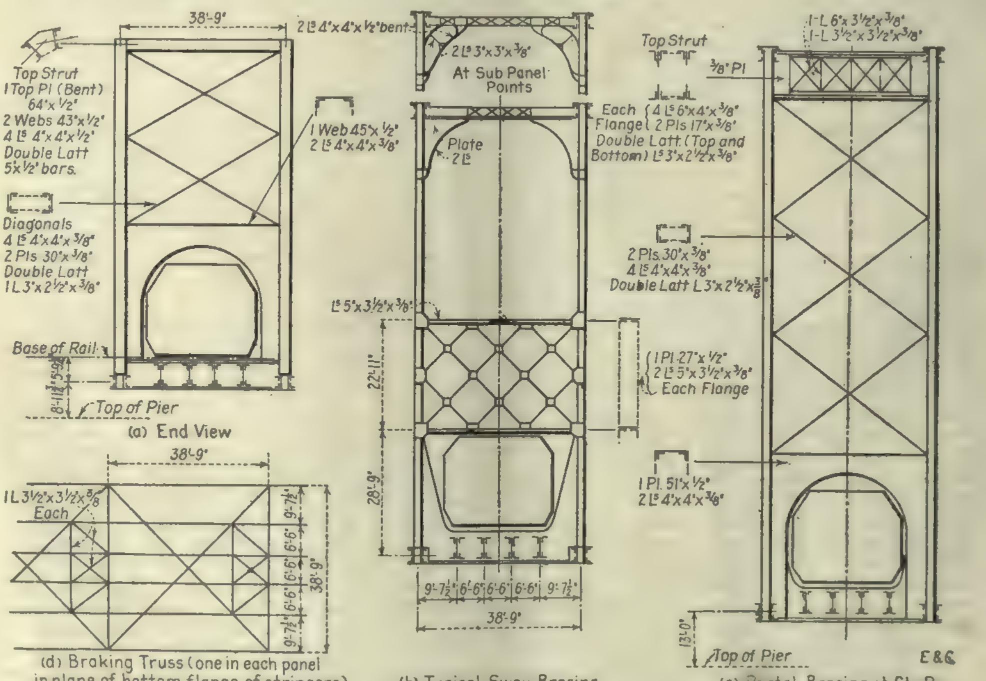
The use of alloy steels was considered, but at present prices they would have effected no saving. For the two 775-ft. spans riveted connections are used throughout, as most of the chord and web members are subjected both to tension and to compression and as there are comparatively few members taking tension only. All joints of members, whether in tension or in compression, are fully spliced.

The piers and abutments are of concrete in the proportions of 1 part cement, 2 parts sand, and 4 parts gravel. They are so dimensioned that no tensile stresses are produced; nevertheless the piers are reinforced with a large number of vertical and horizontal rods in order to prevent temperature and shrinkage cracks.

The following features of the design are unusual and were adopted with a view of obtaining rigidity:

(a) The floorbeams are built as continuous U-frames the vertical portions of which extend up to the lower sway bracing members (see Figs. 2 and 3).

(b) In each panel, in the plane of the bottom lateral system, a truss is provided to transmit the longitudinal forces due to traction and to the braking of trains (see Fig. 2d). No expansion joints are provided in the floor system.



(a) End View

(d) Braking Truss (one in each panel in plane of bottom flange of stringers)

(b) Typical Sway Bracing

(c) Portal Bracing at Ctr Pier.

Fig. 2. Types of Portal and Sway Bracing and Braking Truss Used in Chesapeake & Ohio Northern Ry. Bridge at Sciotoville, O.

(c) In the planes of the inclined posts located over the end and middle piers solid plate girder portals are provided (see Figs. 1a and 1c).

(d) For transverse bracing deep lattice girders and curved knee-braces are used instead of the diagonal system of sway bracing ordinarily employed (see Fig. 2).

The following data on the river spans are of interest on account of the size and type of span used:

Length of each river span, center to center of piers........	775 ft.
Clearance for river traffic at low-water stage	106 ft., 6 ins.
Clearance for river traffic at high-water stage	40 ft.
Height of trusses over center pier	129 ft., 2 ins.
Height of trusses at ends.......	77 ft., 6 ins.
Spacing of trusses, center to center	38 ft., 9 ins.
Length of panels................	38 ft., 9 ins.
Dead load per linear foot of bridge	18,800 lbs.
Approximate weight of steel....	13,500 tons
Heaviest chord member (size, 4 ft. x 4½ x 77½ ft.):	
Section	596 sq. ins.
Weight	228,000 lbs.
Heaviest web member (size, 4 ft. x 4½ ft. x 75 ft.):	
Section	511 sq. ins.
Weight	166,000 lbs.
Largest gusset plates: 130 x 1⅝ ins. x 15 ft., 6 ins.; and 138 x 13/16 ins. x 17 ft., 6 ins.	
Heaviest casting	45,000 lbs.

Largest rivets, 1¼-in. diameter by 7⅜-in. grip.

Each center bearing carries a load of about 8,000 tons, of which 5,000 tons are dead load.

PERSONNEL.

The bridge is being built by the Chesapeake & Ohio Northern Railway Co., G. W. Stevens, President, M. J. Caples, Vice President. The design and detail plans of the bridge and its approaches were worked out by Gustav Lindenthal, Consulting Engineer, of New York, who also is in charge of the execution of the work. The contract for the construction of the substructure was let to the Dravo Contracting Co., of Pittsburgh, and that for the superstructure to the McClintic Marshall Co., of Pittsburgh. Construction of the foundations was started in November, 1914, and it is expected that the bridge will be opened to traffic in November, 1916.

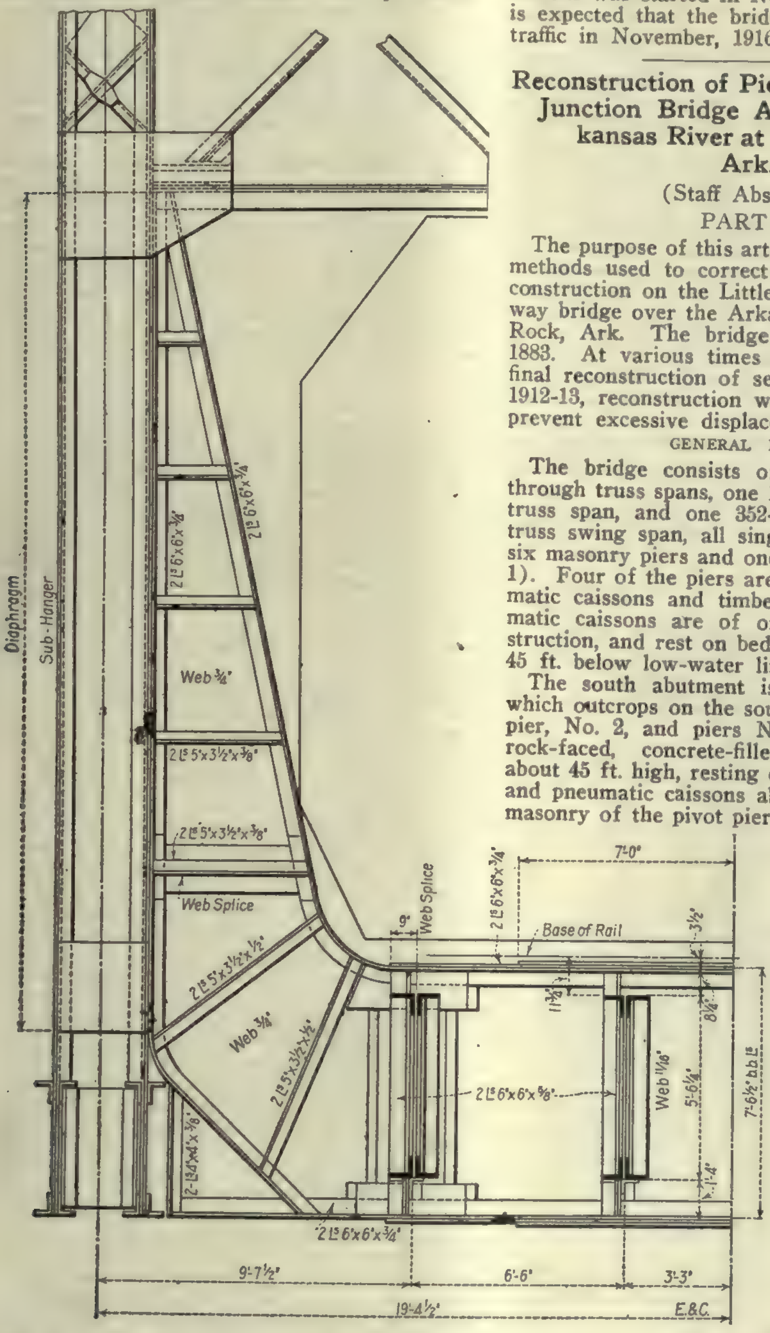


Fig. 3. Rigid Type of Floorbeam Used in Chesapeake & Ohio Northern Ry. Bridge at Sciotoville, O.

Reconstruction of Piers of Little Rock Junction Bridge Across the Arkansas River at Little Rock, Ark.

(Staff Abstract.)

PART I.

The purpose of this article is to describe the methods used to correct the defects of pier construction on the Little Rock Junction railway bridge over the Arkansas River, at Little Rock, Ark. The bridge was constructed in 1883. At various times thereafter, until the final reconstruction of several of its piers in 1912-13, reconstruction work was required to prevent excessive displacements of the piers.

GENERAL DATA.

The bridge consists of three 253-ft. 4-in. through truss spans, one 127-ft. 11-in. through truss span, and one 352-ft. 10-in. through truss swing span, all single track, resting on six masonry piers and one abutment (see Fig. 1). Four of the piers are supported on pneumatic caissons and timber cribs. The pneumatic caissons are of ordinary timber construction, and rest on bed-rock, approximately 45 ft. below low-water line.

The south abutment is founded on rock, which outcrops on the south bank. The pivot pier, No. 2, and piers Nos. 3, 4 and 5, are rock-faced, concrete-filled masonry piers, about 45 ft. high, resting on filled timber cribs and pneumatic caissons about 40 ft. high, the masonry of the pivot pier being annular, with a well extending to the crib. Piers Nos. 6 and 7 (not shown in Fig. 1) are rock-faced, concrete-filled, masonry piers, founded on piles.

The timber cribs over the pneumatic caissons, extending up to low water, consist of 12 x 12-in. timbers, 3 ft. center to center, sheeted outside with 3-in. planks. The spaces between the timbers were supposed to have been filled with rip-rap, but only a small quantity was placed, the greater number of the cavities having been filled with sand discharged from the caissons.

The caissons were poorly located, and when the working chambers were finally sealed, the tops of the timber cribs were considerably out of place. As the steel superstructure was on the ground at the time of the commencement of the masonry work, the masonry piers were located on top of the cribs in such a way that the coping courses were the proper distances apart to receive the steelwork, which made it necessary to place the piers at one side or the other of the timber cribs and use different batters.

The bed of the Arkansas River is composed of fine sand and silt, which is scoured to great depths during floods, especially around obstructions such as piers. The scouring of the river around these piers caused the sand to run out of the cribs through the spaces between the sheeting planks, and the timbers, being deprived of the support of the filling material, settled under the weight of the bridge and traffic.

As the masonry piers were not located concentrically with the cribs, the timbers compressed unequally and caused the piers to lean, their tops moving in various directions. The piers were a constant source of trouble and expense from the date of construction in 1883 until recently when they were reconstructed.

The reconstruction consisted in placing annular pneumatic caissons around the old piers, filling the spaces in the old cribs with concrete, enlarging the footing by filling in with concrete over the new annular caissons, and encasing the old piers in reinforced concrete following symmetrical lines, and enlarged for a double-track superstructure in the future.

The excessive scour of the Arkansas River renders practically impossible the maintenance of falsework for long periods, and swift runouts have been experienced in all months. As the hazard attending the maintenance is very great the work was carried out without falsework.

EARLY TROUBLE.

The early record of the trouble is not clear, but it appears that, immediately after the completion of the bridge, the pivot pier under the draw span and pier No. 4 began to settle and lean. As the bed of the Arkansas River is composed of fine sand, which scours and shifts greatly during floods, it was thought that the settling was due to scour, the opinion immediately being formed that the cutting edges had not been founded on rock. Consequently, large quantities of rip-rap were unloaded around the piers, only to be washed down stream in following floods and requiring replacement. In addition, from time to time as necessity arose, the spans were shifted back and forth to keep their bearings on the piers, the tops of which had been made so small that very little variation could be permitted.

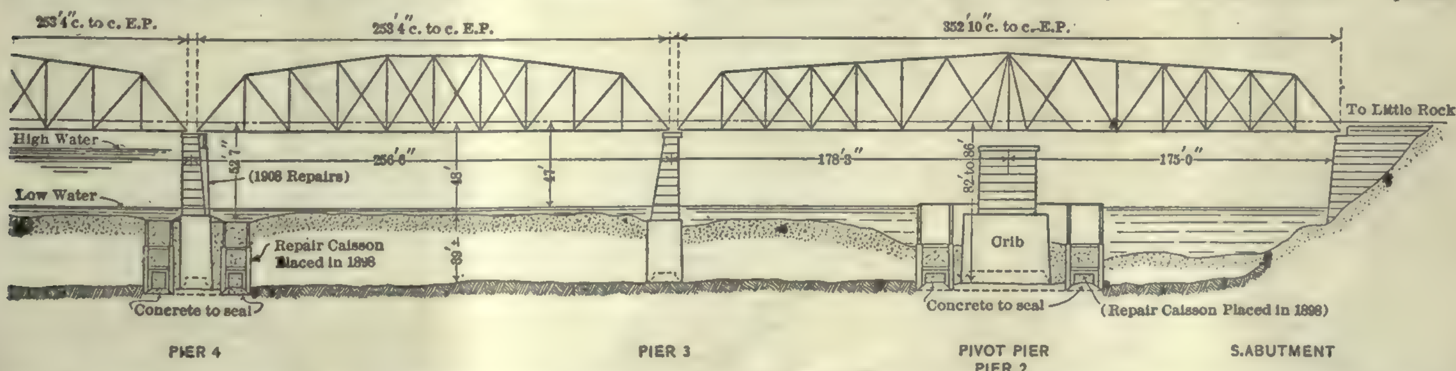


Fig. 1. General Elevation of Portion of Little Rock Junction Bridge Across Arkansas River at Little Rock, Ark., Showing Type of Construction and General Dimensions.

The movement of the pivot pier was quite pronounced, and it necessitated, at great expense, frequent leveling and adjustment of the draw span.

ANNULAR COFFERDAMS SUNK IN 1898 AND 1899.

It was decided to sink annular caissons and cofferdams around piers Nos. 2 and 4 (see Fig. 1), the work being started in the fall of 1898 and completed in the summer of 1899. The contractor for this work was the Missouri Valley Bridge and Iron Co., whose proprietor, the late A. J. Tullock, had made a careful investigation before bidding. The following data apply to this work:

At pier No. 4 a timber caisson, about 50 x 70 ft., was constructed around the old pier (see Fig. 2), the intention being to carry out the work, as nearly as practicable, in accordance with the proposal made by Mr. Tullock.

Two rows of piling were driven around the old pier, 10 ft. apart, the piling being capped and cross capped. A space of from 6 ft. to 7 ft. 6 ins. was left between the annular caisson and the old work. The caissons and cribs were built on top of the caps to a height of 12 ft. Large screws, 16 ft. long, were then used to lower the crib until it floated. The crib projected 4 ft. above the water, and the cutting edge floated about 4 ft. above the bed of the river. Sand was used in filling the crib to sink it, while the men were raising timber on top of the crib.

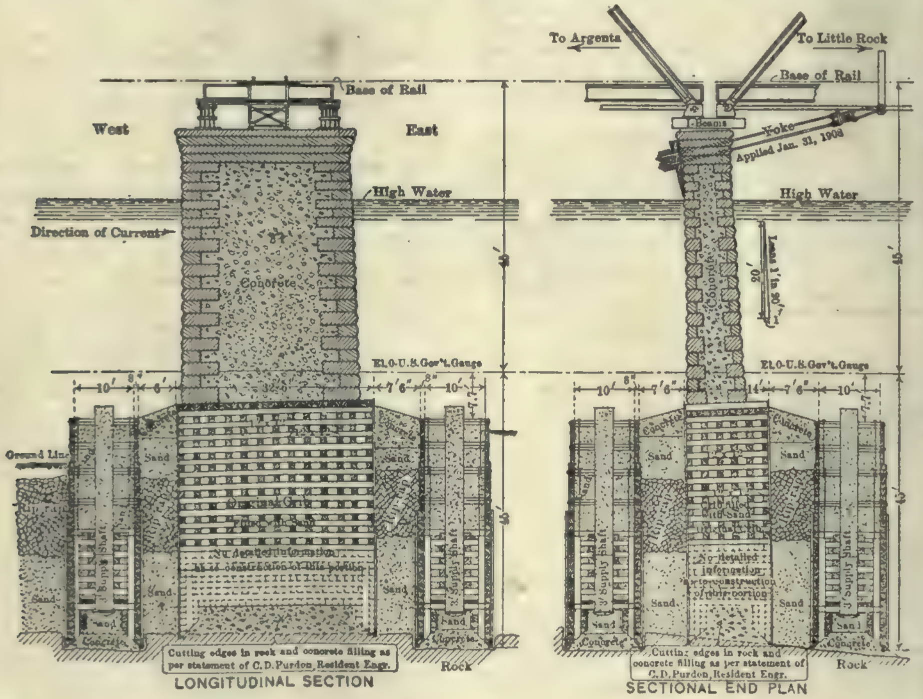


Fig. 2. Longitudinal and Cross Sections of Pier 4 of Little Rock Junction Bridge, Showing Annular Caisson Sunk in 1898-99 and Conditions After Placing I-beams and Yoke.

On Mch. 1, 1899, with the cutting edge on the bed of the river at elevation of —11 ft. air was forced into the working chamber and excavation was made through the following material:

From elevation —11 to —17, sand.
From elevation —17 to —23, rip-rap and sand.
From elevation —23 to —41, sand.

On Apr. 2, 1899, at elevation —41 ft., hard shale was struck near the center of the upstream end. From elevation —41 to —45 ft. excavation was made through very hard black shale on the north side and at the upstream and downstream ends. This rock was nearly as hard as granite, requiring dynamite to make the excavation.

At elevation —45 ft. the inside cutting edge on the south side was landed on rock, except about 10 ft. where the rock was 6 ins. below the edge. The rock under the outside cutting edge on the south side was from 12 to 13 ins. below it. However, the sand was taken out down to the rock, and the working chamber was sealed with from 2 to 4 ft. of concrete, depending on the depth of rock.

The crib was built 58 ft. high, the top being 13 ft. above low water when the caisson was sealed. Later, the top of the crib was disconnected, from 6 to 7 ft. below low water, after concrete had been placed between the old and new cribs (see Fig. 2). The sealing of the working chamber was completed on Apr. 2'. 1899.

The river began rising very rapidly on April 22nd, and on the 23rd a 7-ft. rise was reported at Fort Smith. This reached Little Rock a few hours after the work of sealing the working chamber had been completed, the water rising over the top of the crib. Work was suspended from April 25th until June 30th, and then two pumps and an air lift were used to remove the water between the old and new cribs, and men commenced excavating the loose sand and sediment from around the old pier, but no effort was made to go below the depth uncovered by the pumps or to remove the silt. The silt and sand were cleaned out to a depth of 5 ft. on the upstream and 7 ft. on the downstream end below the top of the old crib. Investigation of the timber in the old crib disclosed crushing on the north side, but only to the extent of compressing the timber, and not dividing the grain. The timber was good and sound.

A great deal of the 3-in. sheeting was found to be torn off, and it was seen that the spaces between the timbers of the crib were filled with sand and loose rock. The sheeting which had been torn off was replaced. It was also observed that the deck or top of the old crib dipped from 1 in. to 1½ in. from a point near the center on the south side of the pier toward the upstream end.

On July 1st, while the loose material between the new cofferdam and the old crib was being excavated, it was discovered that the pier had settled about ½ in. This led to the immediate abandonment of the excavation, but the spaces on the north and west sides were driven full of piles, with a penetration of about 15 ft., and the space already excavated was filled with concrete up to the top of the old crib. None of the material within the old crib was removed, and no effort was made to grout it or to fill in the vacant spaces with concrete. In fact, the sheeting that was replaced effectually prevented the concrete from flowing into the vacant spaces within the crib. The concreting around the old pier was completed on July 6, 1899, and both walls of the annular cofferdam were then removed, down to 6 or 7 ft. below low water.

During May, 1899, the concrete having been placed around the pivot pier, the wheel tread under the drum of the draw span was leveled up and underpinned with concrete, the minimum rise being 2⅜ ins. and the maximum 6½ ins.

At the same time, but prior to the placing of the concrete around pier No. 4, the spans on that pier were also leveled up and carried on oak blocking in place of the bed plates, the spans being raised from 1¼ to 6 ins. This work was done too soon, as a slight settlement of pier No. 4 during the work threw the track out of line.

The pier tops had moved around so much, and their upper surfaces were so small, that the trusses could not be placed on a straight line. The trusses had been built with extra wide clearance to provide for highway traffic, and this permitted considerable latitude in the location of the track. The trusses were permitted to remain out of line, and the track was placed on a tangent, being nearer to one truss than to the other where the spans were out of line.

FURTHER MOVEMENT OF PIER NO. 4.

On account of the large quantity of concrete placed around the pivot pier, and the depth to which it reached, 15 ft. below the top of the crib, no further movement has been detected in this pier. However, the movement of pier No. 4 was not arrested, but as the settlement and movement continued, a policy of "watchful waiting" was followed for several years. The situation again became critical early in 1906, when pier No. 4 had moved so far that one of the spans was in imminent danger of falling off.

At that time J. C. Bland was retained as consulting bridge engineer of the Missouri Pacific Ry. to look into the matter and pass on it.

PLACING OF I-BEAM GRILLAGE AND YOKE AT PIER 4.

Plans were made for placing a nest of I-beams under the truss shoes at each end of pier No. 4, so that the overhanging ends of these beams would support the end of the adjacent span to the south. At the high end of the pier there was only sufficient depth for 15-in. beams, but at the low end 20-in. beams could be used. The plan first contemplated the driving of piles on both sides of pier No. for use in jacking during the placing of the beams. On account of the extreme length of piles required, however, it was decided to jack only from the pier top. The jacking equipment was set in place and jacking was started Jan. 28, 1908. The span to the north was under such pressure from pier No. 4 that the bottom chords were slightly shortened. When the jacks removed the weight from the bed plates the span assumed its proper length, the shoes sliding about 1 in. on the bed plates. This stretching out of the span caused much apprehension, and, as an emergency matter, to retard the movement of the pier, a yoke was placed at its top and connected to the truss as shown in Fig. 2.

After placing the I-beams the spans were shifted slightly to overcome their interference, and the rollers were cleaned and oiled. The yokes were left in place and instructions were issued to have them tightened every month, in order to exert a steady pull of about 50,000 lbs. As the bearing was now considered safe, the matter of permanent repairs was given further study. Figure 2 shows the caisson sunk around pier No. 4 in 1898 and 1899; it also shows the conditions existing after the placing of the I-beams and yoke.

Computations were made to determine the pressure on the timber cribbing at the edge of the pier, to find out if unsafe pressures existed. From the information available at the time it was computed that the maximum pressure on one side was 555 lbs. per square inch, with 17 lbs. per square inch on the other side. (Later information showed that the actual pressure on the timber cribbing in cross bearing was about 888 lbs. per square inch.) It had been contended that there was danger to the pier in permitting the yokes to remain, but the computations convinced all concerned that there was not. No fear was felt as to the effect of the pull on pier No. 3 (at the other end of the span) because the south side of that pier had been built plumb, the natural lean of that pier being opposed to the direction of pull.

CONSTRUCTION OF STEEL BENT AT PIER 4.

In 1908, some one conceived the idea that it would be of advantage to provide further rigid support for the overhanging ends of the I-beams on the high side of the pier to build a concrete footing on the wide edge of the crib, up to low water, and to place a steel bent on top of that footing. The I-beams under the pedestals were to be shifted far enough south to get a bearing on the bent, and the spans were to be shifted as far south as possible to bring the load over toward the high side of the crib. This work was done in the fall of 1908 at a cost of about $2,000. Figure 3 indicates the manner in which this work was done.

Holes were drilled in the top of the crib and in the side of the pier at low water, and bent reinforcing rods were placed in them. A form was lowered through the water to the top of the crib, and the concrete was deposited by a bottom-dump bucket. A steel bent, made of old top-chord sections, was then placed on this footing and held to the pier by U-shaped reinforcing rods set in grouted holes. A concrete shell was constructed between them to ward off drift.

The I-beams and spans were then shifted as far as possible, in order to throw the greatest possible load on the new bent. The work was carried out carefully and expeditiously, and offered no unusual difficulties. Following this work no appreciable movement in the direction of the bridge was apparent for several months, but the movement at right angles to the bridge appeared to increase its rate. The movement of the pier was greatly dependent on the scour line; when the current shifted away from the pier, the bed of the river filled up and stopped the movement; when the opposite was true, the movement was resumed.

OTHER PLANS FOR OVERCOMING DEFECTS AT PIER 4.

Following the work in the fall of 1908, the observations were continued, and the matter of proposed permanent repairs or reconstruction was kept constantly alive for three years, during which time scheme after scheme was evolved and considered, but nothing was started until the fall of 1911. As a number of the schemes were ingenious and interesting, some of them will be described.

(a) It was proposed to take down pier No. 4 to the top of the crib, sink to rock along each side of the crib 12 or 15-in. steel cylinders filled with concrete, by the usual well-drilling methods, and build a structural steel tower on top of the cylinders and crib.

This was first studied on the basis of having the load divided equally between the cylinders and the crib, which would have reduced the maximum pressure on the timbers from 555 to 150 lbs. per square inch, on which basis the estimated cost, including the falsework for supporting the spans and taking down the old pier, was $32,200.

It was realized, however, that on account of the great stiffness of the cylinders and the steel tower, and the great elasticity of the crib, it would be impossible to control the distribution of load among the supports, and, in any event, most of the load would go to the cylinders. If the cylinders were made large and numerous enough and the steel tower strong enough to carry the entire load, the cost was estimated at $43,200. This scheme was therefore abandoned.

(b) The success obtained in placing the steel bent at pier No. 4, and its low cost, led to a proposition to build another steel pier on the north side. As there was no projection of the timber crib on which to rest such a bent, and as the north edge was badly overloaded and thought to be crushing, it was proposed to sink a row of steel cylinders on the north side on which to rest the bent. This scheme also necessitated the use of longer and heavier beams on top of the pier, in order to distribute the load out to the bents. On account of the pedestals of the trusses being so far on the pier, it was almost impossible to study out any plan that would reduce the load on the pier an assumed amount, but, by changing the point of contact between the I-beams and the top of the pier, it was found possible to throw about 250,000 lbs. on the new bent, thereby reducing the maximum pressure on the timbers from 555 to 477 lbs. per square inch. This was estimated to cost about $10,000. The scheme was abandoned on account of its uncertainty.

Of course, it would have been possible to have taken the weight entirely off the old pier and provide cross-girders sufficiently strong to throw the entire load on the steel bent, but the extra expense and uncertainties of this scheme ruled it out.

(c) In the meantime the writer had worked up a plan, which contemplated driving piles to rock by jetting, within two sides of the annular space between the crib and the cofferdam, toward which the pier was moving, the plan being to remove the concrete cap a section at a time, drive several piles, and replace the concrete as a sub-footing course, and incidentally to preserve the side support afforded by the concrete. To accomplish this it was proposed to build a puddle cofferdam around the pier within the 1898 cofferdam to hold out the water against about a 10-ft. head, and to force as much concrete and grout as possible into the crib.

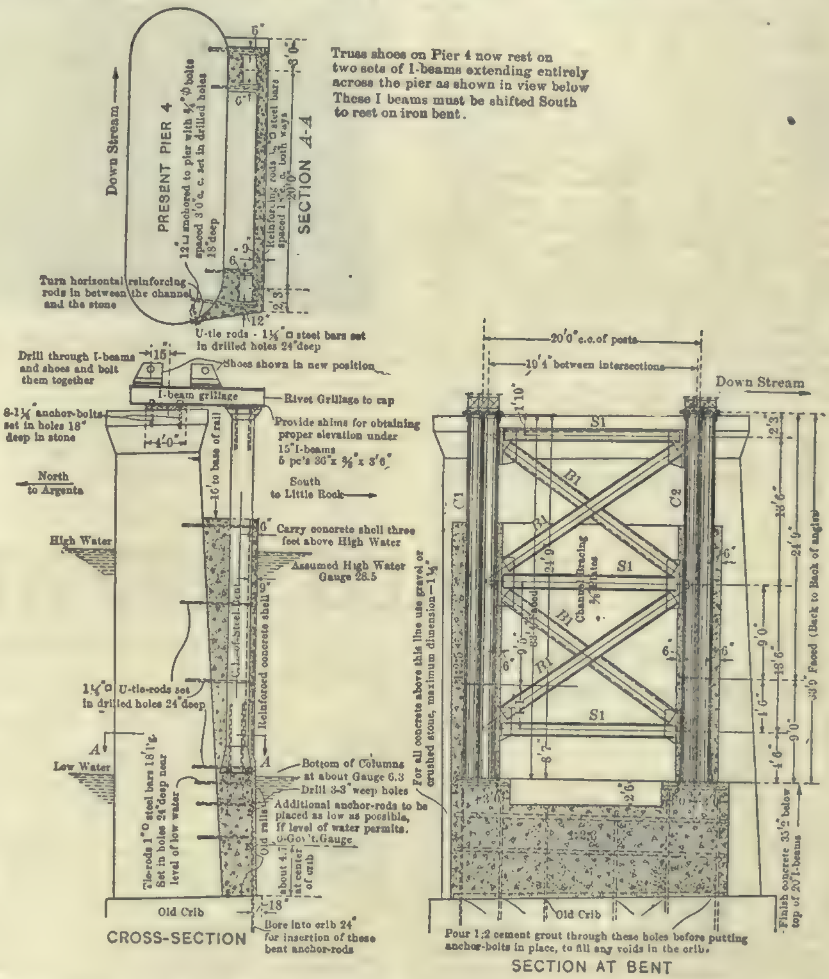

Truss shoes on Pier 4 now rest on two sets of I-beams extending entirely across the pier as shown in view below These I beams must be shifted South to rest on iron bent.
Down Stream
PRESENT PIER 4
12" ⊔ anchored to pier with ¾" Φ bolts spaced 3'0" c. c. set in drilled holes 18" deep
Reinforcing rods ¼" □ steel bars spaced 1'6" c. c. both ways
SECTION A-A
20'0"
Turn horizontal reinforcing rods in between the channel and the stone
U-tie rods - 1¼" □ steel bars set in drilled holes 24" deep
Drill through I-beams and shoes and bolt them together
Shoes shown in new position
I-beam grillage
Rivet Grillage to cap
8-1¼" anchor-bolts set in holes 18" deep in stone
Provide shims for obtaining proper elevation under 15" I-beams 5 pc's 36" x ⅜" x 3'6"
North to Argenta
South to Little Rock
16' to base of rail
Carry concrete shell three feet above High Water
High Water
Assumed High Water Gauge 28.5
C. L. of Steel Bent
Reinforced concrete shell
1¼" □ U-tie-rods set in drilled holes 24" deep
Low Water
Tie-rods 1" □ steel bars 18' 1" ℄ Set in holes 24" deep near level of low water
Bottom of Columns at about Gauge 6.3
Drill 3-3" weep holes
Additional anchor-rods to be placed as low as possible, if level of water permits.
0-Gov't. Gauge
Old rails
about 4.7 at center of crib
Old Crib
Bore into crib 24" for insertion of these bent anchor-rods
CROSS-SECTION
For all concrete above this line use gravel or crushed stone, maximum dimension—1¼"
20'0" c.c. of posts
19'4" between intersections
Down Stream
S1
B1
C1
C2
Channel Bracing ⅜" Plates
2'3"
18'6"
24'9"
9'0"
1'6"
33'9" Faced (Back to Back of angles)
8'7"
2'6"
1:2:3
Finish concrete 33½" below top of 20" I-beams
Old Crib
Pour 1:2 cement grout through these holes before putting anchor-bolts in place, to fill any voids in the crib.
SECTION AT BENT

Fig. 3. Details of Steel Bent and Concrete Reinforcement Placed at Pier 4 in 1908 to Support End of I-Beam Grillage Under Pedestals of Little Rock Junction Bridge.

After grouting the crib, driving the piles, and restoring the concrete cap, it was proposed to construct, around the old pier and on top of the projections of the crib and on the new piles, a solid reinforced concrete structure which would materially enlarge the base, restore the symmetry, and effectually protect the masonry for all future time.

The rough rock face and round ends of the pier made it particularly suited to encasement, but, in order to make the bond as intimate as possible, it was planned to drill through the body of the pier at several places near the bottom and to place second-hand eye bars through the pier, with suitable anchors at each end to be embedded in the concrete shell; also to curve the horizontal reinforcing rods continuously around the ends of the pier, and to place the top by a new thick reinforced concrete cap. This plan had the advantage that no falsework would have been necessary, and it could have been carried out for $12,000. The writer has always felt that this method of repairing pier No. 4 was the best that could have been developed, but it was abandoned on account of numerous objections offered to it by others.

Continuing into 1910, the entire matter was studied from every conceivable standpoint, including reconstruction of all the piers as single track in their old location, reconstruction for double track, an entirely new set of piers and shifting the spans, entirely new single and double track bridges, and rearrangement of the method of operation of the Little Rock terminals so that the bridge could be abandoned, all traffic to use the main line bridge. None of these plans was carried out, but the "watchful waiting" was continued.

RIVER BED CHANGES AT PIERS.

For two or three years prior to 1911, the channel of the river had been moving away from pier No. 4 and concentrating under the draw-span, resulting in the building up of the river bed around this pier with clear fine sand, which early in 1911 covered the top of the crib and reached up on the masonry within 1 or 2 ft. of extreme low water. This sand evidently filtered into the crib and gave increased supporting power in addition to that provided by the sand that enclosed it. As a consequence, the movement of pier No. 4 gradually slowed down, so that it was barely perceptible, and the great uneasiness that had prevailed for several years was partly allayed.

While the river bed was building up around pier No. 4, it was scouring away around pier No. 3, the north rest pier of the draw-span, and this pier started to move quite rapidly directly upstream, at right angles to the axis of the bridge.

The movement in 1911 was more rapid and constant than any experienced previously in the other piers, and indicated the necessity for immediate action. The pier did not move dangerously in the direction of the bridge. Its natural tendency would have been to move south, as the plumb south face and eccentric bearings of the spans made the pressure heaviest on the south side. It was restrained from movement in that direction, however, by the rods and yokes which made this pier an anchor for the pull of pier No. 4. In fact, during the frequent tightening of the yoke rods, pier No. 3 was observed to move slightly north into a more erect position.

PLANS SUGGESTED FOR RECONSTRUCTION OF PIER 3.

The first plan prepared for the reinforcement of pier No. 3 was somewhat similar to the writer's last plan (c), which had been rejected. It consisted of a reinforced concrete shell, tied to the old pier and resting on additional piles to be driven to rock around the old crib. Here, however, there was no surrounding cofferdam, and it was deemed advisable to furnish protection for the piles and additional stability for the pier. This was to be obtained by sinking around the pier mud-cell mattresses, in layers about 4 ft. deep, with enough rip-rap in them to sink them. The result would be a building up of mattresses, of decreasing sizes, and rock; sand sediment would immediately deposit until the top of the crib was nearly reached, when the entire mass would be covered with rip-rap. The latter and the surrounding bed of the river would then be covered by another large protecting mattress. It was also the intention to bore holes in the crib and to force in as much grout as possible. The total cost of this method would have been about $10,000.

A plan was recommended by Ralph Modjeski, which involved the rebuilding of piers Nos. 3 and 4 entirely by supporting the spans on falsework, placing cofferdams around the piers, taking down the masonry, filling the cribs with concrete, and constructing new piers on them. It was decided that this method would be hazardous and expensive, and it was abandoned.

A Portable Railway Crane Used in France for Reinforced Concrete Culvert Construction.

Contributed by **Frank C. Perkins**, Buffalo, N. Y.

In Fig. 1 there is shown, in operation, an interesting and unique type of portable crane and hoisting mechanism used on the Orleans-Paris Ry. in France. This type of crane is used principally in reinforced concrete culvert construction, the view illustrating the replacement of the old culvert blocks by new reinforced concrete sections. The crane and its hoisting mechanism are mounted on two four-wheel railway trucks, which are spaced so as to give a considerable working space between the trucks.

The hoisting mechanism was designed and built at the work shops of Moisant-Laurent-Savey in Paris, France.

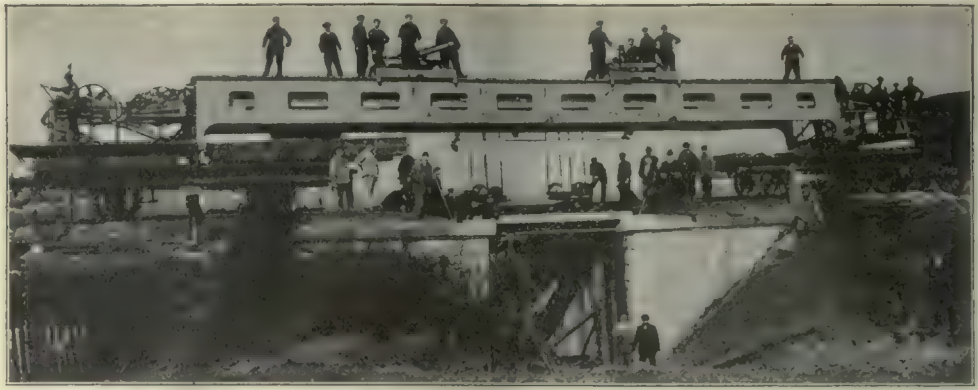


Fig. 1. Portable Railway Crane and Operating Mechanism Used in Constructing Culverts on Orleans-Paris Ry. in France.

An aerial passenger tramway over Niagara River has been suggested by a Spanish construction company, to be used for sight-seeing purposes. The proposed cableway would have a span of about 1,800 ft., and would cross directly over the whirlpool. The cars would have a carrying capacity of 30 people.

ROADS AND STREETS

Some Costs of Brick Pavement and of Concrete Base at Gary, Ind.

Contributed by **W. P. Cottingham**, Assistant City Engineer.

All street improvement work in this city (Gary, Ind.), is done by contract under the supervision of the City Engineer. The writer, assistant engineer in charge of street improvement and maintenance, has a force of inspectors who represent the city on all work. The inspectors keep daily records of all work done, material received and used, equipment used, and prices paid for material and labor. From this information, at the end of each contract or during the following winter, the cost to the contractor on each job is determined. The material and labor prices can usually be accurately determined, but it is always a matter of estimates to determine the amount of discount on the bonds. The contractor receives his pay in Local Improvement District bonds and he has to dispose of them at the prevailing price. The location of the work, the condition of the money market, and his own reputation make this matter of discount a variable that is indeterminate as far as the writer is concerned. The discounts last year are reported to have varied from 4 per cent to 15 per cent. Of course the contractor has to allow for this in his bid.

Contract prices for brick pavements on 6-in. concrete base varied during 1914 from $2.13 to $2.18 per square yard, while the cost data compiled from inspectors' reports show a cost to the contractor of from $1.62 to $1.72. This cost price does not include overhead expense of any kind, nor does it include the discount item referred to above. Grading is paid for as a separate item, as is all other incidental work, such as curbs, sidewalks, catchbasins, headers, etc.

Various cost sheets have been prepared by the writer showing comparative costs on different contracts and for different items of

TABLE I.—COST OF BRICK PAVEMENT IN GARY, IND., IN 1914.

Improvement.		Madison.		26th Ave.		Penn. St.		Alley No. 7w.		25th Ave.	
Sq. yds. pavement............		5,289.8		8,522.4		5,436.7		4,031.1		8,727.1	
Labor item.	Rate.	Hrs.	Per sq. yd.	Hrs.	Per sq. yd.	Hrs.	Per sq. yd.	Hrs.	Per sq. yd.	Hrs.	Per sq. yd.
Team	60c	143	.....	130	.....	42	.....	35	.....	278	.....
Labor	20 to 30c	1,746	.....	1,673	.....	1,180	.....	805	.....	2,612	.....
Bricksetter	50 to 65c	218	.....	130	.....	160	.....	134	.....	447	.....
Foreman	35 to 40c	.....	.....	190	.....	.....	.....	88	.....	152	.....
Water boy	10 to 20c	.....	.....	160	.....	90	.....	.....	.....	100	.....
Labor cost*		.....	$0.113	.....	$0.086	.....	$0.076	.....	$0.074	.....	$0.114
		Per M.		Per M.		Per M.		Per M.		Per M.	
Brick hauled		$1.50	.06	$2.15	.090	$1.24	.06	$2.11	.081	$2.02	.08
Brick cost		22.50	.902	22.50	.958	24.00	.92	24.00	.917	22.00	.89
Cement, sq. yds. per bag......		12.0	.....	13.5	.....	10.8	.....	11.8	.....	9.6	.....
Grout-cement-water		.....	.03	.....	.026	.....	.034	.....	.041	.....	.036
Total unit cost		.....	$1.105	.....	$1.16	.....	$1.09	.....	$1.113	.....	$1.12

*Includes cost of making sand cushion, laying, rolling and grouting brick.

TABLE II.—COST OF 6-IN., 1:3:5, CONCRETE BASE IN GARY, IND., IN 1914.

Improvement		Madison St., 21st-23rd.				26th Ave., Bdy.-Harr.				25th Ave., Bdy.-Prospect.			
Square yards		5,289.8				8,522.4				8,727.1			
Labor item.	Rate, cents.		Hours.		Cost, sq. yd.		Hours.		Cost, sq. yd.		Hours.		Cost, sq. yd.
Team	60		.....		......		230		......		.....		......
Labor	20-25		1,630		......		1,730		......		321		......
Spreader	25-35		.....		......		409		......		228		......
Barrowmen	25		.....		......		.....		......		666		......
Mixerman	30-35		320		......		221		......		244		......
Foreman	35-50		100		......		231		......		137		......
Waterboy	10-20		.....		......		251		......		102		......
Watchman	25-28		120		......		240		......		108		......
Materials = M.		Amount.	At.	M sq. yds.	$0.100	Amount.	At.	M sq. yds.	$0.114	Amount.	At.	M sq. yds.	$0.057
Cement, bags		4,771	$0.30	.90	.270	5,128	$0.30	.60	.180	5,604	$0.30	.642	.193
Sand, cu. yds....................		269	1.00	.05	.050	500	1.05	.058	.061	480	1.10	.054	.059
Gravel, cu. yds..................		682	1.00	.13	.130	1,040	1.05	.12	.128	910	1.10	.104	.114
Water		....	....	...	.008	....	....	...	.008	....	....	....	....
Haul		$216.80 per 1,000 sq. yds.			.041	$616.00 per 5,200 sq. yds.			.072	$704.20 per 3,500 sq. yds.			.080
Total cose per sq. yd....................					$0.599				$0.563				$0.503
		Old Foote mixer.				Standard mixer.				Austin cube paver.			

work. Accompanying this are the sheets, Tables I and II, pertaining to the cost of building concrete base and laying brick pavement. In all cases the concrete base is 6 ins. thick and of a 1:3:5 mix, using washed gravel for the coarse aggregate and torpedo sand for the fine. The surface of the concrete base must be parallel to the finished crown of the pavement, but is not struck with a template—it is merely given a shovel float finish. The cost of the sand cushion is included in the cost of the brick pavement. The depth of the cost of the brick pavement. The depth of the cushion is 2 ins. Sand is always available in Gary for this cushion and rarely has to to be hauled to the job. The local sand is also used to make the grout for filling joints—a mixture of one part sand to one part cement being used.

On light traffic streets and in alleys the brick pavement is laid on the sand subgrade. Two such jobs are included in the cost sheet for brick pavements, and show that the cost of laying the brick is practically the same in each case. The cost of bringing in sand to make the sand cushion of the concrete base is about equalized by the extra work of shaping the subgrade to receive the bricks where no concrete base is used.

Relative 20-Year Economy of Various Types of Roads and Pavements.

(Staff Abstract.)

Considered from a modern point of view, the available classes of road construction may be taken as macadam, paved and asphalt, and these three classes will be individually considered in that order. To arrive at a true valuation to put on any road the points that must be considered are: (1) the initial cost of the road; (2) the average yearly maintenance charge of the road; (3) the life of the road, or the number of years that can be counted upon during which no extensive rebuilding is necessary; and (4) the periodic rebuilding or renewa charge. The relative importance of these four conditions governing the economic value of the various classes of road construction are tabulated in Table I, for highways of 18-ft. roadbed, to which reference will be made when considering the individual types of construction. The measure of economic value of the roads will be arbitrarily based on the total cost of the roads per mile for a period of 20 years as in such period the average road would have been subjected to the complete cycle of expenses to which it is subject and also as that length of time is frequently the period chosen for the life of construction bonds issued for raising the necessary capital.

TABLE I.—AVERAGE ROAD BUILDING COSTS PER MILE OF 18-FT. ROADBED, ETC.

Class of road construction.	Initial cost.	Maintenance charge.	Average life, years.	Renewal charge.
High-grade macadam.	$12,000	$1,000	10	$ 6,000
Paved roads, no foundations—				
Vitrified brick laid on edge	21,000	50	25	......
Vitrified brick laid flat	11,000	55	10	11,000
Stone block	22,500	75	40	......
Hardwood block	30,000	600	15	30,000
Soft wood block	23,000	800	12	23,000
Asphalt paving, no foundations	22,000	1,250	10	22,000

Macadam Roads.—The severity of modern demands on roads is such that in considering roads of macadam construction one type only need be considered. The water-consolidated macadam construction has been almost entirely superseded by the tar macadam or similar construction. Without going into a detailed description of the method of construction of a high grade macadam road of modern development, such discussion being beyond the scope of this necessarily brief article, the average initial cost of construction per mile of 18-ft. roadbed is very close to $12,000. The use of such roads is of necessity limited nowadays to comparatively small towns and as connecting highways between various cities or towns, etc., and are the most common class of rural highway construction. Their average maintenance charge should not, if the road is properly constructed, exceed $1,000 per mile per year, and they should not require renewal or reconstruction for a period of 10 years, at the expiration of which period they should be thoroughly overhauled and renewed at an average cost of about $6,000 per mile.

To arrive at the 20-year cost of a road, the measure of its true or net economic value, the various capital charges must all carry a certain rate of interest for the period during which such investment is actually tied up in the road—i. e., from the time the investment is made until the end of the 20-year period that is taken as the measure of the economic value of the road. In algebraic form this is done in the derivation of Formula I, which equation conveniently expresses the 20-year cost of a high-grade macadam road of 18-ft. roadbed in dollars per mile. The interest that a municipality has to pay for money is seldom less than 2 per cent per annum and a community of any standing would rarely have to pay more than 5 per cent. These limits have considerable effect upon the 20-year cost of the road, however, and in the case of the macadam construction (see Example 1) the difference in the economic value of the road for which the capital was raised by an issue of bonds carrying interest at 2 per cent and an issue bearing interest at the rate of 5 per cent, for instance, would be a sum equivalent to nearly 120 per cent of the original cost of construction, the two issues of bonds being taken at equally advantageous terms.

DERIVATION OF FORMULA I, 20-YEAR COST OF MACADAM HIGHWAY PER MILE.

Macadam Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile	$12,000	
Interest on initial cost (20-yr.)		12,000×20×I
Renewal charge per mile (end of 10 yrs.)	6,000	
Interest on renewal charge (10-yr.)		6,000×10×I
Maintenance charges per mile (18×$1,000)	18,000	
Interest on 18 increments of $1,000 each, equivalent to		1,000×179×I

20-year cost per mile=12,000+240,000×I+6,000+60,000×I+18,000+179,000×I.
20-year. C=36,000+479,000×I.........Formula I.

Example I.

Required:—20-year cost of high-grade macadam road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum, respectively.
At 2%=36,000+ 9,580=$45,580.
3%=36,000+14,370= 50,370.
4%=36,000+19,160= 55,160.
5%=36,000+23,950= 59,950.

Paved Roads.—The second class of highway, the paved roads, are particularly adapted to modern requirements of resistance to traffic wear and today find an economic field in rural service as well as in its former particular field in cities and localities of congested traffic. The modern vitrified brick highway is the class of road construction that forms the common link between roads for urban and rural service and which at the present time has a tendency to revolutionize established road building practices.

Roads may be classified according to the two general kinds of service, urban and rural. The paved roads for city service are of stone block (blocks of granite or of stone of similar characteristics), vitrified brick and of hard or soft wood block construction. For country service the vitrified brick paved road has proved not only suitable but truly economic. These paved roads, one and all, require suitable foundations for supporting the paving and the most adaptable construction, ordinarily also the cheapest and most durable, is the concrete foundation. Old macadam roadbeds or similar foundations may be used in particular instances, but in a general consideration of the economics of road building it may be assumed that the correct and usual foundation for paved streets is that of concrete of thickness suitable for the service to which the road is to be subject. (See Table II.). The cost of excavation, etc., may also be grouped with the cost of the foundation so that in straight-ahead road work a reliably accurate average cost of foundations, including excavation, etc., is known that varies directly with the thickness or depth of foundations. This cost of foundations is approximately the same whatever class of paving is to be employed and a reliable figure for this expense is $1,100 per mile of 18-ft. roadbed for each inch in thickness of foundations. Based on such general values, the 20-year cost of the various types of paved roads, the measure of the economic value of the road, will be taken up independently.

TABLE II.—AVERAGE THICKNESS OF CONCRETE FOUNDATIONS—VARIOUS CLASSES OF ROAD.

Average cost, $1,100 per mile per inch depth, 18-ft. roadbed.

Class of road.	Thickness of concrete foundation.
Stone block paved	about 9-in.
Vitrified brick paved	4-in. to 6-in.
Hardwood block paved	about 8-in.
Soft wood block paved	about 9-in.
Asphalt paved streets	about 9-in.

Stone Block.—Formerly the stone block paved road, such as is commonly known as "Belgian block roads" in many localities, was universally used for city service where the traffic was heavy and such construction is still by far the most lasting of pavements, a properly constructed road of such class having an average life of some 40 years, during which time the average total yearly cost of maintenance per mile of 18-ft. roadbed should not exceed $75 per mile. Without going into the details of construction, etc., the initial cost of such a road without foundations is about $22,500 per mile. The thickness of foundation should be about 8 ins. or 9 ins., preferably the latter. In fact, certain of the more eminent road building engineers claim that heavy trucking on stone-paved roads demands a minimum thickness of 9 ins. for supporting concrete foundations The derivation of Formula II is dependent upon the foregoing and clearly indicates the various interest charges that such class of road construction must carry. Example 2, giving the average 20-year cost of stone-paved roads built with capital of varying values, shows that, on account of the heavy initial expense and low maintenance charges of this class of road, the same proportional difference does not exist in the 20-year cost with capital of different value as when the initial cost is not so great and the maintenance expenses are greater.

DERIVATION OF FORMULA II, 20-YEAR COST OF STONE PAVED ROADS.

Stone Paved Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$22,500	
Concrete foundations	1,100×t	
Interest on initial cost (20-yr.)—		
No foundations		22,500×20×I
Foundations		1,100×t×20×I
Maintenance charges per mile (19×$75)	1,425	
Interest on 19 increments of $75 each, equivalent to		75×190×I

20-year cost per mile =22,500+450,000×I+1,100×t+22,000×t×I+1,425+14,250×I.
20-yr. C=23,925+1,100×t+(464,250+22,000×t) 1.

Formula II.

Example 2.

Required:—20-year cost of stone block paved road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum respectively—concrete foundation, 9" thick.
At 2%=23,925+9,900+(464,250+198,000) 0.02=
At 2%=23,925+9,900+(464,250+198,000) 0,02= $47,080.00
3%=23,925+9,900+(464,250+198,000) 0.03= $53,702.50.
4%=23,925+9,900+(464,250+198,000) 0.04= $60,825.00.
5%=23,925+9,900+(464,250+198,000) 0.05= $66,947.50.

Vitrified Brick.—The constantly increasing use of vitrified brick for paving both urban and rural highways makes the consideration of this class of road construction of particular and important interest at this time. In fact, it is this class of road construction by which its enthusiastic advocates plan a certain upheaval of past road building methods. Unquestionably the construction is economical and possesses many excellent points for both city and country roads, so that its adoption in many instances is good economic practice, even if not so in all cases. In all cases, unless local conditions are extremely favorable to some other kind of road, the vitrified brick highway built of brick on edge and supported by a suitable concrete foundation is the construction possessing the greatest 20-year economic value—i. e., the construction with the lowest 20-year cost. Another method of brick construction is the use of the brick laid flat as paving. The former method requires nearly 50 per cent more brick for a given area than does the latter and correspondingly the average normal life of the type requiring the greatest number of brick is more than twice that of the latter method. The average life, during which only comparatively light yearly maintenance charges are necessary, of the two methods of laying the paving being from 20 to 25 for the one and about 10 years for the less durable construction. The initial cost of the two types of vitrified brick roads, disregarding the cost of foundations or excavation, which is about the same for either, is, for brick on edge, about $21,000 per mile of 18-ft. roadbed and, for brick laid flat, about $11,000 per mile. The former construction, having a life of 20 years or more, requires no renewal expenses during a 20-year period, simply a quite nominal maintenance charge of about $50 per mile per year; the latter, having a life of but 10 years, requires complete rebuilding at the expiration of that period at a cost of about $11,000 per mile, and during the years in which simply a maintenance charge is necessary for keeping the road in good repair, this maintenance charge amounts to about $55 per mile per year. For urban service, the thickness of the suitable concrete foundation is about 6 ins., while for rural roads a 4-in. concrete foundation is generally all that is required. Formula III and III-a give the average 20-year cost of vitrified brick roads of 18-ft. roadbed, the former for roads where the paving is laid on edge and the later where the brick is laid flat, the derivation of which explains the various charges that such roads must carry. Example 3 gives the average 20-year cost of these roads for both city and country service and a comparison of these costs with similar costs for any other class of road construction indicates that for a 20-year period such roads are apparently the most economical that can be constructed and explains the keen interest that has recently been taken in this class of road by administrative bodies.

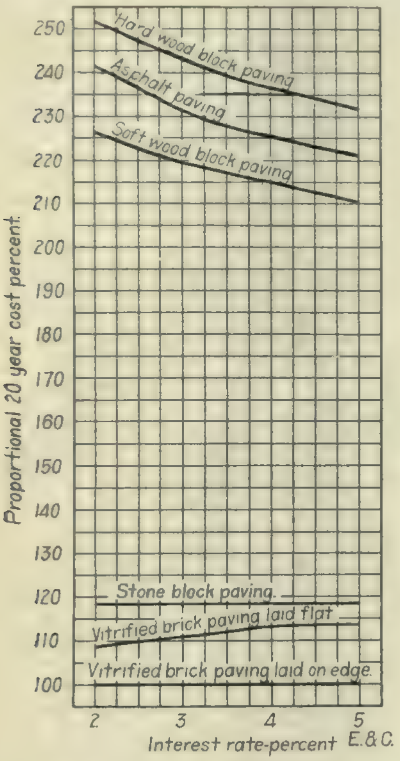


Fig. 1. Relative 20-year Economy of Various Classes of Roads for Urban Service Built with Capital Bearing 2 to 5 Per Cent Interest.

DERIVATION OF FORMULA III AND III-A, 20-YEAR COST OF BRICK HIGHWAYS.

Vitrified Brick Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations—brick on edge	$21,000	
Flat	11,000	
Concrete foundations	1,100×t	
Interest on initial costs (20-year)—		
No foundations, brick on edge		21,000×20×I
Flat		11,000×20×I
Foundations		1,100×t×20×I
Maintenance charges per mile brick on edge (19×$50)	950	
Flat (18×$55)	990	
Interest on 19 increments of $50 each, equivalent to		50×190×I
18 increments of $55 each, equivalent to		55×179×I
Renewal charge (end of 10 years) brick laid flat	11,000	
Interest on renewal charge.		11,000×10×I

20-year cost per mile (brick on edge)=21,000+1,100×t+420,000×I+22,000×t×I+950+9,500×I.

20-yr. C=21,950+1,100×t+(429,500+22,000×t) I.

Formula III.

20-year cost per mile (brick laid flat)=11,000+1,100×t+220,000×I+22,000×t×I+990+9,845×I+11,000+110,000×I.

20-yr. C=22,900+1,100×t+(559,845+22,000×t) I.

Formula III-a.

Example 3.

Required:—20-year cost of vitrified brick roads (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum—concrete foundations, 4-in. and 6-in. thick.

Brick laid on edge (urban service, foundation 6-in. thick):

At 2%=21,950+6,600+(429,500+132,000) 0.02=$39,780.00.
3%=21,950+6,600+(429,500+132,000) 0.03=$45,395.00.
4%=21,950+6,600+(429,500+132,000) 0.04=$51,010.00.
5%=21,950+6,600+(429,500+132,000) 0.05=$56,625.00.

Brick laid on edge (rural service, foundations 4-in. thick):

At 2%=21,950+4,400+(429,500+88,000) 0.02=$36,700.00.
3%=21,950+4,400+(429,500+88,000) 0.03=$41,875.00.
4%=21,950+4,400+(429,500+88,000) 0.04=$47,050.00.
5%=21,950+4,400+(429.500+88,000) 0.05=$52,225.00.

Brick laid flat (urban service, foundations 6-in thick):

At 2%=22,990+6,600+(559.845+132,000) 0.02=$43,426.90.
3%=22,990+6,600+(559.845+132,000) 0.03=$50,345.35.
4%=22,990+6,600+(559,845+132,000) 0.04=$57,263.80.
5%=22,990+6,600+(559.845+132,000) 0.05=$64,182.25.

Brick laid flat (rural service, foundations 4-in. thick):

At 2%=22,990+4,400+(559.845+88,000) 0.02=$40,346.90.
3%=22,990+4,400+(559.845+88,000) 0.03=$46,825.35.
4%=22,990+4,400+(559.845+88,000) 0.04=$53,503.80.
5%=22,990+4,400+(559.845+88,000) 0.05=$59,982.25.

Wood Block.—Noiselessness is the main advantage of any wood block paving and, though their slipperiness in wet and wintry weather is a drawback, they find a true economic and satisfactory use in city service. Both hard and soft wood blocks are used, the former usually simply being dipped in a mixture of tar and pitch or creosote oil before being laid, while the impregnating mixture is forced into the latter type of wood block under suitable pressure. Both kinds of blocks are laid upon foundations of concrete, coated in cement and grouted in either cement or pitch. Expansion and contraction, which ordinarily is greater and harder to control with the hard wood block, is taken care of by providing an expansion space along either curb, which space is usually filled with puddled clay. As in the case of all city streets, the width of roadbed is usually more than 18 ft., but, as the cost of any class of road depends directly upon the width of its roadbed, the 20-year cost of such roads will also be considered as 18 ft., so that ready comparison of its true economic value can easily be made with the other classes of construction that have been and will be considered. The hard wood block paving is the more costly but it also has a somewhat longer life than the soft wood block paving and the latter carries a heavier maintenance charge per year. The various charges incidental to the two classes of wood block paving are itemized in the derivation of the Formulæ IV and V, the former of which gives the average 20-year cost of hard wood block roads per mile and the latter the average 20-year cost of similar roads constructed of soft wood block paving. Examples 4 and 5 give the average 20-year costs of hard and soft wood block roads respectively per mile built on concrete foundations of standard depth or thickness for city service with capital commanding from 2 to 5 per cent per year. These examples would tend to indicate that the soft wood block road is in reality of higher economic value, lower 20-year cost, than the somewhat more durable hard wood block road, even though the foundations for the former are advisably somewhat thicker. Practice also confirms this deduction if the soft wood blocks are suitably and thoroughly impregnated with a mixture of tar and pitch or similar compound.

DERIVATION OF FORMULA IV, 20-YEAR COST OF HARDWOOD BLOCK HIGHWAY.

Hardwood Block Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$30,000	
Concrete foundations	1,100×t	
Interest on initial cost (20-yr.)—		
No foundations		30,000×20×I
Concrete foundations		1,100×t×20×I
Maintenance charges per mile, 18×$600	10,800	
Interest on 18 increments of $600 each, equivalent to		600×184×I
Renewal charge per mile at end of 15 years	30,000	
Interest on renewal charge (5-yr)		30,000×5×1

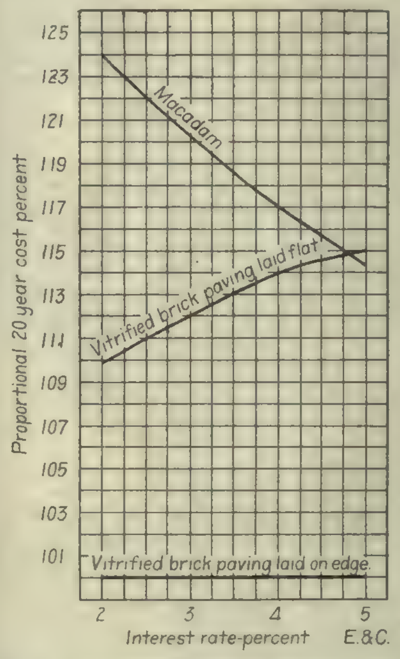


Fig. 2. Relative 20-year Economy of Various Classes of Roads for Rural Service Built with Capital Bearing 2 to 5 Per Cent Interest.

20-year cost per mile=3,000+600,000×I+1,100×t+22,000×t×I+10,800+110,800×1+30,000+150,000×I.

20-yr. C=70,800+1,100×t+(860,400+22,000×t) I.

Formula IV.

Example 4.

Required:—20-year cost of hardwood block road

(18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum, respectively—concrete foundation 8-in. thick.

At $2\%=70{,}800+8{,}800+(860{,}400+176{,}000)\ 0.02=\$100{,}328.00.$

$3\%=70{,}800+8{,}800+(860{,}400+176{,}000)\ 0.03=\$110{,}692.00.$

$4\%=70{,}800+8{,}800+(860{,}400+176{,}000)\ 0.04=\$121{,}056.00.$

$5\%=70{,}800+8{,}800+(860{,}400+176{,}000)\ 0.05=\$131{,}420.00.$

DERIVATION OF FORMULA V, 20-YEAR COST OF SOFT WOOD BLOCK HIGHWAY.

Soft Wood Block Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$23,000	
Concrete foundations	$1{,}100\times t$	
Interest on initial costs (20-yr.)—		
No foundations		$23{,}000\times 20\times I$
Concrete foundations		$1{,}100\times t\times 20\times I$
Maintenance charges per mile, 18×$800	14,400	
Interest on 18 increments of $800 each, equivalent to..		$800\times 181\times I$
Renewal charge per mile at end of 12 years	23,000	
Interest on renewal charge (8-yr.)		$23{,}000\times 8\times I$

$$20\text{-year cost per mile}=23{,}000+460{,}000\times I+1{,}100\times t+22{,}000\times t\times I+14{,}400+144{,}800\times I+23{,}000+184{,}000\times I.$$

$$20\text{-yr. } C=60{,}400+1{,}100\times t+(788{,}800+22{,}000\times t)\ I.$$

Formula V.

Example 5.

Required:—20-year cost of soft wood block road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum, respectively—concrete foundation, 9-in. thick.

At $2\%=60{,}400+9{,}900+(788{,}800+198{,}000)\ 0.02=\$90{,}036.00.$

$3\%=60{,}400+9{,}900+(788{,}800+198{,}000)\ 0.03=\$99{,}904.00.$

$4\%=50{,}400+9{,}900+(788{,}800+198{,}000)\ 0.04=\$109{,}772.00.$

$5\%=60{,}400+9{,}900+(788{,}800+198{,}000)\ 0.05=\$119{,}640.00.$

Asphalt Paved Streets.—The popularity of asphalt pavement for city service lies not only in the freedom from noise but also in the ease with which such roads can be kept clean. The softening of the paving surface, if subjected to even the summer temperature of many localities, limits the use of this class of road to cities in the temperate zone, in even which localities the softening of the asphalt surface has much to do with the very high maintenance charge that is necessary to keep such roads in good repair. A maintenance charge of $1,250 per mile of 18-ft. roadbed and proportionately greater for wider roads is about the charge that has to be carried even when the asphalt is laid on a good and firm concrete foundation. Without such foundation the maintenance charge is even greater, but the more stable construction will only be considered. Asphalt paving laid over good stone paving supported on suitable concrete foundations also makes an excellent road, but such road is only built when local requirements demand the "noiseless" road where formerly a high-grade stone-paved but noisy road had proved satisfactory, so cannot rightfully be a road with an individual economic value. The 20-year cost of such road can, however, be easily ascertained by the use of the formula applying to the construction of a stone-paved highway in conjunction with the following equations pertaining to asphalt-paved streets. The economic value of such combination road would be high, as its life would be little, if any, longer than that of an asphalt street built on suitable concrete foundation without the intervening layer of stone paving.

DERIVATION OF FORMULA VI, 20-YEAR COST OF ASPHALT PAVED STREETS.

Asphalt Paved Highway—18-ft. roadbed.
Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$22,000	
Concrete foundations	$1{,}100\times t$	
Interest on initial costs (20-yr.)—		
No foundations		$22{,}000\times 20\times I$
Concrete foundations		$1{,}100\times t\times 20\times I$
Maintenance charges per mile, 18×$1,250	22,500	
Interest on 18 increments of $1,250 each, equivalent to		$1{,}250\times 179\times I$
Renewal charge per mile at end of 10 years	22,000	
Interest on renewal charge (10-yr.)		$22{,}000\times 10\times I$

$$20\text{-year cost per mile}=22{,}000+440{,}000\times I+1{,}100\times t+22{,}000\times t\times I=22{,}500+123{,}750\times I+22{,}000+220{,}000\times I.$$

$$20\text{-yr. } C=66{,}500+1{,}100\times t+(783{,}750+22{,}000\times t)\ I.$$

Formula VI.

Example 6.

Required:—20-year cost of asphalt paved street (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent per annum, respectively—concrete foundation, 9-in. thick.

At $2\%=66{,}500+9{,}900+(783{,}750+198{,}000)\ 0.02=\$96{,}035.00.$

$3\%=66{,}500+9{,}900+(783{,}750+198{,}000)\ 0.03=\$105{,}852.50.$

$4\%=66{,}500+9{,}900+(783{,}750+198{,}000)\ 0.04=\$115{,}670.00.$

$5\%=66{,}500+9{,}900+(783{,}750+198{,}000)\ 0.05=\$125{,}487.50.$

The life of a well-laid and well-constructed asphalt street is rarely much more than ten years, at the end of which period the street requires complete renewal at a cost of about $22,000 per mile of 18-foot roadbed. Notwithstanding these heavy expenses, the asphalt paving continues to be extensively used and does make an excellent city highway where traffic is not too severe. In fact, its 20-year cost (average) shows that its economic value in urban service is greater than that of the hard wood block street and about equally more expensive than the soft wood block construction, the 20-year cost of an asphalt road being about a mean between similar costs of hard and soft wood block paved streets. The usual foundation construction for paved streets is ordinarily resorted to for the asphalt street as well, so the average cost of foundations is applicable to such construction. The various charges that the ordinary high-grade asphalt highway is called upon to carry are all itemized in the derivation of Formula VI, by which equation the average 20-year cost of an 18-ft. highway of asphalt paving per mile can be readily ascertained. Example 6 gives the average cash outlay necessary for such roads built on concrete foundations 9 ins. thick, the depth of foundation required for satisfactory city service, with capital of values of from 2 to 5 per cent per annum.

A comparison of the various examples that have been given shows that the cheapest road, as far as 20-year cost is concerned, is, both for rural and urban service, the vitrified brick highway built of brick on edge. Comparing the 20-year cost of other classes of roads with that of roads paved with vitrified brick laid so as to develop the greater life and representing such basic cost as 100 per cent, the relative 20-year economy, as measured by the proportional 20-year cost, of various classes of roads is graphically depicted on Figs. 1 and 2, the roads being classed as to their use for urban or rural service. A study of these charts emphasizes certain interesting points, among which not the least interesting is that the past road building practice has not been as incorrect as modern revolutionists in the science of building roads have implied. It is true that what may be termed a relatively modern vitrified brick road is the most economical in 20-year cost for both city and country service, but that in order to realize the full economy of the brick road the brick must be laid on edge. The cheaper construction (cheaper in initial cost) of laying the brick flat, though relatively economical when money for road building is cheap, decreases in economy as the money used from construction increases in value. For urban service, the vitrified brick road with brick laid flat is little more economical in 20-year cost than the stone block road when the value of the capital so invested approaches 5 per cent per annum. For rural service, the type of lesser economical brick construction is less economical than high-grade macadam when money is worth 5 per cent. With the solitary exception of the vitrified brick road with brick laid flat, the proportional 20-year cost—the economic vitrified brick construction serving in all cases as the basis of comparison—of all roads diminishes as the capital involved in their construction becomes more valuable. This does not mean that it is cheaper to build with expensive capital but that, should a road of relatively high 20-year cost be constructed with money commanding a high rate of interest, the proportional increase in cost compared to that of vitrified brick highway (20-year cost) would not be as great as when capital can be obtained at more advantageous terms. The chart showing the relative 20-year economy of rural roads is of particular interest in that it brings out the fact that the small community which has to pay a high rate of interest for its money is in a much better position to afford a high-grade macadam road—in fact, such road is usually the only possible one for such a community, owing to its comparatively low initial cost—than a more important community more fortunately situated, as far as obtaining money at a low rate of interest is concerned.

The great discrepancy in the proportional 20-year cost of wood paved or asphalt streets and of the stone or vitrified brick paved streets for city service cannot be taken as truly indicative of the respective economic value of the "noisy" and the "noiseless" streets, for between these two varieties comparison can only be made when a true valuation can be put on noise, or, rather, lack of noise. Local requirements must decide such point and the convenience of the public be the gage of economic value of the respective varietiec. However, the urban service chart shows that the six available classes of road naturally divide themselves according to their freedom from noise and a comparatively wide choice of construction exists for either the "noisy" or the "noiseless" streets.—Partial Reprint of Article in "Canadian Engineer" by Reginald Trautschold, New York, N. Y.

Thin Concrete Base for Brick Pavement.

To the Editors:—I have read with interest the staff abstract from the discussion by Prof. James I. Tucker and also his reply to the comments of Mr. Bilger of the Illinois Highway Department.

The question as to whether there is a grain or fiber in brick, while it may be interesting from a class room standpoint, certainly has no practical value at the present time.

Grout filling has its friends and advocates as do the soft fillers. There can not be any legitimate denial of the fact that each has some advantages.

To Mr. Tucker's fourth contention, namely that thick plain concrete foundations are illogical and wasteful, I desire, however, to take exception. Such an attitude can only come from an entire failure to recognize the unstable nature of earth foundations and from a failure to appreciate the loads to which an earth foundation under a thin crust is subjected by ordinary modern wheel traffic.

In the first place Mr. Tucker bases his reasoning on a wheel load of 1,500 pounds. Now, as a matter of fact, the ten-ton truck is with us and it is probably here to stay. Such a truck under a moderate overload may reach a total weight of 30,000 pounds of which two-thirds will often rest on the rear wheels. This is equivalent to a load of 10,000 pounds per wheel.

But this load of 10,000 pounds is not a dead load. When applied under the rates of travel common for such vehicles this load is always a suddenly applied load and wherever there are inequalities in the road surface, or loose stones on the surface these irregularities may and frequently do cause the application of the full load as an impact load. Therefore, instead of a dead load of 10,000 pounds it is actually necessary to deal with a minimum suddenly applied load of 20,000 pounds and a maximum impact load of say 40,000 pounds.

Now, accepting Mr. Tucker's assumption that the divergence of load lines is at an angle of 45°, it develops that with an ordinary 3x8-in. brick laid on a 2-in. concrete base covered by a 1-in. sand cushion, the wheel load will be distributed over only about 120 sq. ins. of subgrade. This is equivalent to a unit load of 333 lbs. per square inch or approximately 24 tons to the square foot. Of course, under such a load as this, Mr. Tucker's proposed pavement would fail at once. Yet this is rather a common loading under present traffic conditions.

The point which I desire to bring out is that the actual strains which must be met in highway construction are not caused by the wagon load of from one to two tons but are caused by the heavy, rapidly moving trucks. These trucks move so rapidly that their loads are not adequately treated when considered as dead loads and while it may be somewhat extreme to consider these loads as impact loads, any engineer who desires to do so can satisfy himself that wherever heavy trucks are operating over a rough or an uneven surface the loads generated do partake of the nature of impact loads. Therefore, they should be figured as impact loads.

In justification of the assumption, that modern traffic conditions frequently produce impact loads, one has only to note the effect of any sharp ridge left where two pavements join. A hollow place always appears below the ridge, due to the impact of the loads which come over this ridge. It is also noteworthy that once a hole begins to form it increases in size very rapidly due to this same tendency of rolling loads to become impact loads wherever there are uneven places or obstructions in the pavement. Therefore, in designing modern pavements, it is not sufficient to allow for the dead loads which will be produced by ordinary forms of traffic, but it is advisable and in fact necessary to consider the heavy loads which are caused by modern trucks and to allow for these loads not as dead loads but as impact loads.

Mr. Tucker's paper also contains another assumption which engineers ought to get away from as rapidly as possible and that is the dry subgrade assumption. There is no such thing! To assume that the location of the water table in any locality is materially affected by placing a 15-ft. strip of concrete ten miles long across this locality is little short of ridiculous. The laws of capillary attraction and the laws governing the flow of ground waters, work just as well under a concrete pavement as they do under the open sky. It is true that a concrete pavement will shed storm water but after all this is not the water which causes the trouble in securing stable foundations under a pavement. Soft spots are caused by the water that comes up from beneath a pavement and not by the water which rains down on top of it. That this is the case should be self-evident from the fact that one of the principal difficulties with concrete pavements is that they are heaved up and badly cracked by the freezing of the ground water under them. If the ground under a pavement was actually dry there would be no water there to freeze and consequently no heaving of the pavement during the winter months.

The net result to be obtained from considering these two points is simply this: That instead of endeavoring to save money by designing the thinnest pavement imaginable every highway engineer should emphasize to his clients the really enormous loads which pavements transfer to their foundations and which the foundations must carry. He should admit frankly that there is no possibility of securing an absolutely uniform subgrade and should assert that safety requires that pavements be thick enough to spread out the heavy loads caused by modern forms of traffic so that an earth subgrade can be expected to carry these loads.

Very respectfully,
J. L. Harrison.
District Engineer, Bulacan,
Care Bureau of Public Works, Manila, P. I.
Malolos, June 22, 1915.

Method of Recording and Filing Information Concerning Bids Received and Bidders.

(Staff Article.)

The convenient method illustrated here for recording and filing bidding prices and bidders on engineering construction is sent by C. M. Stokes, with Charles Kerby Fox, civil engineer, Pomona, Cal. The sheet sent is 16 x 10½ ins.; there are 20 entry lines under the top heading and 10 entry lines under the bottom heading. Under the top heading are tabulated the bids received. The other form is for recording information concerning bidders. If secrecy is required a key can be used to designate this information or the "data relating to bidders" blank can be printed separately.

BIDS RECEIVED—(Date) ——————
SCHEDULE No. ——————
——(Name of work) ——————

(Name and address of Company)

We have opened, checked and tabulated on this sheet, all the bids received for this work and recommend that the contract be awarded to Bidder No. —— ——————

(Signed)—————— Chief Engineer. (Signed)—————— Title.

Item No.	WORK	Quantity	Engineer's Estimate		1		2		3		4		5		6		7		8		9		10	
			U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.	U.P.	AMT.
1																								
2																								
3																								

DATA RELATING TO BIDDERS.

BIDDERS			President	Secretary	Organized under Laws of	Bond	Capital	Rating	Reputation	Time	Experience	Outfit	All or Part Time	REMARKS
No.	Name.	Address												
1														Note relating to keys: A—Best; B—satisfactory; C—look into further; D—unsatisfactory. Financial keys can be obtained from commercial agencies. Any other keys or symbols may be used if secrecy is required.
2														
3														

Forms for Recording and Filing Data on Bids and Bidders.

DRAINAGE AND IRRIGATION

Method and Cost of Making a Drainage Survey for the Washington Bayou Drainage District, Mississippi.

Contributed by O. W. Melin, 6210 Kimbark Ave., Chicago, Ill.

The survey here described was made during the months of January, February, March and a part of April of 1914 under the direction or Mr. C. H. West as engineer of the district. The survey was ordered by the chancellor of the court at the petition of property owners of the district.

Washington Bayou Drainage District comprises parts of Washington and Issaquena counties of Mississippi and is bounded on the west and north by the Mississippi levee; on the east by east line of Lot 3, Section 2, T. 15 N., R. 9 W., Lake Washington, Washington Bayou and Steeles Bayou; on the south by the south township line of T. 13 N., R. 8 W.

The topography of the district is that of a typical delta region being comparatively flat with a great number of sloughs. The northern part of the district was entirely cleared with the exception of the sloughs which were full of timber, brush and vines. In the southern part of the district a greater portion of the land was covered with timber, the sloughs being more numerous and the land lower.

The southwest part of the district, being immediately at the 1913 break in the levee, was covered with sand—the depth varying from 1 in. to 4 or 5 ft. While a good deal of land was ruined, at the same time a large part of the land was really benefited, the sand mixing with the tough buckshot and making a loam. The principal damage resulted from the fact that all of the sloughs were filled with sand thus destroying all natural drainage for a land that especially needs good drainage being immediately below the levee and which undoubtedly will be troubled with seep water.

SURVEY PARTY ORGANIZATION.

The party consisted of 15 men as follows: One chief of party, three instrumentmen, three rodmen, six axemen, one cook and one cook's helper—the axemen, cook and helper being negroes. The camp equipment, which was purchased from the Otter Bayou Drainage District, included five tents—one used as a sleeping tent for whites, one for office and dining tent, one cook tent and two for sleeping tents for blacks. The chief of party and one rodman also slept in the office tent. The other equipment is shown in detail by the cost data.

At the first camping place, above Leota Landing, we lived in the chief of party's plantation home, which reduced expenses a little. All other camps were in tents placed conveniently near water and some plantation home.

No wagons were used on the survey, it being concluded before the survey was started that the Mississippi roads at that time of the year are practically impassable at times and that it would be easier to walk to and from work. As it happened the winter was unusually dry for Mississippi and walking was good; and, due to the round-about ways of the roads, a good deal of time was saved in parts of the district especially the southern half.

For moving purposes, teams were hired from the plantations—a moving outfit consisting usually of three double teams of mules with cotton wagons. The average move was about six miles, there being three moves only, not including the hauling of the outfit from Erwin Station to the chief of party's home, and the final hauling of the outfit from Lakeside Store to Grace—four miles.

The party was divided into three units, each party consisting of one instrumentman, one rodman, and two axemen. This, of course, was an arbitrary division, one party using three axemen and one party getting along with one, depending on the nature of the work and natural difficulties encountered.

BASE LINE.

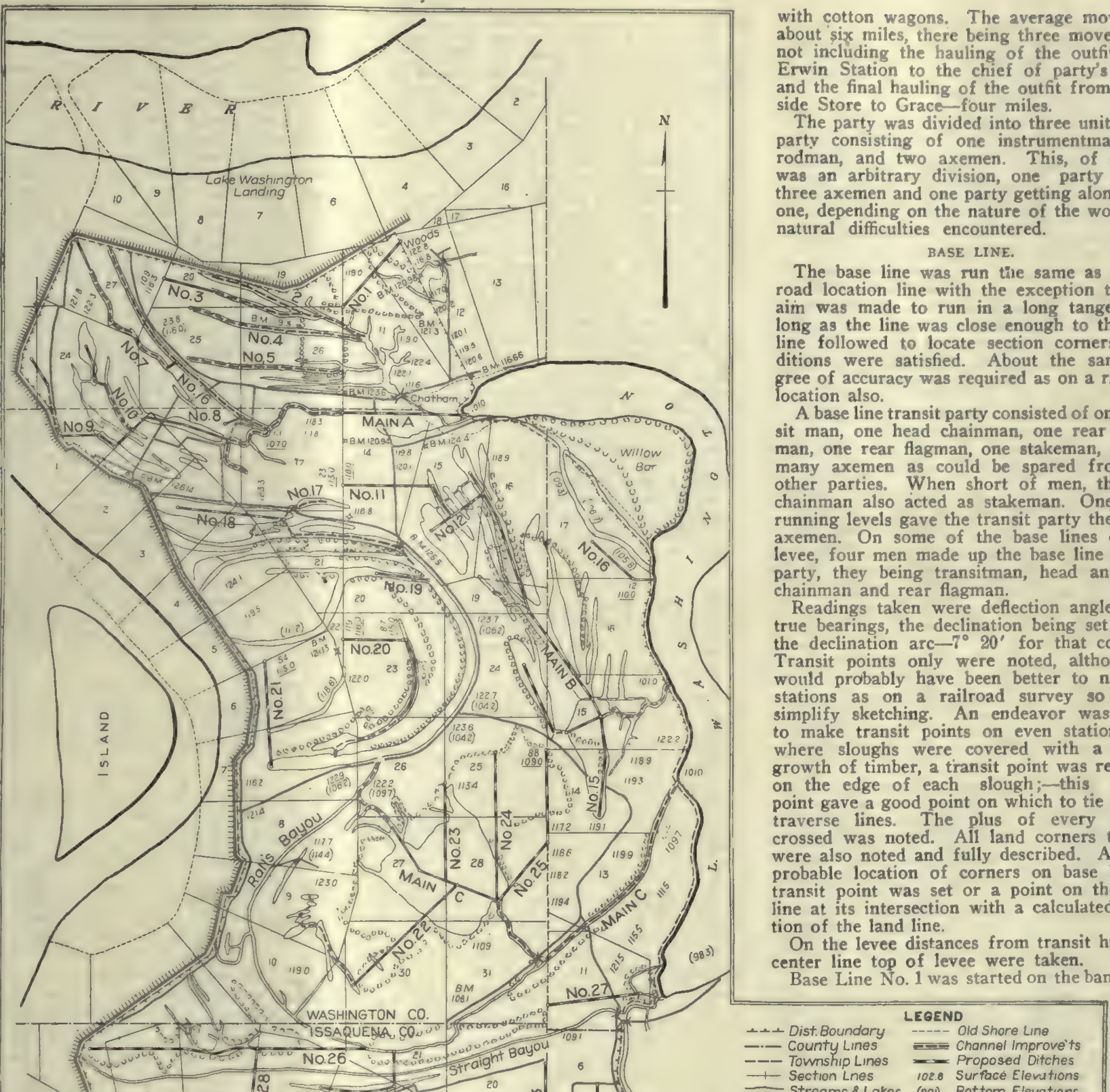
The base line was run the same as a railroad location line with the exception that no aim was made to run in a long tangent; as long as the line was close enough to the land line followed to locate section corners, conditions were satisfied. About the same degree of accuracy was required as on a railroad location also.

A base line transit party consisted of one transit man, one head chainman, one rear chainman, one rear flagman, one stakeman, and as many axemen as could be spared from the other parties. When short of men, the rear chainman also acted as stakeman. One party running levels gave the transit party their two axemen. On some of the base lines on the levee, four men made up the base line transit party, they being transitman, head and rear chainman and rear flagman.

Readings taken were deflection angles, and true bearings, the declination being set off in the declination arc—7° 20′ for that country. Transit points only were noted, although it would probably have been better to note all stations as on a railroad survey so as to simplify sketching. An endeavor was made to make transit points on even stations but where sloughs were covered with a thick growth of timber, a transit point was required on the edge of each slough;—this transit point gave a good point on which to tie slough traverse lines. The plus of every slough crossed was noted. All land corners tied to were also noted and fully described. At each probable location of corners on base line, a transit point was set or a point on the base line at its intersection with a calculated position of the land line.

On the levee distances from transit hubs to center line top of levee were taken.

Base Line No. 1 was started on the banquette



Map of the Washington Bayou Drainage District, Mississippi.

of the levee at Leota Landing, run north and east on the levee bankette to the eastern boundary of the district and then along the eastern boundary, which was a lot line, to the bank of Lake Washington.

Base Line No. 2 was run from the levee south along the section line between Sections 11 and 26 of T. 15 N., R. 9 W., to the south township line of T. 15 N., R. 9 W., then west to the levee along the township line to the levee and up the levee to the point of beginning of Base Line No. 1.

Base Line No. 3 was run south on the levee two miles from Base Line No. 2.

Base Line No. 4 was run south along the section line between Sections 20, 21, T. 14 N., R. 9 W., to the section corner of Sections 20, 21, 22, 23; then east to the range line; then south along the range line to the township and county line; then west along the county line to the levee and up the levee to Base Line No. 3.

Base Line No. 5 was run south from the county line along the range line to the N. W. corner of Section 19, T. 13 N., R. 8 W; then west to the levee and up the levee to Base Line No. 4.

Base Line No. 6 was run from N. W. corner of Section 19, T. 13 N., R. 8 W., east to section corner of Sections 16, 17, 20, 21; then south to the township line and south boundary of district; then west along boundry to the levee and up the levee to Base Line No. 5.

Base Line No. 7 was run from Base Line No. 6 along the south boundary to the bank of Steeles Bayou.

As much of the Base Line was run from each camp as would be necessary for taking topography. All stakes used were cut in the fields from saplings and old boards that might be found. The error in closure ran from 1/1,500 to 1/10,000, the larger error being satisfactory.

The speed of the transit party varied with the difficulty of the going and with the number of axemen. In a slough, such as Cockle Burr Slough, covered with thick timber, brush and vines, only 1¼ miles per day could be made with three axemen. On the levee with no cutting and sights limited only by turns in the levee, as much as 4½ miles were made with a party of four men. This speed could not have been maintained day after day, however, because of the long walk to and from camp.

Some difficulty was found in following land lines and finding corners because of the fact that property lines did not usually coincide with land lines as is customary in some regions. Also the natives, being negroes, did not even know what a section corner was.

The level party started one day behind the transit party and consisted of levelman and rodman, all clearing being done by transit party. A Wye level was used and a Philadelphia rod without a target. Readings were taken to hundredths only. The double peg method was used, the check notes being kept on loose sheets, which were destroyed after final check. The differences were noted in the field book. The levels were started off a U. S. G. S. B. M. at Leota Landing and the final check was also made on a U. S. G. S. B. M. on the levee. B. M.'s were put in every half mile. The level run and notes kept were about the same as on a railroad location survey, except that care was taken to get the elevation of all transit hubs. When on the levee the level party took topography for a distance of 300 to 600 ft. out depending on difficulty and necessity. The speed of the land party varied with the natural difficulty somewhat but an average of three miles a day of double peg levels might be considered fair.

TRANSIT TRAVERSE.

All traverses were run with transit and stadia. The country being practically level no vertical circle was needed, the telescope being kept horizontal. The stadia board generally preferred was one of 10 ft. length and a 14-ft. board available for deep sloughs. All three cross wires were read and noted. By subtracting the bottom wire reading from the middle wire reading and the middle wire reading from the top wire reading, the transitman immediately had a check on both elevation and distance. The two wires should be so adjusted that the two intervals are equal.

The declination being set off on the declination arc, true bearings were read. Care was taken to read the north end of the needle, this necessitated being careful to get the bearings opposite in backsight readings.

If possible the sloughs were traversed in pairs, this being done in a few cases only. On some of the wide sloughs traverse lines were run on both sides and cross section traverses every 1,500 ft. In traversing a slough the line was started off of a base line transit point or B. M., or off some other traverse transit point or B. M. which had been closed and checked. On the larger sloughs cross-sections were taken every third set up, and readings in the middle at every set up. In the shallow sloughs, readings were taken in the middle or low point, and the width, as estimated by the transitman, recorded. Most of the sloughs being full of timber the traverses were run just off the edge of timber. If this did not happen to be the top of bank, a side shot was taken and noted as top of bank. Where two sloughs were traversed with one line which was usually run on the ridge between the two, side shot readings were taken in the middle of each slough and the widths estimated.

TABLE I.

L 50 Traverse Cockle Burr Slough East Branch.

Party—John Doe, trans.; J. Smith, rod.; E. Andrews, axe; E. Murphy, axe.

Left hand page.					Right hand page.			
Stat.	B. S.	H. I.	F. S.	Elev.	From T. stat.	True bearing.	Dist.	Stadia.
0	4.34	115.93	....	110.59	..	....	...	...
				L 58 — 0 = B L 6 — 43				
1	....	......	5.2	110.7	0-1	N 34° 45′ E	360	614 434 254
A	....	......	5.3	110.6	1-A	550° 00′ W	100	Head of slough
2	4.97	115.56	5.34	110.59	1-2	....	...	...
3	....	......	5.2	110.4	2-3	N 45° 15′ E	328	661 497 333
			X Section Slough Stat. 3 Top East Bank					
+30	....	......	9.8	105.8	Middle slough. Slough covered with thick growth			
+60	....	......	4.9	110.7	Top west bank. Timber and vines			
4	5.89	117.83	3.62	119.94	3-4	N 40° 20′ E	535	630 352 333
5	....	......	5:1	112.7	4-5	N 38° 10′ E	600	889 589 289
..	....	......	....	......	Peg 5-1	S 45° 20′ E	230	...
		1 in. sq. iron axle 1 ft. above ground 300 N. E. res. Scott Jones (negro)						
A	....	......	13.2	105.6	Middle slough. 5 top east bank 70′ wide.			
..	....	......	....	......	5-6	N 85° 00′ E	600	N. E. cor. res. E. Smith, 2-story frame.
..	....	110.46	....	......	...	....	...	...
68	....	......	4.23	106.23	6-7	S 84° 25′ E	540	693 423 153
		L 58 — 68 = L 43 — 95 Error Closure 0.18.						

The usual method of station numbering was used, excepting the + 00 were not marked on the stakes. The initial point being some known elevation on some other line, always gave an equality, thus: station L34-0 = BL6-234. The transit station would be L34-1 and the next forward point L34-2. This made the transit point always an odd numbered station and the turning points even numbered stations. No stakes were placed on the transit stations. For turns small pegs were used and marking stakes were of the same kind as were used on the base line.

The lines were numbered L1, L2 until L100 was reached and then other letters were used. The writer used a method that worked out all right—that is any line starting from some other line was numbered the same with a letter as suffix, thus: L54-A, L54-B. In some cases as many as seven lines were started off the one traverse and the lettering showed immediately the sloughs traversed probably led into the slough traversed by the main line. A method which might be a good one to use would be to give each transitman a letter to use as a prefix. If different, the first letters of the transitmen's surname might be used. This would do away with the possibility of duplicating a line number and also would make it possible to see immediately which party had run the traverse. The three transitmen kept from duplicating numbers in the method used by each one taking a series of numbers from 0 to 10, 10 to 20, etc.

Where several shots were taken from one set up the letters of the alphabet were used as A, B, C, etc. Where the water was deep as in the small lakes the water surface was read and then side shots of points sounded the bearing and distance being noted and the depth as taken, usually with the 14-ft. board. Where the bank was too high to get the water surface or a cross section from a regular transit station, the station was set ahead first and then a side line run down into the slough. The water surface was taken by first driving a peg flush with the water surface. Having taken the water surface or cross section, the transitman could then go ahead to next transit station—thus the advisability of setting the forward turning point before running the side line into the slough.

Public roads were traversed in much the same way as the sloughs, excepting that no cross sections were taken. All buildings occupied or used by whites were located and their description noted. Backwater and high water elevations were taken, wherever fairly definite information could be gotten. The elevation, date and source of information were noted. All land corners and property corners were located and a description noted. In order that the draftsman could correctly interpret the transitman's notes easily a good sketch was kept. This sketch, it was found, saved a great deal of worry to both field and office parties, even in the case where each transitman plotted his own topography on the map.

Wherever another traverse or the base line was crossed, a tie was taken and noted, both for bearing distance and elevation.

In the southern part of the district all quarter lines and section lines were run in order that the elevation of the ridges might be found.

The notes were kept as shown by Table I. Both pages being used for general notes, the remarks were crowded into the little remaining space, or what was better, a line was used for the same. The sketch would have to be made on a separate page or part of a page.

OFFICE WORK.

The map was drawn in camp on detail paper to a scale of 1 in. equal 1,000 ft. This sheet was divided into squares, which scaled

5,000 ft., the initial point being so selected so as to make all latitudes and departures plus and also so as to make the map complete on the one sheet. Each transitman plotted his own line and put on his topography, with the exception of the base line, which was taken care of by the one transitman. The base line was plotted by latitudes and departures. For computations, a traverse table, which read to minutes, was used. The base line was inked in red. The station numbers were also in red and elevations in black. The traverse lines were plotted with a 16-in. paper protector and inked in red. The stations and line numbers were in red and elevations in black. The high and low elevations of the slough traverse points were noted. The topography, such as edge of sloughs, houses, corners, etc., were in full black lines. Woods line was represented by a dotted black line. Public roads were shown in brown and water lines in blue. Remarks as to character of cultivation and timber were noted on the map. Land lines were put on the map from data given on land office township plats and adjusted to fit the land corners located in the field. Land lines were in fine black lines.

In plotting traverses, the error of closure was distributed in the last few stations, it happening that no large error of closure occured.

For field use a map was made from land office sheets. These being made from the original survey of 1826, or thereabouts, of course, were not accurate, but they served the purpose of locating land lines to a little extent. The map, of course, was made up in the engineer's office before the start of the survey and a print of it was given to each transitman.

The final map for which the canal was platted was made in Mr. West's office being reduced from the large map, the scale of the same being 1"=C, whatever map sent in shows.

COST.

In considering the cost of this survey it should be noted that the equipment was bought second-hand, that the party was organized and experienced, having just finished a survey of a similar nature, and that the weather was unusually fine for the winter months in Mississippi. Very few days were lost because of rain and those only at the latter part of the survey when there was a great deal of office work which might be done. For the average conditions the writer would add about 10 per cent to the total cost for a survey of the same scope.

The camp equipment was bought from the Otter Bayou Drainage District, a discount of 33⅓ per cent of the original cost new, being made for depreciation. It is listed below:

PURCHASED FROM GEISE-MANN HARDWARE COMPANY.
December 31, 1913.

1 range	$38.00
4 baking pans	1.70
2 frying pans	.70
3 sauce pans	2.25
12 small mess pans	.75
2 large mess pans	.50
1 large dish pan	1.25
1 set waffle irons	1.25
2 coffee pots and dippers	1.70
1 alarm clock	1.00
3 lamps	1.50
9 tin pie plates	.35
2 sifters	.15
3 butcher knives	1.00
1 colander	.35
1 milk strainer	.15
1 large spoon	.10
2 skimmers	.30
2 flesh forks	.10
6 granite dippers	1.00
7 water buckets	1.20
1 meat cleaver	1.25
1 hand saw	1.50
1 monkey wrench	.35
1 screw driver	.25
10 tin pint cups	.40
1 syrup pitcher	.50
18 dinner plates	1.00
14 saucers and 12 cups	2.00
2 meat dishes	1.25
4 vegetable dishes	1.50
3 wash basins	2.40
1 gallon oil can	.20
1 butter dish	.25
1 sugar bowl	.25
1 cream dish	.15
8 soup bowls	1.25
2 water pitchers	1.00
3 wash tubs	1.75
1 5-gallon oil can	1.00
4 pole axes	3.00
12 bush axes (7 good)	5.00
6 lanterns	1.25
19 tablespoons	1.00
18 teaspoons	1.50
18 table knives and forks	3.50
1 coffee mill	1.00
1 grindstone	1.00
1 pair hand scales	.25
24 tumblers	1.30
1 waiter	.35
1 pound nails	.25
8 joints pipe	.75
1 elbow	.25
1 rolling pin	.15
1 potato masher	.15
1 salt and pepper cruet	.35
1 broom	.40
Total	$95.20

PURCHASED OF HOOD-SHARKEY HARDWARE COMPANY.

4 tent heaters	$ 6.00
18 joints 5-in. pipe	2.25
8 elbows	1.20
4 pieces tin	2.00
10 camp stools	4.50
17 canvas cots	43.50
2 rodman's hatchets	1.40
Total	$60.85

PURCHASED OF MORRISON TENT & AWNING COMPANY.

5 four-foot wall tents, 14x16, 10-oz., and 5 flys for same (both mildew proofed)	$229.63

PURCHASED OF ALEXANDER LUMBER COMPANY.

8 pieces 1x12	$3.36
6 pieces 1x4	.84
Total	$4.20

PURCHASED OF GOYER COMPANY.

2 short handle spades	$2.50
2 two-gal. water kegs	1.50
1 water barrel	1.25
Total	$5.25
Total value new	$395.13
Less 33⅓ per cent for depreciation	131.71
	$263.42

The salaries were distributed at the following rates per month:

One chief of party	$150.00
One instrumentman	100.00
Two instrumentmen (each)	90.00
Three rodmen (each)	40.00
Six axemen (each)	30.00
One cook	30.00
One cook's helper	30.00

The regular cook getting dismissed and an axeman being cook, accounts for $30 for a cook. Otherwise, $40 would have been the wage. The same is true with the cook's helper, the wage of which could have been $20. The result, however, is the same. This gave a total monthly wage of $790.

On this basis the survey was of 3.207 months duration. For meals, this gave an average of about 17½ cts. for each meal—two meals in camp and a lunch. While no fancy foods were served, good wholesome meals were provided and one might say the party was well fed. The above cost included groceries, wood and water, but not the wage of the cook.

The following grocer bill will give the unit cost of groceries, this being the bill for February:

1 brl. P. G. flour	1	.....	$5.30
1 sack granulated sugar	100	.....	4.40
1 sack 272 rice	100	.6¼	6.25
1 sack navy beans	165	$2.50	6.88
1 crate picnic hams	103	.13	13.39
1 crate dairy hams	105	.17½	18.38
1 sack D. S. ribs	50	.12¾	6.38
1 sack Minn. bacon bellies	27½	.17½	4.81
1 case 1/50 F. W. lard	50	.9¼	4.63
1 box Daisy cheese	21	.19½	4.10
1 sack potatoes	2½	$1.00	2.50
2 cans 10-lb. green velva molasses	2	.55	1.10
1 bundle 5-lb. yellow bags	1	.....	.75
1 case tall Pet milk	1	.....	3.95
1 can Maracaibo coffee, ground	25	.28	7.00
1 case ½-lb. ham and steak	2	$1.25	2.50
1 case No. 2 B. B. corn	2	.85	1.70
1 box soda crackers	22	.6½	1.43
1 case 3-lb. tomatoes	2	$1.00	2.00
1 case Peacock asst. fruit	2	2.05	4.10
1 case 2-lb. grated pineapples	2	1.90	3.80
1 box 60/70 prunes	25	.9½	2.38
1 case 1-lb. corned beef	2	$2.35	4.70
½ bu. onions	28	.....	1.10
1 gal. apple vinegar	1	.....	.40
1 case Van Camp's catsup	1	.....	4.40
1 case 1-lb. spaghetti	1	.....	1.50
10 cans 1-lb. G. L. baking powder	10	.....	.80
1 carton S. L. matches, D. D.	1	.....	.40
1 case 8-oz. mixed pickles	2	.90	1.80
20 lbs. grits	20	.....	.50
2 sacks 48-lb. meal	½	.....	1.70
Prepaid	...	.....	3.50
			$128.53

The total cost of the survey was as follows:

Cost of camp equipment	$ 263.42
Rent of instruments	136.70
Pay of men on survey	2,533.86
Cost of groceries	458.21
Cost of supplying wood and water	45.00
Moving camps, teams, transportation and all other incidentals	245.80
Total	$3,682.99

The writer is indebted to Mr. C. H. West, member of American Society of Civil Engineers, member of Mississippi River Commission for the cost data and map.

Cost of Electric Dredging for Land Reclamation, San Diego, Cal.

Contributed by L. R. W. Allison, 170 Roseville Ave., Newark, N. J.

The city of San Diego, Cal., has a municipally owned waterfront, extending from National City to the United States military reservation at Point Loma, a distance of ten miles, and comprising a total area of about 1,460 acres. The city harbor embraces the Bay of San Diego and affords particular natural advantages for economic and effective development; extensive improvements to this harbor have recently been made to provide for the increased water traffic attending the use of the Panama Canal.

A total appropriation of $1,000,000 was allotted as a Harbor Improvement Fund, covering expenditures involved in carrying out the various features of the work. These improvements consist of a reinforced-concrete and steel pier, 800 ft. long and 130 ft. wide, costing about $374,000; a gravity type bulkhead wharf, approximately 2,700 ft. long, totaling $329,289; and the reclamation of about 60 acres of tidelands. These latter include an area reaching from the business section of the city to the deep waters of the harbor.

In connection with this reclamation work the city purchased and operated two hydraulic suction dredges, known as the "E. M. Capps" and the "Silver Gate," and representing an investment of $39,000 and $53,000, respectively. The dredges are electrically operated, transmission lines being swung on pontoons from the plant of the San Diego Consolidated Gas & Electric Co. to the point of operation.

The first mentioned and smaller dredge has a 12-in. centrifugal pump, with rated capacity of 5,000 gals. per minute. During the inaugural period of activities it was operated by contractors, who under the terms of their agreement with the city were privileged to enlist its use at any time by defraying the cost of operation; in this, the service was largely restricted to trench excavation.

The "Silver Gate" dredge was installed by the city in August, 1913, and after actual test try-outs was formally accepted and placed in regular service in December of that year. This dredge, the largest in use on the Pacific Coast, has an 18-in. centrifugal pump, with rated capacity of 12,000 gals. per minute, and 14-in. discharge. This pump is operated by a 480 k.v.a., 2,200 volt, direct-connected synchronous motor, running at 450 r.p.m.; this unit, of the revolving field type, has a 15 kw. exciter mounted on the main shaft.

Other electrical equipment of this dredger consists of a 150 h.p., 2,200 volt, variable speed induction motor operating a 5-ft. mud cutter, a friction clutch being provided on the cutter shaft to allow release where the blades encounter any unusual obstructions; a 40 h.p., 220 volt motor of the same type, belt-connected to six winches, operating through changeable gears, and a 7½ h.p., 220 volt induction motor direct-connected to a 3-in. pump, used for priming.

The accompanying data regarding operation of these electric power dredges, based upon a report of the city harbor engineer, illustrate the low cost factors and results of this municipal dredging enterprise:

Careful surveys and computations show that 447,000 cu. yds. of earth were excavated from the bottom of the bay at an aggregate cost of $51,905.67, or at the rate of 11.6 cts. per cubic yard. This was accomplished notwithstanding the frequent difficulties encountered at the commencement of the work and the time in which the operation of the dredges was being perfected. The "Silver Gate" dredge operated for a few weeks in rather soft earth, with output abnormal; later it engaged with a stratum of very hard ground, closely allied to stone, about 10 ft. in depth. The removal of this entailed excessive strains upon the machine, causing delay and expense through failure of the spuds and winches, breaking lines, and other items.

Through the earlier period of try-out of the "Silver Gate," the dredgings were deposited south of Broadway, together with the dredgings of the "E. M. Capps." Following, the "Silver Gate" was changed to discharge into the area north of Broadway, accompanied by the deposits of the smaller dredge. At this site, it was found that 165,000 cu. yds. of earth were excavated from the bottom of the bay at a cost of $11,977, or at the rate of 7½ cts. per cubic yard.

The "Silver Gate" was run in three shifts of 8 hours each. With electric energy furnished at the rate of 1½ cts. per kw.-hour, operation cost averaged $6.09 per working hour, with pump, winch and cutter motors in action. The average daily period of running this apparatus ranged from 14 to 24 hours, or an approximate total of 18 out of 24 hours. The monthly labor cost of operating this dredge is:

Three levermen at $100	$300.00
One chief electrician	125.00
Two electricians at $100	200.00
Three deckmen at $75	225.00
Three pipemen at $75	225.00
One blacksmith	100.00
Total monthly labor cost, 24-hour basis	$1,175.00

It has been found that $30 per day will allow for wear and tear, such as cutter blades, tooth holders, teeth, rubber pipe sleeves, and the like, while incidentals involving such items as moving lines, driving dolphins, etc., represent a cost of $10 per day, based upon a 24-hour period.

The daily cost of operating the "Silver Gate," 24-hour day, accordingly is as follows:

Labor	$ 39.16
Electric energy, 18-hour run basis	109.62
Repairs, wear and tear	30.00
Incidentals	10.00
Total, 24-hour day	$188.78

Similarly, the cost of operation of the smaller dredge, "E. M. Capps," is found to be $70.55 per 24-hour day.

The daily discharge of the "Silver Gate," with its capacity of 12,000 gals. per minute, water and solid matter combined, and figured on 18-hour run, is as follows: On a basis of 10 per cent solid matter, 6,400 cu. yds.; 7½ per cent solid matter, 4,800 cu. yds.; and 5 per cent solid matter, 3,200 cu. yds.

From this it will be noted that the net cost to the city per cubic yard of dredging has been 3 cts. for a 10 per cent solution of water and solid matter; 4½ cts. for a 7½ per cent solution, and 6 cts. for a 5 per cent solution.

These figures are further interesting in considering the low cost obtained through this electric dredging work. If the cost to operate the dredge was doubled, or the output reduced by one-half, the proportionate prices would be 5.8 cts., 8.8 cts. and 11.8 cts., respectively, for the different solution percentages noted, still a low average cost for dredging work, and indicating particular efficiency in operation.

Pumping for Irrigation Studies.

(Staff Abstract.)

The active interest taken in irrigation by pumping is evidenced by the studies completed and being prosecuted by the Division of Irrigation Investigations. A summary of the latest news from this Division gives the following information:

Professor B. P. Fleming of the University of Iowa, who was employed during the season of 1914 on a series of tests of pumping plants in the Snake River Valley of Idaho, has submitted his report on these investigations. The report brings out the low efficiency of small pumping plants, and calls attention to prevailing causes for this, which are chiefly the use of pumps under conditions for which they were not designed, poor transmission and large losses from entrance head.

F. L. Bixby, I. E., has submitted a report on a series of tests conducted on a well-known make of centrifugal pumps in the laboratory at the New Mexico Agricultural College. The laboratory has recently been equipped with apparatus to permit determinations of power input, static and friction heads and water pumped, and the tests will be continued.

Thirty-five collaborators at small monthly salaries have recently been appointed to collect information on costs of operating pumping plants in Nebraska. These employes are owners or operators of plants and have been instructed to keep daily records of fuel consumed, lubricating oils used, cost of repairs and attendance, time plants are run and the lands on which pumped water is used. This work is being carried on under H. C. Diesem, I. E. Mr. LeRoy Rhodes, a member of the faculty of the University of Nebraska, with which the Division is co-operating in these studies, has been employed to assist Mr. Diesem for the summer.

Co-operative investigations have been proposed by the University of Nevada which, if undertaken, will include the keeping of similar records to those being collected in Nebraska, but will cover principally plants operated by the University under a special appropriation made by the legislature for pumping investigations.

A portable pumping plant has recently been purchased by the office for the purpose of testing capacities of wells and other sources of supply used in irrigation in the humid states. This will be used in connection with the investigations being carried on by M. B. Williams and F. W. Stanley.

The co-operative investigations in Utah include the installation and operation of experimental pumping plants and the keeping of cost data.

Mr. Samuel Fortier is chief of the Division.

CONSTRUCTION PLANT

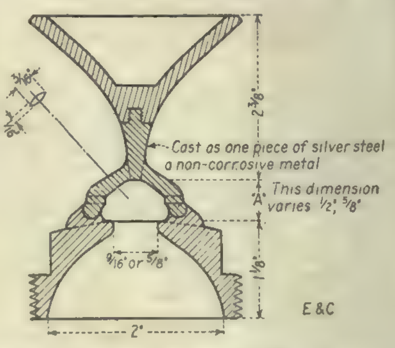
MACHINES DEVICES MATERIALS

A New Type of Sewage Spraying Nozzle.

The "Universal" sewage spraying nozzle is illustrated herewith in a sectional view. This nozzle gives a circular spray. The cone of the sprayer is adjusted at the factory so as to give the best distribution with the particular nozzle capacity for which a certain plant is designed. Great uniformity of distribution is claimed by the use of this nozzle and it is also claimed that partial clogging is reduced to a minimum. The spray is equal in intensity along all radii. This is brought about by the design of the spindle upon which the deflecting cone is attached.

The use of the circular spray type of nozzle is said to obviate internal clogging. Moreover any clogging material which catches on the arm is removed without unscrewing any of the parts. This is a matter of importance where the parts are small and the thread may either be worn or crossed in the process of screwing and unscrewing the nozzle. Another advantage of the nozzle is that it may be cleaned while in operation. This is a feature which saves time and prevents the overdosing which always results when a nozzle or a part of it is removed for the purpose of passing some large particle. The freedom from clogging also makes it possible for the sewage plant operator to keep his hands out of the sewage more than is possible with nozzles subject to clogging. It is claimed further that in the use of this nozzle the screen which is sometimes introduced between the settling tank and the sprinkling filter bed may be done away with.

This nozzle is manufactured and sold by The Snow & Petrelli Manufacturing Co., New Haven, Conn.


3/16"
2 3/8"
Cast as one piece of silver steel a non-corrosive metal
"A"
This dimension varies 1/2", 5/8"
9/16" or 5/8"
1 1/8"
2"
E&C

Vertical Section of the Universal Sewage Spraying Nozzle.

A New Oscillating Piston Water Meter.

A new type of Trident water meter, known as the "Victor," and illustrated herewith, has recently been placed upon the market. Some water works operators prefer the oscillating piston type of meter to the disc meter and for this reason the "Victor" has been brought out by the manufacturers. The new meter is practically proof against damage from freezing. Protection against freezing is furnished by the accuracy of the workmanship in the measuring chamber. The parts of this chamber are all finished to a precision of 1/1,000 part of an inch, and the machined surfaces have a snug fit. They are held in this position against the water pressure by the accurately machined supporting webs which are cast on the inside of the bronze outer casing. They give way under the excess pressure developed by the freezing of the water, due to the breaking of the removable bottom which holds the measuring chamber in place.

The removable bottom is an iron casting which is brass lined and of the breakable type which is used in other Trident meters. In freezing the cast iron supporting arms which attach the cast iron bottom to the meter are broken and thus permit the ice to expand. With all restriction thus removed the measuring chamber is free to open under the pressure of the freezing ice. This protects the more delicate mechanism of the meter as well as the bronze casing itself. These cast iron breakable bottoms are easily replaced at a cost of about 35 cts. each.

The gear-train is made up of broad-faced gears which have substantial teeth. Hard rubber bushings are employed on all of the spindles to guard them against corrosion and the gear-train itself is assembled as a self-contained unit which may readily be removed from the bronze main housing by taking out the measuring chamber below it.

View of the New Trident "Victor" Water Meter Showing the Breakable Bottom.

The registering dial is also a self-contained unit and may be had either of the straight reading or clock type. The Chicago office of the Neptune Meter Co. is at 565 West Washington Blvd.

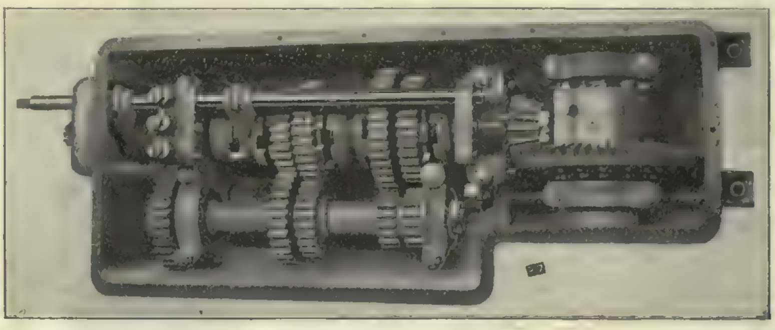
Light Steel Lining Plates as a Substitute for Timbering in Tunneling.

(Contributed.)

The illustration shows three sections of plates for an 8-ft. tunnel. These plates are used in soft ground tunnels to do away with timbering. Timbering has heretofore been one of the most troublesome and expensive problems in soft ground tunnel construction, due to the scarcity of experienced labor for this class of work, and due to the extremely high cost of performing the work, as well as to the dangers that have been encountered. These plates were designed to eliminate entirely the use of timbering in tunnels. Their advantages are:

First.—The amount of excavation is considerably less, due to the fact that the plates are from 2 to 2½ ins. deep, and therefore, the amount of excavation beyond the interior of the finished tunnel need not be so great.

Steel Tunnel Lining Plates.



Improved Transmission for Motor Trucks.

Second.—They are very light and easily handled, and can be placed by ordinary, unskilled labor.

Third.—They can be placed very quickly after a miner has dug a very small opening at the crown, and therefore the roof can be always supported much closer to the excavation than is the case with timbering.

Fourth.—The first cost of these plates, and the cost of placing them, is generally considerably less than the cost of timber and the cost of placing timber.

The plates themselves are usually made about 12 ins. wide and from 2½ to 3 ft. long. They are made so that they are absolutely interchangeable with each other, and so that the radial plates can be spliced. They are generally bolted together by four bolts on each side and three bolts on the end.

These plates can be used equally well in a tunnel, whether it be in free or compressed air, and are now being used on some very large tunnel work. They are made by the Blaw Steel Construction Co., Pittsburgh, Pa.

Special Motor Truck Transmission.

A special transmission for motor trucks is illustrated in the accompanying engraving. This transmission is used on all trucks of the Gramm-Bernstein Co., Lima, Ohio. It is of the individual clutch type always in mesh. The various speeds become engaged by means of dog clutches and here is the particularly special feature: the alternate dogs in each face of gear are lower than the others, thus ensuring immediate engagement. Change from one speed to another is made without racking or chattering and stripping of gears is impossible. Gears and shafts operate on ball bearings and gears cannot become disengaged. Change of speeds is accomplished by the ordinary hand lever and quadrant arrangement but it is interlocked so that only one speed at a time can be used. A worm drive is employed, meshing overhead with the gear on the rear axle. The clutch is dry plate, multiple disk. The driving shaft is double jointed.

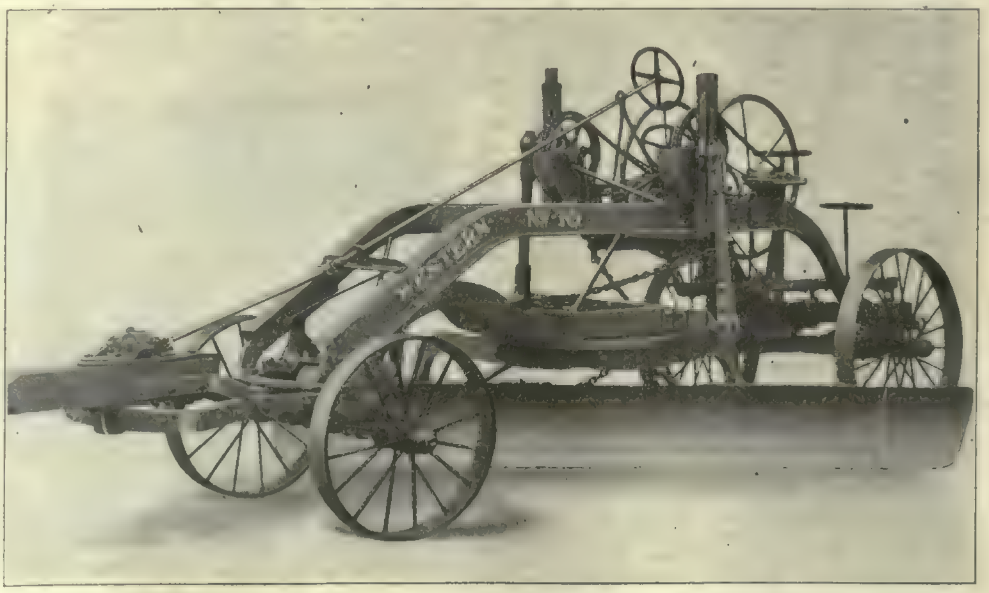
A Guaranteed Traction Grader.

(Contributed.)

The road grader illustrated is designed for traction haulage. It is guaranteed against breakage regardless of power used. This guarantee is protected by strength of construction alone, no brake pin on any other safety device being used.

Strength, which is the main essential of a heavy tractor grader, having been assured, the next most important point is to secure a machine with the greatest range of convenient adjustments to accomplish the maximum results under most varied conditions. The machine illustrated is a composite design, in which is embodied all necessary or desirable features, together with several important, exclusive improvements, which make this machine distinctive.

Heavy Z bars are used on the main frame and in place of bolts and nuts ¾-in. rivets are used, thereby eliminating lost motion which results from loose parts and making certain a smooth, even cut.



Road Grader Designed for Traction Haul.

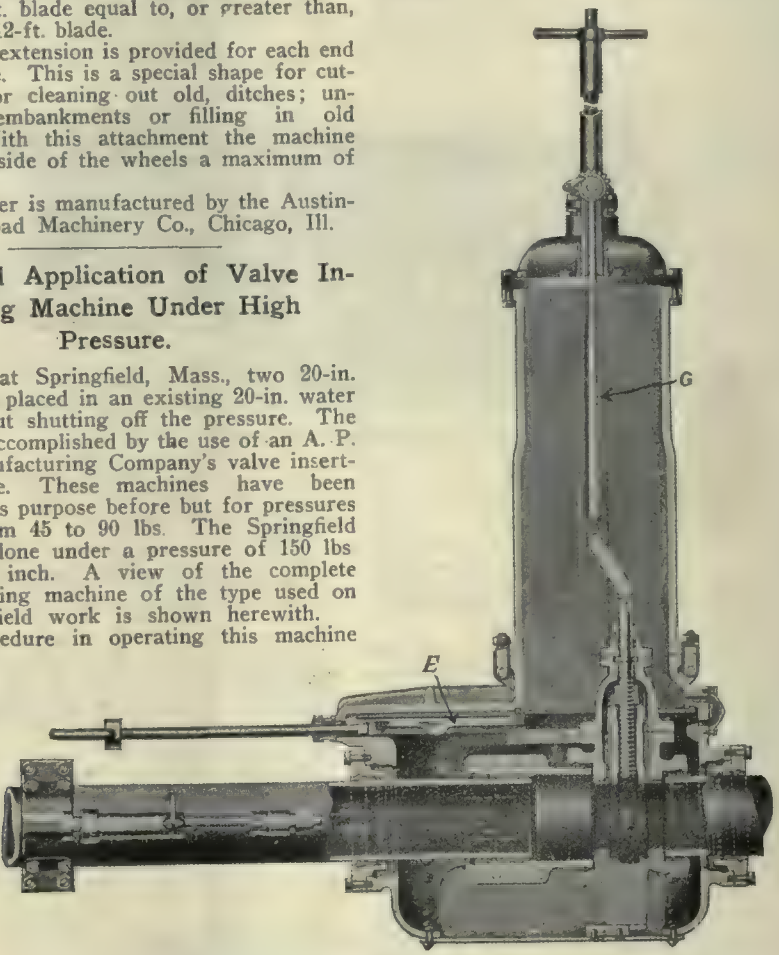
The blade is not rigidly attached to the blade beams but has a lateral adjustment of 22 ins. in either direction. This adjustment is automatic and controlled by the position of the stay chains. This feature brings the cutting point in a more direct line with the draft and relieves the machine of the tremendous leverage, or strain, which has proved so disastrous to machines with 12 or 10 ft. blades. Furthermore, this automatic side shift places the blade in such position that its entire length is utilized; making the capacity of this machine with a 10-ft. blade equal to, or greater than, any with a 12-ft. blade.

An 18-in. extension is provided for each end of the blade. This is a special shape for cutting new, or cleaning out old, ditches; undermining embankments or filling in old ditches. With this attachment the machine will cut outside of the wheels a maximum of 4 ft.

This grader is manufactured by the Austin-Western Road Machinery Co., Chicago, Ill.

Successful Application of Valve Inserting Machine Under High Pressure.

Recently at Springfield, Mass., two 20-in. valves were placed in an existing 20-in. water main without shutting off the pressure. The work was accomplished by the use of an A. P. Smith Manufacturing Company's valve inserting machine. These machines have been used for this purpose before but for pressures ranging from 45 to 90 lbs. The Springfield work was done under a pressure of 150 lbs per square inch. A view of the complete valve inserting machine of the type used on the Springfield work is shown herewith.



Sectional View of Smith Valve Inserting Machine, Sleeve and Valve.

The procedure in operating this machine may be described briefly as follows: The cutting machine is first placed on the water main at the point where it is desired to insert a valve. The pipe is cut about half way through the wall and then the special sleeve is bolted around the pipe and the end of the sleeve is placed about ¼ in. from the cutting tool. The valve inserting machine is then bolted around the pipe and the sleeve and completely encloses the cutting machinery. The joints between the pipe and the machine casing are run full of lead and calked in the usual manner. The pinion shaft is then rotated until the section of pipe is cut clear through.

The cutting machine together with the section of pipe which has been cut out is then drawn up into the dome of the machine by means of the central rod marked "G" in the accompanying view. The sliding valve "E" is then closed and the dome is removed and the cutting machine is taken out and the special valve is substituted for it. The dome is then replaced. The sliding valve is then reopened and the special valve is lowered into its place between the ends of the pipe. The special sleeve is then forced forward by means of jacks until it enters the large hub of the special valve. The opposite or small hub of the special valve is also forced onto the pipe. Both of the hubs are provided with wedge shaped lugs which enter the pipe and sleeve ends and hold in place the rubber gaskets which make the temporary joints between these and the valve. The upper casing is then removed and the joints at both ends of the valve and the sleeve are leaded and calked in the usual manner. The valve inserting machine here described is manufactured and marketed by the A. P. Smith Manufacturing Company of East Orange, N. J.

A Power Scraper Back Filler and Leveler.

The illustration shows a street fill being leveled by means of a new power operated scraper. This machine is designed particularly for backfilling trenches. The mode of operation is indicated clearly by the illustration. The machine is all steel and is self-propelling in both directions. The engine is a 6-hp., Novo gas engine and the clutch used in pulling the cable is of the standard hoisting engine type. The engine is also equipped with a brake for holding the line when raising pipe and also with a ratchet and pawl which enable the hoist to be set permanently. The hauling cable is at the machine run through a swiveling sheave which permits the scraper to be hauled from any angle. A number of these machines are in successful operatio They are manufactured by the Oshkos Manufacturing Co., Oshkosh, Wis.

Power Scraper for Backfilling Trenches.

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CURRENT NEWS

The Doings of the Week.

General business conditions continued to show improvement during the past week. Industrial operations showed gains, the labor situation was quieter and crop reports were excellent. The recent activity in the iron and steel industry was well sustained and there was no slowing up in war orders. The activities in the export trade and the fine crop reports have caused increased optimism as to excellent business for the fall. In the metropolitan district of New York building materials closed to the month of July considerably stiffer in prices and terms than they were a month ago. In the construction field the amount of new work coming up for proposals is well up to the average of previous weeks. No exceptionally large undertakings appear to have reached the call for bids stage during the past week. The highway and street improvement and bridge construction fields continue to offer many construction opportunities. Water works and sewerage developments, mostly for smaller municipalities, also are offering a considerable amount of work. In the iron and steel trade business is now nearly up to the normal average. Some observers believe that before the end of the year this country will have sold over 1,000,000 tons of steel bars to Europe. Orders already placed aggregate over 500,000 tons, and an additional 100,000 tons is now being negotiated. France alone has purchased 350,000 tons of steel in the United States. An important feature of the week was the Steel Corporation's report showing larger earnings for the second quarter than was expected. The Steel Corporation plants are now working at about 94 per cent of ingoa capacity. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending July 28 were as follows:

Finished Iron and Steel.	July 28.	July 21.
Per lb. to large buyers:	Cts.	Cts.
Bess. rails, heavy, at mill.....	1.25	1.25
Iron bars, Philadelphia.......	1.30	1.22½
Iron bars, Pittsburgh..........	1.25	1.25
Iron bars, Chicago............	1.20	1.20
Steel bars, Pittsburgh.........	1.25	1.25
Steel bars, New York.........	1.469	1.419
Tank plates, Pittsburgh.......	1.25	1.25
Tank plates, New York.......	1.369	1.369
Beams, etc., Pittsburgh.......	1.25	1.25
Beams, etc., New York.......	1.419	1.419
Skelp, grooved steel, P'gh.....	1.25	1.20
Skelp, sheared steel, P'gh.....	1.30	1.25
Steel hoops, Pittsburgh.......	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers:		
Sheets, black, No. 28, P'gh....	1.75	1.75
Galv. sheets, No. 28, P'gh.....	4.00	4.50
Wire nails, Pittsburgh........	1.60	1.60
Cut nails, Pittsburgh..........	1.55	1.55
Fence wire, base, Pittsburgh..	1.40	1.40
Barb wire, galv., Pittsburgh..	2.50	2.40

For structural material f. o. b. Pittsburgh the Iron Age prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.25 cts.

Railways.—There was some activity in the railway field during the past week. Several contracts were reported let and one or two other jobs were stated to have come up for bids. The latter included a 6-mile line in West Virginia. The Southern Ry. is understood to be about to take bids for double track work in South Carolina and Georgia. Bonds to the amount of $3,500,000 have been sold for these improvements. The contracts let include a 30 mile extension of the Central Oregon branch of the Oregon-Washington R. R. & Navigation Co. Twohy Bros., Portland, Ore., secured this job at about $1,500,000. A. G. Chatom, Turlock, Cal., has been awarded the contract for grading for a 15 mile extension of the Tidewater Southern Ry., and J. B. Trexler, Reading, Pa., secured 5 miles of grading for the Shenandoah, Frackville & Pottsville Electric Ry. The Holbrook, Cabot & Rollins Corp., New York City, at about $3,741,000, was low bidder on 38th St. to 51st St. section of Broadway subway, New York City; Dock Contractor Co., New York City, at approximately $1,700,000, was low bidder on section of Eastern Parkway subway.

Roads and Streets.—A considerable amount of road construction, state, county and district, is being advertised. Ohio is calling for bids on state highway work to cost $500,000; Connecticut and Massachusetts are advertising several jobs. It is likely that Pennsylvania also will have a fair amount of work to offer. Several good sized concrete road jobs in Indiana counties are now ready for bids. Road District No. 3 of Wabash County, Ill., is asking proposals on 20 miles of gravel road estimated to cost $60,000. Numerous street paving jobs reached the call for bids stage during the past week. Perhaps the largest of these is the work for Philadelphia, Pa. This calls for an expenditure of about $300,000. One of the most costly highway jobs of the year was placed under contract. This is the Storm King Road in New York. It will be 4.03 miles in length and the contract price was $395,176. John L. Haynes Construction Co., Yonkers, N. Y., secured the contract. Other contracts let include the following: 16 miles of gravel road near Ashdown, Ark.; 30 miles of asphalt surfaced road near Tavares, Fla.; a $125,000 asphalt paving contract at Spencer, Ia.; a 600,000 cu. yds. earth fill highway job for New Orleans, La., and a $63,471 paving contract for the same city.

Bridges.—Several good sized bridge undertakings came up for advertising for bids during the past week. The County Commissioners at Tulsa, Okla., are asking proposals for a reinforced concrete bridge at Tulsa, Okla., to consist of 18 arch spans, 78 ft. each, and requiring about 9,800 cu. yds. of concrete and about 270 tons of reinforcing steel. The State Highway Commissioner at Hartford, Conn., opens bids Aug. 10 on a 12 span reinforced concrete bridge, 512 ft. in length. The State Highway Commission of California is asking proposals on a 532 ft. reinforced concrete bridge with one arch of 180 ft. and two arches of about 114 ft. clear span. Bids were opened by Seattle, Wash., on the two Lake Washington Canal bridges. A $46,000 contract was let for a bridge between Tilton and Belmont, N. H.

Drainage and Irrigation.—Larger jobs in the drainage field coming up for bids include 105,000 ft. of tile work for a ditch for Minnesota County, and 1,000,000 cu. yds. of ditch work and levees for the Burt-Washington Drainage District of Tekamah, Neb. The U. S. Reclamation Service is asking bids for 65,900 cu. yds. of excavation for North Canal extension, Belle Fourche Project, and for steel bridge and movable crest for Vandalia Dam of Milk River Project. L. P. Axelsen, Clear Lake, Ia., has been awarded contract, at $110,000, for Judicial Ditch No. 9 in Minnesota.

Water Works and Sewerage.—Water Works Co., Louisville, Ky., is taking bids for furnishing 48 in. pipe and will receive proposals about Sept. 1 for laying the mains. Wellsville, N. Y., is asking proposals for water works improvements to include storage reservoir, filters, etc. Numerous other projects in both the water works and sewerage fields also are ready for bids. Covington, Ky., awarded contract for 2,000 tons of 24 in. pipe for emergency main from Fort Thomas Reservoir. Topeka, Kan., let a $125,000 contract for the east side sewer. Maywood, N. J., awarded an $88,000 contract for a sanitary sewer and sewage disposal plant.

Rivers and Harbors.—A considerable amount of government river and harbor work is now ready for bids. Most of these jobs, however, are small. The Port Commissioners of Boston, Mass., are asking proposals on two small dredging contracts. Dredging contracts in the Calumet River, Ill., and at Philadelphia, Pa., are being advertised by U. S. Engineers. The Port Commissioners of New Orleans, La., have rejected the low bid of $1,109,000 for work in connection with the cotton warehouse and terminal in that city. Philadelphia, Pa., awarded a $75,000 dredging contract.

Securing Information.

A somewhat unusual method of securing information regarding highway construction was taken recently by the road commissioner of a county in a Southern state. Bids were publicly asked for improving a certain mileage of road with various types of surfacing, the understanding being that the class of pavement selected would be determined after the bids were opend. The proposals were tentative and were received for the purpose of determining the type and character of the pavements to be used and for the purpose of assisting the board in determining what work would be done under the available appropriation. Bidders were required to submit with their bids a bond of 5 per cent of their total estimate as a guarantee that the same bid would be submitted and that the bidder would enter into a contract after the type of surfacing material had been adopted and the work readvertised.

Capital for Investment.

Bank statements furnish interesting reading these days. For many institutions the item "cash on hand or on deposit in other banks" shows a total far in excess of the reserve requirement. This indicates very clearly the enormous cash resources available for investment. Eastern financiers in particular have been holding great sums in reserve in the expectation that European holders of American securities would be glad to sell at bargain prices. The people on the other side, however, have shown a disposition to hold onto their investments in this country. As a consequence only about $500,000,000 of a total of $6,000,000,000 of American stocks and bonds have come back. Capitalists are now beginning to realize that there is little chance of a foreign liquidation They have great stores of idle capital. It is reasonable to suppose that part at least of this enormous surplus will soon be available for industrial, transportation and public utility developments in this country.

Then and Now.

A year ago last Sunday things began to happen in Europe. In the United States affairs were in a turmoil. The stock exchanges were closed and emergency measures were taken by banks for the protection of their gold reserves. There was every indication of a most disastrous panic. Many hard-headed financiers freely predicted that this country was headed for bankruptcy. And now after 12 months of the greatest war in all history the United States, instead of being busted, is the great lending and selling country of the world. The warring nations have come to it for capital; it has loaned to South American republics and neutral countries, and in the year just passed it has accumulated a trade balance of over $1,000,000,000. We have at least these things to be thankful for.

The Lighter Side of Engineering and Contracting

Everything Going Out; Nothing Coming In.

MIKE KELLEY, to hear him tell it, was the most unfortunate contractor that ever scraped together a levee. Seemingly Mike roomed with ill luck and boarded with hard times. There was never a job, according to Kelley, on which he made money; he didn't even break even, he invariably lost. He always was explaining to the engineers in charge of whatever job he was on how he was losing money. Perhaps he did this to work on the sympathy of the engineer, but in any case he made it a point to tell just how much coin he had lost on every job. One engineer made notes of these trouble tales as Mike would give them from time to time, and then figured up the totals. One day the engineer came along the work and met the contractor, who promptly proceeded to spring his tale of woe. The engineer listened, then pulled a memorandum out of his pocket and said: "Say, Kelley, you must have been a hell of a rich man when you started contracting. I've jotted down the losses on your various jobs just as you gave them to me, and I find that they total over $400,000 and you claim to be still losing."

If You Smoke, Try This One.

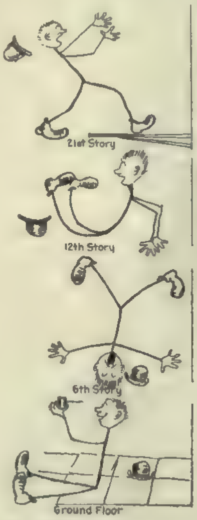
WHEN I was out on construction work I gradually acclimated myself to the smoke of 15 cigars per day, and an occasional pipe. Two things happened: I grew a nervous system where there had never been one and was forced to convert my bank balances ("one by one") into drafts to Habana. So it came about that I swore off in self-defense. One evening, a month or so later, I met an aged ex-contractor. In the course of our conversation I mentioned that I had given up smoking. "So've I," he replied. "You don't say!" I said, surprised. "Yep," he said. "I smoked since I was 16 years old. Last night as I was sitting on my porch I laid down my pipe and said to myself, 'Better quit it, Tom, or you'll get the habit" The next morning I bought a box of cigars for myself.—W. F. S., New York City.

A Little Bit Off the Bottom.

BARTSEVIOUS FLOCK, a large hearted German, had taken a ditch contract near Bucyrus, O. He generously decided that he would not be stingy with his excavation and so he made the ditch deeper than the specifications called for. The engineer on the job discovered a discrepancy and took the contractor to task. Bartsevious was surprised and hurt at the lack of appreciation of his generosity, and finally said, in justification of himself: "I make de deepenings und de videnings yust like de paper call for—only a little bit deeper."—F. L. H., Bucyrus, O.

The Jack Ass Projectile.

MANY years ago John Scott had the contract for building a railroad through a mountainous section in the West. There was an Indian reservation near the work and the redmen and the hoboes were constantly getting into fights. One day after a particularly vicious scrap the Indians got hold of some fire water and then held a pow-wow and a big war dance. When they had got well lit up they decided to lift the hoboes' scalps for revenge. The heaviest section of the contract was about two-thirds the way up the mountain and at this point a big side hill rock cut was being taken out with carts and mules. The men had just fixed a charge of about 200 kegs of powder when the Indians, with hair-raising war whoops, unexpectedly charged up the mountain. In the excitement someone touched off the big blast without warning. Everything in the vicinity immediately went elsewhere. Tons of big boulders were hurled down the slope. A mule and cart standing at the dump were blown end over end down the mountain side and landed right in the midst of the bewildered scalp-lifters. The Indians did not hesitate—they ran so fast their shadows could not keep up with them. A few days later Scott met one of the Indians and proceeded to jolly him. "Red man is not brave," said the contractor; "he runs first time white man shoots." The Indian pounded himself on the breast and replied: "Injun him heap brave. No 'fraid white man if white man fight fair—shoot gun. But when white man shoot off whole Jackass right at Injun, Injun no understand. Him run."



Oh Well! I had to come down for mortar anyhow.

"Lay On, MacDuff, and Damned be He Who First Cries Hold, Enough."

TWO Irishmen of my section gang had some difference of opinion, and decided to settle the matter with their fists, first agreeing that the one who should force the other to cry "enough" should be declared the victor. Accordingly they were soon engaged in mortal combat. Finally Mike succeeded in getting Pat down, and was pounding him mercilessly, unmindful of Pat's cries of "enough!" "enough!" Unable to stand it longer, I walked over to them and said to Mike, "why don't you let him up, he says he has had enough?" "I know," sputtered Mike betwen blows, "but he's such a domned liar ye niver can tell when he's tellin' the truth."—Reader, Pittsburgh, Pa.

Injured Innocence.

MAT and Pat, two brother Irishmen, had taken a sub-contract to build a railroad fill across about ¼ mile of marsh land. The ground being soft and oozy caused much trouble and extra work on account of settling so much over-night that the work of the day before would entirely disappear and had to be done all over again. Finally the two Irishmen hit on a scheme to overcome this difficulty. By working late at night and very early in the morning (or at such hours when there was little danger of being seen by the engineer or his assistants) they would build a log crib several feet high in the center of the fill and cover it over so skillfully with earth that no one would suspect the trick. This made a fill of very little weight and very little dirt and they progressed swimingly for several days without further trouble with the fill sinking. Very early one morning the engineer happened along before Mat and his brother had quite finished their crib work preparatory to the day's run. An early visit of this kind was something very unusual and unexpected and both men were very diligently placing logs with no thoughts of impending trouble. The engineer stood on a little hill a short distance away watching the two brothers, until finally being sure of what was going on he called out, "Say, what in hell do you fellows think you are doing?" Pat glanced from under his hat brim, and seeing who the visitor was, replied without an instant hesitation, "We're trying to get out these g—— d—— logs." And about that time they were.—F. H. M., Glasford, Ill.

Hindside Foremost.

A COMBINATION of political "argymint" and a slow car made Pat short of time at the job. In his haste to "report" he slipped on his overalls rear side before. Running up the ladder he slipped and fell to the pavement.

"Are you kilt, Pat?' said Mike running to the fallen man.

"No-o," says Pat, and then, catching sight of the overalls, "but I got a divil of a twist."

Skinner Mulvey says: I desire to avail myself of this opportunity of renewing to your excellencies the assurance of my most distinguished consideration. Smoke up!

NEW WATER WORKS FOR WATERVLIET, N. Y.

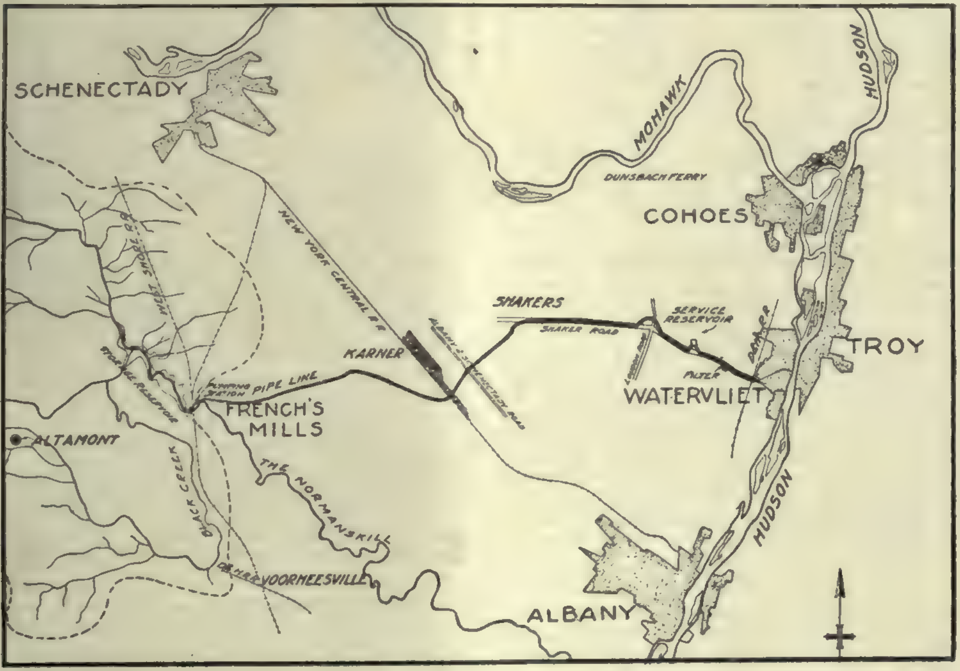
Supply to Be Obtained from Normanskill.

Storage Reservoir — Pumping Plant — Supply Main—Distribution System.

The city of Watervliet, N. Y., is now calling for bids for constructing a complete water works system. The supply will be obtained from the Normanskill at French Mills in the Town of Guilderland, Albany County, New York.

The site of the development is about 12 miles west of the city. The water will be impounded in a reinforced concrete dam which will be constructed across the rock gorge just above the West Shore R. R. bridge. A pumping station will be built about 1,400 ft. downstream. Water for the power and water supply will be delivered to the station through a 50-in. steel flume. Two hydraulic turbines will develop the power for pumping. These will be direct connected to two centrifugal pumps of a 24-hour capacity of 2,250,000 gals. each.

From the pumping station a 20-in. main will extend easterly through Karners and "The Shakers" to the Shaker Road. It will then run along that road to the service reservoir located about 1¼ miles up the Loudon Road. The pressure on the pipe line will be controlled by means of an elevated tank, three surge pipes or by relief valves. The service reservoir will have a capacity of 15,000,000 gals, and will be provided with inlet, outlet and overflow works, and the interior slopes will be lined with concrete or other acceptable material.



A filter of the mechanical gravity type with a capacity of 3,000,000 gals. per day will be constructed about 1 mile west of the city. Provision will be made for aeration before filtration. An 18-in. cast iron main will lead from the clear water well at the filter to a point on the Shaker Road at the western end of the arsenal wall, where connection will be made with the distribution system through a 12-in. and 14-in. main. The distribution system will consist of about 20 miles of 4-in. to 14-in. cast iron pipe.

The storage reservoir will cover an area of about 460 acres, the greater part of which is cultivated. There will be about 50 acres of clearing within this area. Grubbing also will be required at certain points. A marginal strip 120 ft. will extend around the reservoir, and this will be enclosed by a wire fence. The dam at French Mills will be a reinforced concrete structure, 36 ft. high at its maximum section, and 380 ft. long, with a spillway of 324 ft. and a free height of 8½ ft. Flashboards 3 ft. high will extend over the full spillway length. A rollway will extend the full spillway length of the dam and will be carried down to rock. At the north and south banks the dam will be keyed to solid rock with concrete tie walls. A 48-in. sluice gate will be located in the old channel of the stream and will be operated by geared mechanism under the deck of the dam. Water will be taken from the storage reservoir through an opening in the north end of the dam and will be carried through the steel flume to the pumping station.

This flume will be circular in shape, 50 ins. in diameter and about 1,423 ft. in length. It will be built of ¼-in. steel plates. It will extend from the north side of the dam through a rock cut along the north bank of the stream, following closely the old flume line formerly existing at that point. At the falls immediately below the dam the flume will be carried from the upper ledge on concrete pillars to the lower level, where it will be placed in a trench, and run thence to the pumping station, where it will be again carried on concrete supports along the south side of the station and discharge to the turbines and pumps through four inlets of smaller diameter. A surge pipe will be placed near the highway bridge and will be carried up the hillside and made secure by concrete anchorages.

The pumping station will be a 1-story brick structure, 30 ft. wide by 50 ft. long, with concrete substructure, and ferro inclave roof, supported on steel roof trusses. The floors will be of concrete, except where steel plates cover the pipe gallery below the floor level.

The supply main will be about 14 miles in length and 20 ins. and 16 ins. in diameter. Bids will be received on cast iron pipe for the entire length, and also on about 10½ miles of 20-in. wood stave pipe. The pipe invert will be approximately 5 ft. below the surface.

The service reservoir will be an earth structure trapezoidal in plan, and partly in cut and partly in fill. The inside slope of the embankment will be 2½ on 1 and the outside slope 2 on 1 with a crest 15 ft. wide. A 30-in. cast iron pipe culvert under the reservoir will provide drainage for the area immediately north. The inlet, outlet and overflow works will be constructed of cast iron pipe and so arranged as to be controlled at the toe of the south embankment.

The filter plant will consist of a brick and concrete building in which will be installed a mechanical gravity type filter, an aerator, subsidence basin and clear water well. The filter units will be in two groups of three each, with provision for a pipe gallery between them. The aerator may be of the spray nozzle or baffle type. The subsidence basin will be constructed of concrete and will be divided into two independent basins, each of a capacity of 187,500 gals. The clear water basin will have a capacity of 800,000 gals. and may be divided into two structures, one under the filters and the other in a separate outside structure. It is intended to employ sulphate of alumina as a coagulent, and it is proposed to use two reinforced concrete chemical solution tanks, each of sufficient capacity to run the plant at the 4,000,000 rate for 24 hours.

Bids for furnishing the material and constructing the waterworks will be received until 2:30 p. m., Aug. 16, by the Board of Water Commissioners of Watervliet, N. Y. The complete work may be let as one contract, or may be divided into four independent contracts as follows: (1) Storage reservoir, dam, flume and pumping station; (2) supply main and service reservoir; (3) filter plant and aeration works; (4) distribution system. Solmon, Norcross & Keis, Atlanta, Ga., are the engineers.

Progress with Wanaque River Water Supply Development.

The State Water Supply Commission of New Jersey is making good progress with the preliminaries for the development of a water supply from the Wanaque water shed, as described in our issue of June 23, 1915. The Commission has taken up the work of drafting the details of a joint development plan with the taking over of the Little Falls plant of the East Jersey Water Co. in prospective.

At a hearing of the Commission on July 21 representatives of Paterson announced that that city would contract for 5,000,000 gals. of the supply. Passaic will take 4,000,000 gals. and Montclair 2,000,000 gals. Kearney previously had contracted for 2,000,000 gals. and Harrison has voted to join in the development plan to the extent of taking 2,000,000 gals. daily. It is expected that Newark will take at least 10,000,000 gals., which will make a sufficient demand to justify the Commission in proceeding at least with the work of securing the right of way and reservoir sites.

As noted in the June 23 issue, two plans for this development are under consideration. One of these provides for the construction of a low-level water supply system estimated to cost $5,862,000. The other calls for a high-level project to cost about $3,428,750.

Second National Conference on Concrete Road Building.

The organization of sub-committees for the Second National Conference on Concrete Road Building, to be held in Chicago, February 15, 16, 17 and 18, 1916, has been completed. Seventeen committees have been named, each to investigate and submit a report upon a specific topic in connection with the construction of concrete roads. The committees are made up of college and university professors, state, city and county authorities, engineers and contractors. The committees are as follows: (1) Drainage and Preparation of Subgrade. (2) Economical Widths of Pavement and Shoulders. (3) Problems of Design, Thickness, Crown and Grade. (4) Aggregates. (5) Handling and Hauling Materials and Water Supply. (6) Organization of Concreting Crew. (7) Proportions of Materials and Consistency of Concrete. (8) Mixing and Placing Concrete. (9) Reinforcing. (10) Joint Location and Construction. (11) Expansion and Contraction. (12) Finishing and Curing. (13) Construction of Shoulders and Curbs. (14) Methods and Cost of Maintenance. (15) Form of Specifications. (16) Cost of Construction. (17) Estimating and Inspection Problems. The secretary is J. P. Beck, 208 S. La Salle St., Chicago.

A $500,000 State Road Letting in Ohio.

A road letting calling for an approximate expenditure of $500,000 is being advertised by the State Highway Department of Ohio. The work covers 20 contracts for road construction, three contracts for bridges and culverts, and one contract for lining a tunnel.

Three sections of the National Road in Licking County are included in this letting. One of these sections is 7½ miles in length and is located in Union, Harrison and Etna Townships. Another section is 7.07 miles in length and will be built in Etna Township. The estimated costs of the bridges and culverts (on which bids are asked separately) for these sections are $11,032 and $6,333 respectively. Bids on the road improvements proper on these sections will be received on concrete, tar bound macadam and asphalt macadam. Bids also are asked for paving two short sections of the National Road in Muskingum County with reinforced concrete.

One of the larger contracts, other than those for the National Road, provides for constructing bridges and culverts, grading roadway and paving 3 miles of the Cleveland-East Liverpool Road in Bedford Township, Cuyahoga County, with brick, bitulithic or bituminous concrete. The estimated costs of this improvement range from $82,602 for brick with sand cushion, to $88,000 for bitulithic or bituminous concrete.

Details of the contracts are given in Table I. Bids will be received on this work until 2 p. m., Aug. 6, by Clinton Cowen, State Highway Commissioner, Columbus, O.

TABLE I.—DETAILS OF OHIO STATE HIGHWAY CONTRACTS, BIDS ON WHICH ARE TO BE OPENED AUG. 6.

County.	Road section.	Road.	Township.	Type.	Length, miles.	Width pavement, ft.	Width roadway, ft.	Estimated cost.
Champaign	Sec. N	Urbana-Sidney	Concord	W. B. macadam	1.00	14	26	$ 8,401
Clermont	Sec. J	Cincinnati-Chillicothe	Goshen	W. B. macadam	3.00	14	26	15,977
Clermont	Sec. D	Cincinnati-Batavia	Union	W. B. macadam	3.04	14	26	19,308
Cuyahoga	Sec. I	Cleveland-East Liverpool	Bedford	Brick[1]	3.00	18	32	82,602[2]
Fairfield	Sec. C	Columbus-Lancaster	Violet	........[3]	14.00	..	..	3,991
Hocking	Sec. I	Logan-Athens	Green	Brick	1.46	14	[illegible]	26,967
Licking	Sec. O[4]	Columbus-Millersburg	Monroe	W. B. macadam	2.71	16	26	27,688
Licking	Sec. L	Main Market IV	Union	Concrete[5]	.89	16	..	12,038
Licking	Sec. M[4]	Main Market IV	Union	Concrete[6]	7.50	16	..	110,851[9]
Licking	Sec. M[4]	Main Market IV	Union	........[3]	7.50	..	..	11,032
Licking	Sec. N[4]	Main Market IV	Etna	Concrete[7]	7.07	16	..	97,367
Licking	Sec. N[4]	Main Market IV	Etna	........[3]	7.07	..	..	6,333
Lorain	Sec. D	Milan-Elyria	Amherst	W. B. macadam	4.40	14	24	32,611
Muskingum	Sec. O	National Road	Union	Reinf. concrete	.059	16	34	1,105
Muskingum	Sec. P	National Road	Union	Reinf. concrete	.048	16	34	900
Shelby	Sec. C	Sidney-Wapakoneta	Clinton	W. B. macadam	2.75	16	26	30,013
Trumbull	Sec. P	Youngstown-Sharon	Hubbard	Bit. macadam	3.84	15	26	46,703
Wood	Sec. C	Toledo-Perrysburg	Perrysburg	Reinf. concrete	1.15	18	..	14,884
Wood	Sec. C	Toledo-Perrysburg	Perrysburg	Reinf. concrete	3.65[8]	18	..	38,316
Bureau of Maintenance and Repair:								
Licking	Sec. B	Columbus-Newark	Newark	Bit. macadam	.98	16	26	7,214
Lawrence	Sec. A	Ironton-Miller	Upper	........[9]	....	..	..	2,399

[1] Brick, bitulithic or bituminous concrete. [2] Brick with sand cushion; $87,834 for brick using sand-cement cushion; $88,064 for bitulithic or bituminous concrete using sand cushion with hillside block. [3] Bridge and culvert construction only. [4] Part of National Road. [5] Separate bids on bridges and culverts, estimated to cost $876. [6] Bids on concrete estimated to cost as above; bids also on tar-bound macadam to cost $99,885, and on asphalt-bound macadam to cost $98,460. [7] Bids also on tar-bound macadam to cost $85,781, and on asphalt-bound macadam to cost $84,404. [8] Grading and building roadbed for 3.65 miles and paving for 2.5 miles. [9] For linking tunnel for about 100 ft.

Plans to Be Prepared for Municipal Water Works for Denver.—Another stage in the water works controversy at Denver, Colo., has been reached. The Public Utilities Commission on July 20 entered into a contract with the Van Sant-Houghton Engineering Co., San Francisco, Cal., to make preliminary surveys and draw up plans and specifications for the construction of municipal water works. According to press dispatches, the cost of the engineering work will not exceed $150,000. This expense will be met by the sale of bonds authorized under the $8,000,000 water bond issue approved by the citizens in 1910.

$10,250,000 for U. S. Reclamation Project.—The sum of $10,250,000 will be expended on the various projects of the U. S. Reclamation Service during the fiscal year ending June 30, 1916. The allotments to the various works made by S. B. Williamson, Chief of Construction of the Service, have been approved by the Secretary of the Interior. The amount will be spent on 27 projects under the direction of Mr. Williamson and will be disbursed from the headquarters recently established in Denver, Colo.

NEWS LETTERS

St. Louis Items.

A. L. Cook of Ottawa, Kans., can use several small team outfits on force account work at points on the Rock Island R. R. Will pay teams 40c per hour, laborers 20c per hour and pay cash each week. Outfits consisting from 4 to 8 teams each will suit him best.

A special session of the Board of Aldermen was held last week to pass an ordinance authorizing the construction of a viaduct over the Missouri Pacific and Frisco Railroad tracks at Chouteau Ave. The city recently reached an agreement with the two railroad companies and the United Railways Company whereby they will pay into the city treasury the sum of $200,000 to defray the cost of the viaduct. The expense of building the viaduct is prorated as follows: Missouri Pacific $155,000, Frisco $35,000, United Railways $10,000, total $200,000. In addition to building the viaduct the city will purchase a 30-ft. strip of property on the south side of the viaduct to provide a driveway for industrial plants located on that side. This will cost approximately $38,000. The city also is preparing to grade Chouteau Ave. from Grand Ave. to Spring Ave. by cutting about 8 ft. from the hill there.

A. T. Bivens, chairman, and E. M. Dorsey and W. C. Gates, members of the Alton Good Roads Committee, made a contract in Godfrey with James Cook and Thomas Maher to grade and drag the roads from the Alton city limits to the edge of Madison County on the Brighton road. The contract is for a certain amount for each dragging and the road is to be dragged whenever the committee orders.

Mulvill Bros. of Alton, Ill., have 18,000 yds. of grading to let at East Alton, Ill.

Harrington Bros. secured a job from Cameron, Joyce & Co. of putting in a switch for the Burlington R. R. Co. at Keokuk, Ia. About 30,000 yds. of grading to be done.

Jas. Dunigan writes us from Franklin, Ill., that he has finished his work at that point. Is in the market for any kind of grading.

John Keeley is making preparations to begin work on the big levee job across the river.

C. E. Smith, formerly assistant chief engineer of the Missouri Pacific and Iron Mountain Railways, has been employed as consulting engineer for the city of St. Louis at a salary of $200 a month, according to an announcement made Monday by Director of Public Utilities Hooke. For this salary Mr. Smith will devote one-third of his time to the city in an advisory capacity. Whether this time will be a certain number of hours each day or two days a week, was not stated. At any rate Mr. Smith will advise the directors of public utilities on matters affecting grading crossings, river transportation and free bridge terminals. He will have nothing to do with problems concerning the street railways.

M. D. Bagwell of Joyce Bros. & Bagwell passed through St. Louis the other day on his way from Kansas City to their levee work at Birds Point, Mo.

The roof on Koenig's new addition to his office was completed last Friday. Plasterers, electricians and finishers are now busy with the inside and Koenig has assurances from the contractor that he will be able to occupy the new office by Sept. 1. The contractors' rooms on second floor will be ready to receive visitors about fifteen days later. In addition to having the most complete and up-to-date labor office and contractors' headquarters in the country, Koenig is installing a shower bath in rear of office where contractors passing through the city can come and clean up free of charge. If you are not acquainted with Koenig come around and get acquainted when in the city and get cool in under the shower.

Messrs. Merritt & Gilbert of the Merritt-Gilbert Contract Co. are in the city looking up work for a steam-shovel plant that they have idle in Florida.

John McInerney expects to finish his work at Apex, Mo., within the next two weeks, weather permitting. The high water this spring has made him move off of this job three times and Johnnie is hoping for the rivers to fall and continue falling for the rest of the year.

Good roads building and the erection of permanent bridges in St. Clair County, Illinois, is on the upward climb, many thousands of dollars worth of improvements having already been made this year and nearly as much more planned. The Highway Commissioners of Canteen Township on July 27 opened bids for the construction of a bridge on the Canteen-East St. Louis Township line. E. A. Koerner of St. Louis got the contract for $800. The Highway Commissioners of St. Clair Township will meet in a couple of days and open bids for the construction of the Hartmann, Marsh and Gundlach culverts in that township.

The Board of Public Service on July 27 awarded the following contracts for street construction: Grading Louisville from Clayton to Dale; awarded to Murphy Contracting Company for $4,275. Improvements of Berling from Union to De Baliviere with treated wood block pavement and granite curb; awarded to Foxhall P. McCormack for $27,119. Improvement of California from Osceola to Meramec with vitrified brick pavement and granite curb; awarded to Century Construction Company for $21,525. Improvement of Pattison from Kingshighway to Macklin with vitrified brick pavement and granite curb; awarded to Skrainka Construction Company for $26,319. Improvement of Colorado from Kansas to Bates with vitrified brick pavement and granite curb; awarded to Eyerman Construction Company for $21,525.

A. B. Koenig.

PERSONALS

D. C. Miller, for the past year assistant professor, has been made associate professor of civil engineering at the Agricultural and Mechanical College of Texas.

Mr. J. E. Conley has been appointed superintendent of construction for the combined departments of sewer, water and highways, at Norwood, Mass. The town has recently voted $100,000 for the extension of sewer, water and underground electric light systems and for granite and bituminous pavements.

Mr. Kenneth C. Grant, who for the past two years has been connected with the Morgan Engineering Co., in the preparation of plans for the control of floods in the Miami valley in western Ohio has been appointed by Governor Willis as a delegate to represent the state of Ohio at the Fifth National Drainage Congress, to be held in San Francisco, Sept. 17 to 21. Mr. Grant is a member of the American Society of Civil Engineers.

The Agricultural and Mechanical College of Texas has further expanded its Civil Engineering Department by the creation of the division of Railway Engineering in that Department, and A. C. Love, for the past two years associate professor of civil engineering, has been appointed professor of railway engineering. Professor Love gained his railroad engineering experience with the Santa Fe and Southern Pacific Systems and is a member of the American Society of Civil Engineers.

Mr. B. H. Klyce has been appointed city engineer of Miami, Fla., where he is in charge of 20 miles of sewer construction and 3½ miles of asphaltic concrete pavement. He will also have charge of the making of plans for several miles of additional storm and sanitary sewer and three miles of street paving. Mr. Klyce has formerly served as city engineer of Jackson, Miss., and of Waycross, Ga. He was for a time engineer on design and construction of sewers and paving for Americus, Ga. For some time past he has been consulting engineer on paving and sewers for the city of Miami.

Mr. Harold G. McGee was recently appointed city sanitary engineer for Jackson, Mich. His duties in that office consist of resident engineership on construction of sewers, and general review of the existing system and treatment plant, for the purpose of making recommendations relative to relief sewers and necessary changes in the treatment plant. Mr. McGee was graduated in civil engineering from the University of Michigan in 1913, and for a few months was teaching assistant in the University's summer surveying camp. In October of 1913 he was appointed assistant engineer for the Ohio State Board of Health, and in January, 1915, was appointed acting medical inspector, Michigan State Board of Health, in the office of the state sanitary engineer.

Mr. George B. Massey has opened consulting engineering offices in the Peoples Gas Building, Chicago, under the name of Geo. B Massey Co., and will specialize in the selection, installation and operation of excavating machinery. Mr. Massey has had considerable experience in this particular line, having been, from 1899 to 1903, outside director, purchasing agent and assistant engineer for the Bucyrus Co. of South Milwaukee, and for the past seven years he has been foreign sales manager for that company. Mr. Massey is a graduate in mechanical engineering of the Sheffield Scientific School of Yale University, class of 1895. For about three years he was in Mexico as assistant to the superintendent of motive power of the Mexico International Railroad. During the Spanish-American war he was assistant engineer in the U. S. navy service in Cuba and the Philippines. In 1903, he left the Bucyrus Co. to become vice-president of the Massey Machine Co. of Watertown, N. Y., returning in 1908 to take the position of foreign sales manager.

OBITUARIES

Dr. Joseph Austin Holmes, whose recent death at Denver, Colo., has been announced, was director of the U. S. Bureau of Mines since its creation in 1910, and prior to that had been in the U. S. Geological Survey since 1904. The service rendered by Dr. Holmes has been of inestimable value to humanity and to the Government. His greatest achievement was the development of mine rescue work by the Government, and the scientific investigation of mine accidents with a view to removal of their causes. It was due to his persistancy that the mine rescue cars were equipped and placed in various mining regions, and have since been the means of saving many lives.

Dr. Holmes was born at Laurens, S. C., in 1859, and was graduated from Cornell University in 1881. He was professor of geology and natural history at the University of North Carolina and later state geologist of North Carolina. In 1904 he was placed in charge of the U. S. laboratory for testing fuels and structural materials at St. Louis and Pittsburgh. From 1907 to 1910 he was chief of the technologic branch, U. S. Geological Survey, in charge of investigations of mine accidents. When the new Bureau of Mines was created in 1910, President Taft made him director. Since that time his activity and enthusiasm have been unremiting, and though suffering from tuberculosis for more than a year past Dr. Holmes has continued supervision of the affairs of the Bureau. Dr Holmes was a member of the American Society of Mechanical Engineers, the American Society for Testing Materials, the Engineers' Club of New York City, and other professional and scientific societies.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces examinations as follows:

Junior civil engineer, Engineer Department at Large; also to qualify for Corps of Engineers, U. S. army, Aug. 25-26.

Junior mechanical and electrical engineers, Engineer Department at Large; also to qualify for Corps of Engineers, U. S. army, Aug. 25-26.

NEW CATALOGUES

Zelnicker Bulletins.—Paper, leaflets. Walter A. Zelnicker Supply Co., St. Louis.

Net price list of Zelnicker second-growth hand-shaved hickory handles. Also illustrated leaflet showing a double clutch car mover.

Duplex Power Pumps.—Paper, 6x9 ins.; 8 pp. The Gardner Governor Co., Quincy, Ill.

Circular P-A describing Gardner duplex power pumps, including packed piston and center packed plunger types. Gives tables of capacities and illustrates several types.

Air Compressors.—Paper, 6x9 ins.; 24 pp. American Compressor & Pump Co., 801 E. Pratt St., Baltimore, Md.

Catalogue B, illustrating and describing "Peerless" air compressors; also describes "Peerless" air-lift pumping systems and high duty dry vacuum pumps. Gives tables of air volumes, volumetric efficiencies, etc.

Steel Pile Foundations.—Paper, 6x9 ins.; 22 pp. Underpinning and Foundation Co., 290 Broadway, New York City.

Consists of illustrations of Hercules steel pile methods of construction, showing approved loadings, tentative plans, etc., with brief introductory explanation of the Hercules type of foundation, tables of loadings and list of installations.

Electric Grinders.—Paper, 6x9 ins.; 8 pp. Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago.

Bulletin E-36, describing Duntley electric grinders adapted for use in foundries, machine shops, structural shops and for grinding rails on street railways. Gives data as to sizes, speed, etc., and illustrations of the various types.

Concrete Silos.—Paper, 3¼x5¼ ins.; 4 pp. F. A. Moorhead, West Jefferson, O.

Calls attention to the advantages of the concrete silo and shows two views of silos constructed by the company.

Farm Level.—Paper; circular. Keuffel & Esser Co., 127 Fulton St., New York City.

Describes the "Favorite" farm level for use in designing drainage or ditching, terracing, road or building work. Illustrated by duotone photograph.

Concrete Mixers.—Paper; circular. Koehring Machine Co., Milwaukee, Wis.

Describes the special features of Koehring mixers, particularly the trunnion rollers and double drive. Illustrated.

Horse Power Chart.—Paper, 6x9 ins.; 4 pp. Mesta Machine Co., Pittsburgh, Pa.

Bulletin "Ka" on power transmission machinery. It contains a horsepower chart for gears and pulleys. Also lists machinery bulletins issued by company, and briefly describes with cut, special high-speed fly wheel.

CATALOGUE REVIEWS

Steel Sash.—Paper, 8½x11 ins.; 128 pp. Trussed Concrete Steel Co., Youngstown, Ohio.

The United Steel Sash Book, seventh edition, recently received from the above company, covers all the various types of sash with their applications in building construction, with numerous photographs, diagrams and valuable data.

The book is divided into sections, the first of which is devoted to general discussion of steel sash construction, covering questions of strength, weathering, workmanship, daylighting, ventilation, hardware and glazing. The second portion of the book shows the variety of sections that are combined to make up United Steel sash.

Standard pivoted sash, with illustrations, tables, diagrams and details of installations is taken up next. The following sections cover in turn, continuous sash of the top hung and center pivoted types; vertical sliding sash; casements of standard and economy types; United Steel fire windows; United Steel partitions and sliding and swinging doors. Instructions for handling and installing steel sash are given in brief, also a description of certain fire tests.

The last 30 pages of the book are devoted to photographic reproductions of important installations.

Locomotives.—Cloth, 8½x11 ins.; 152 pp. H. K. Porter Company, 1208 Union Bank Building, Pittsburgh, Pa.

The eleventh edition of the Porter Steam Locomotive Catalogue describes 673 locomotives, according to the preface, including light and heavy, steam and compressed air, wide and narrow gage, for industrial, mining, logging, and many other purposes.

The catalogue is in the nature of a text book, giving a large amount of data and technical information which should be useful to engineers, superintendents of plants, master mechanics, etc. These include engineering tables and formulæ on tractive force, hauling capacity, grades, curves, etc., data on operating costs, estimates of costs of railroad track per mile, weights and capacities of logging, dump, colliery and other cars, rail weights, ties per mile, and similar matters. The book also gives tables of American and metric standards of thickness which are useful.

The text is extensively illustrated with half-tone reproductions showing the types of locomotives and drawings and sections illustrating the standard specifications given.

This book will be sent free by the H. K. Porter Co. to those in the market for equipment, and will be furnished to others interested on receipt of $1.

RAILWAYS

PROSPECTIVE WORK.

California:

San Bernardino, Cal.—Santa Fe System has completed plans for double tracking between San Bernardino and Riverside and between Fullerton and Los Angeles, a total distance of 34 miles. Estimated cost is about $22,000 per mile. Work probably will not be done until next year.

Illinois:

Paxton, Ill.—Kankakee & Urbana Electric Ry., Urbana, Ill., proposes to extend its line from Ludlow to Paxton this fall.

Kansas:

Hutchinson, Kan.—About 15 miles of grade had been completed Aug. 1 on extension of Arkansas Valley Interurban Ry. (Wichita) from Halstead to Hutchinson. About 7 miles of grading remains to be done, and this is under contract.

Maryland:

Hagerstown, Md.—Baltimore & Ohio R. R. reported contemplating construction of 4 mile spur from Hagerstown to Security to plant of Security Cement & Lime Co.

Minnesota:

Thief River Falls, Minn.—Minneapolis, St. Paul & Sault Ste. Marie Ry. is reported to have acquired Minnesota Northwestern Electric Ry. system extending from Thief River Falls to Goodrich, 18 miles. Extensions may be made.

New York:

Syracuse, N. Y.—General terms of proposed contract between city and Delaware, Lackawanna & Western R. R. for elimination of grade crossings have been agreed upon. Plans were prepared by Henry C. Allen, Engineer for city.

Port Jervis, N. Y.—A Philadelphia syndicate headed by Edward E. Mandeville, Philadelphia, is considering constructing electric railway from Port Jervis to Milford, Pa.

New Jersey:

Netcong, N. J.—Company will be organized to build electric and street railway from Landing to Lake Hopatcong and thence through Port Morris to Netcong. Morris County Traction Co., C. O. Weidman, Gen'l Mgr., Morristown, N. J., is interested.

North Carolina:

Rutherfordton, N. C.—Both Southern Ry. and Seaboard Air Line Ry. are reported contemplating extending their lines into this town.

Statesville, N. C.—Statesville Air Line R. R. Co. will sell $1,250,000 of bonds to receive funds for completion of its line from Statesville to Mt. Airy. D. M. Ansley is General Manager.

Raleigh, N. C.—Linville River Ry. has filed amendment to its charter providing for extension from present terminus at Pinola. E. P. Earle, Johnson City, Tenn, is President.

Murphy, N. C.—Graham Timber Co. has made surveys of four different routes for railroad from Murphy to timberland in Graham County. Work probably will involve 75,000 cu. yds. earth excavation, 25,000 cu. yds. rock excavation, and 1,500 lin. ft. of trestle. W. C. Sandlin, Andrews, N. C., Engineer.

Ohio:

Fort Loramie, O.—Dayton & St. Mary's Traction Co. has been incorporated with initial capitalization of $10,000 and proposes trolley extension from Covington to Fort Loramie. Judge Dennie Dwyer, Dayton, O., is an incorporator.

Cleveland, O.—Plans are to be started shortly for subway, freight station, docks and waterfront development for Cleveland, Akron & Canton Terminal Ry. Co. The Foundation Co., New York City, will work on these plans in co-operation with the Osborne Engineering Co., Cleveland.

South Carolina:

Spartansburg, S. C.—Southern Ry. has sold $3,500,000 of bonds, proceeds to be used for double tracking between Spartansburg and Central, S. C., 56 miles, and between New Holland and Cornelia, Ga., 21 miles.

South Dakota:

Watertown, S. Dak.—Electric Short Line Ry., E. D. Luce, President, Minneapolis, Minn., is reported contemplating construction of 45 miles of new line this season at a cost of $440,000.

Texas:

Lubbock, Tex.—Plan is under consideration for constructing railroad, 40 miles in length, from Lubboch to either Brownfield or Gomez. Charles H. Doak, O'Donnell, Tex., is interested.

Utah:

Salt Lake City, Utah.—San Pedro, Los Angeles & Salt Lake R. R. has placed order for 8,000 tons of 90-lb. rails, to be used in replacing 75-lbs. rails on about 100 miles of track between Los Angeles and Salt Lake.

Provo, Utah.—Salt Lake & Utah Interurban Ry. has filed condemnation suits for right of way for an extension south to Spanish Fork.

West Virginia:

Fairmont, W. Va.—Fairmont & Helens Run R. R. has been chartered and proposes line to connect new mines of Consolidated Coal Co. on Helens Run with Baltimore & Ohio R. R. near Worthington. Incorporators of new line include H. R. Pratt, Baltimore, Md., Chief Engineer of Western Maryland R. R. Bids for the construction are reported now in hands of official of W. M. R. R.

BIDS OPENED; CONTRACTS LET

California:

Modesto, Cal.—A. G. Chatom, Turlock, Cal., has been awarded contract for grading for 16-mile extension of Tidewater Southern Ry. from Modesto to Turlock. Tracklaying and bridge work will be done by railway, of which B. A. Bearce, Stockton, is President.

New York:

New York, N. Y.—Holbrook, Cabot & Rollins Corp., New York, at $3,741,000 was low bidder on section of Broadway subway from 38th St. to 51st St.; Dock Contractor Co., New York, at $1,700,000 was low bidder on section of Eastern Parkway subway, Brooklyn.

Oregon:

Riverside, Ore.—Twohy Bros., Portland, Ore., have been awarded contract for extension of Oregon-Washington R. R. & Navigation Co. central Oregon branch from Riverside westerly to Crane Creek Gap, 30 miles. Work will cost about $1,500,000.

Pennsylvania:

Shenandoah, Pa.—Shenandoah, Frackville & Pottsville Ry. Co. awarded contract to J. B. Trexler, Reading, Pa., for grading for electric railway, to connect Shenandoah and Pottsville. Contract covers 5 miles of line from Frackville to St. Clair.

Alberta:

Edmonton, Alberta.—G. H. Webster, Calgary, Alberta, has been awarded contract for 60-mile section of Edmonton, Dunvegan & British Columbia Ry.

ROADS STREETS

BIDS ASKED

Alabama:

Marion, Ala.—Until Aug. 9, by County Commissioners, for grading, draining and graveling about 8 miles of Marion and Uniontown road.

Scottsboro, Ala.—Until Aug. 21, by County Commissioners, of grading and draining about 6½ miles of road.

Vernon, Ala.—Until Ang. 24, by County Commissioners, for grading, drainage and graveling part of Millport and Vernon Road. cost $4,600.

California:

Glendale, Cal.—Until 7:30 p. m., Aug. 9, by City Clerk, for improving Ivy St.

Bakersfield, Cal.—Until 10:30 a. m.. Aug. 12, by County Supervisors, for improving section of East Bakersfield-Edison Road.

Bakersfield, Cal.—Until 10 a. m., Aug. 10, by County Supervisors, I. L. Miller, Clerk, for furnishing road scarifier.

Connecticut:

Hartford, Conn.—Until 2 p. m., Aug. 16, by Charles J. Bennett, State Highway Commissioner, for North Haven, 4,950 lin. ft. macadam construction. Plans and specifications at selectmen's office, North Haven. Southington, 6,200 lin. ft. 2-in. bituminous macadam resurfacing. Plans and specifications at selectmen's office, Southington. Waterford, 5,937 lin. ft. native stone macadam construction. Plans and specifications at house of Albert H. Lamphier, first selectman. Durham, 4,940 lin. ft. 2-in. bituminous macadam resurfacing. Specifications at house of J. Franklin Bailey, first selectman. Killingly, 2,950 lin. ft. concrete, amiesite, warrenite or bituminous concrete pavement. Specifications at office of E. C. Welden, Division Engineer, Jordon Blk., Willimantic.

District of Columbia:

Washington, D. C.—Until 2 p. m., Aug. 10, by Department of Agriculture, for bituminous surface treatment of Falls Road from Rockville to Potomac, Montgomery County, Md. Road is 5.4 miles long and 15 ft. wide. Specifications may be obtained from office of Public Roads and Rural Engineering, 517 14th St., N. W., Washington.

Florida:

Kissimmee, Fla.—Until Aug. 15, by J. E. Johnston, City and County Engineer, for about 29,500 sq. yds. of brick pavement on sand base and about 5 miles of 4x10-in. curb. Estimated cost $45,000.

Illinois:

Mt. Carmel, Ill.—Until Aug. 12, by E. E. Seiler, District Clerk, for 20 miles of gravel road to cost $60,000.

Chicago, Ill.—Until 11 a. m., Aug. 11, by Board of Local Improvements, for 23 contracts for street improvements, by paving.

Woodstock, Ill.—Until 1 p. m., Aug. 14, by Board of Local Improvements, G. W. Frame, Secretary, for 13,800 sq. yds. of concrete pavement. H. M. Price, Engineer, 1205 Hartford Bldg., Chicago.

Indiana:

Laporte, Ind.—Bids are asked by city for 10,000 sq. yds. of modern pavement. Specifications from City Engineer, 1st Natl. Bank Bldg.

Fort Wayne, Ind.—Until Aug. 12, by Board of Works, for city's portion of work of separating grades at Osage St.

Vincennes, Ind.—Until 4 p. m., Aug. 9, by Board of Public Works, G. C. Meyer, Clerk, for 5,500 sq. yds. of pavement.

Indianapolis, Ind.—Until Aug. 9, by W. T. Patten, County Auditor, for 5 concrete roads.

Brownstown, Ind.—Until 8 p. m., Aug. 9, by A. P. Lucas, Town Clerk, for paving 17 blocks of street with brick, asphalt, concrete, macadam.

Vincennes, Ind.—Until 4 p. m., Aug. 9, by Board of Public Works, for paving Main St.

Greencastle, Ind.—Until 2 p. m., Sept. 4, by C. L. Airhart, County Auditor, for gravel road on line between Putnam and Parke County.

Fort Wayne, Ind.—Until 10 a. m., Aug. 17, by Will Johnson, County Auditor, for stone roads in Perry and Maumee Townships.

Goshen, Ind.—Until 1 p. m., Aug. 14, re-advertised, by J. W. Brown, County Auditor, for constructing concrete road in Concord, Harrison and Olive Townships. Work covers about 10 miles of highway and will cost about $135,000.

Greencastle, Ind.—Until 2 p. m., Aug. 14, by C. L. Airhart, County Auditor, for gravel roads in Franklin and Madison Townships.

Jeffersonville, Ind.—Until 10 a. m., Aug. 14, by Geo. W. Stoner, County Auditor, for stone work in Jeffersonville Township.

Crown Point, Ind.—Until 1 p. m., Aug. 11, by E. Simon, County Auditor, for construction of six gravel roads.

Danville, Ind.—Until 10 a. m., Aug. 10, by L. W. Borders, County Auditor, for two roads in Center and Clay Townships.

Indianapolis, Ind.—Until 10 a. m., Aug. 9, by W. P. Patten, Contractor, for three roads

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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The Training of Future Executives.

The building up and retaining of an efficient organization is becoming increasingly difficult as the combination of business interests continues. Keen competition between companies engaged in similar lines of business also tends to make it more difficult to retain an efficient organization after it has been developed. In the past, business organizations have grown up without a proper realization by those in charge of ways and means of continuing them. It is now being more generally realized that some systematic plan of selecting and training men for executive positions is necessary if our large corporations are to continue.

The plan followed by the Cutler-Hammer Manufacturing Company, of Milwaukee, is worthy of careful consideration in that it attaches importance to considerations not generally given prominence. In building up its sales and engineering staffs to meet the needs of its rapidly increasing business this company has followed a plan which makes the continued retention of its employes the principal objective, rather than the replacing of members of its force from time to time. That the plan has proved successful in the case of this company is evidenced by the fact that of the total number of men employed since its adoption in 1905, 69 per cent are still with the company, while in the engineering department at Milwaukee this percentage is 74. With a single exception, the district managers of nearly 70 branch offices were secured under the plan now in use, the essential features of which, as reported by *The Iron Age,* are as follows:

Each year as the spring term of college approaches the company makes an estimate of the number of new men needed. Some one school is selected and from this institution the entire group is drawn, provided the number can be secured without sacrificing quality. The men are selected by a committee, ordinarily composed of the general superintendent, a representative of the engineering department, and one from the sales department. These men visit the college, and in an address outline the company's proposition. The committee then interviews individually each candidate who presents himself. Consideration is given to the candidate's general record in school as regards regularity and dependability, to his athletic record, to his college activities and social affiliations, to his personal tastes, and to his scholastic record, although special prominence is not given to the latter item. Each member of the committee makes his own estimate of the worth of each candidate, and the committee then confers as to the candidate's fitness for a position.

In choosing the group of men each year from a single school the company operates under the theory that a very strong bond has already been established among these men, which will act to keep them together in the employ of the company, and which will be likely to cause the men to associate and room together and will thus tend to encourage a discussion of their work and of the things they are learning, outside of working hours. Men are not chosen for work in their home towns, as it is believed this is a handicap in influencing the direction in which the young man's connections are built up. Great importance is attached to a correlating of the beginner's work inside the shop with the development of his character and associations outside of it.

The men are first placed in the shops of the company to give them a practical and working insight into the various products manufactured. From records kept by the company it is estimated that it costs approximately $2,000 to train one of these men to the point where he is of real value and is prepared to create results. Although, the plan is not an inexpensive one, the company has found that its adoption has resulted in a decided saving as compared with the cost of hiring men who have already acquired what would be of equal value to the company.

It is evident that the success of the above plan is due mainly to an appreciation by those in charge of the advisability of systematically selecting and training technically educated young men, with the understanding that they are to become permanent members of the organization. Evidently the officers of this company realize that it is an important part of an officer's work to give personal attention to the training of men who will ultimately replace them as leaders.

Efficiency Factors in County Road Organizations.

Three things are essential to economical road construction and maintenance: (1) An efficient organization, (2) a comprehensive plan of improvement and maintenance, and (3) a consistent policy of yearly betterment. For it must be remembered that the care of the road is with us always and with the growth of the country more skill and more money are required to keep the roads up to the standard of other improvements.

An efficient road organization is one that accomplishes the greatest amount of first-class work for the least expenditure of money. It is the experience of business men that work not done in a first-class manner is uneconomical, hence the distinction. To accomplish first class work skilled supervision is necessary such as comes only from training and experience. Hence it is necessary to have in the organization for road work men that have made a business of road building and are trained and experienced in the methods of securing first-class work.

A method of accounting that will show accurately the cost of the elements of work undertaken on each road is necessary to an economic organization. Such an accounting system enables the road officials to take full advantage of their own experience, furnishes a record that will inform the public as to the cost of work accomplished and provides a means of accurately predicting the amount of work that can be done from year to year with the funds available.

The adoption of a comprehensive plan of road improvement and maintenance contemplates the use of modern efficient methods of road management. In the average county at least 75 per cent of the total traffic is carried on about 15 per cent of the total road mileage. It stands to reason, therefore, that this mileage must be put in condition to care for the traffic as rapidly as the funds of the county will permit. Double-tracking and the laying of larger rail on heavy traffic lines by railroads may be cited as an application of the principle of providing for the traffic.

The division of the county into maintenance districts and the provision for road dragging and repair without delay when needed within their bounds is another proved plan of economical road management. Such organization, moreover, permits the large county road crews to engage in work of a more permanent nature than the upkeep of the present roads. The yearly cost of patrolling 222 miles of dirt road in one county in Iowa was $11,400 or $52 a mile. Of that amount $2,500 was expended for dragging and $8,900 for repairs. All labor was hired at 45 cts. an hour for teams and 25 cts. an hour for men. These costs represent an average cost of thorough maintenance.

Good management suggests the surveying of all of the main roads of the county, the establishing of satisfactory grades and the location of culverts and bridges at the proper points so that when work is accomplished it will conform to a well arranged plan and will not have to be done over again at some future time.

By a policy of yearly betterment is meant the accomplishing of a certain amount of relatively permanent work each year. The roads of numerous counties have been gradually improved by a process of "saving up" such as their plan provides. A portion of the funds available each year are spent for permanent works.

The principle of yearly betterment is in line with the business policy of successful men and corporations. It is a good plan to improve one part of an undertaking in a thorough manner rather than attempt a slight improvement in all parts. Improvements spread over too large an area are apt to be so slight that they will be destroyed before further improvements can be added. The yearly betterment may involve but the building up of a few miles of relatively permanent road with the necessary drainage structures, but the work accomplished should be first-class.

Can "Good Times" in America Flow from the War in Europe?

Many political economists have answered this question in the negative. They are of the school that reasons that any large "destruction of wealth" in any part of the world inevitably reacts unfavorably upon wealth production in other parts of the world. But it is noteworthy that they rarely define "destruction of wealth." The fact is that nearly all wealth is "destroyed" almost as soon as it is created, if by "destruction" is meant consumption. Hence an explosion of ammunition is a "destruction of wealth" that does not differ essentially from the wearing out of a silk dress or the drinking of a cocktail.

A very small percentage of the wealth produced annually is added to the world's stock of wealth. This stock is capital, and is largely used as an instrument for producing more wealth. To destroy capital in large quantities may very well lead to the impoverishment of its owners, but to destroy wealth not used as capital is quite another matter.

A comparatively slight amount of the world's capital has thus far been destroyed by the great war, and there is no likelihood that any considerable percentage will be destroyed It is important to bear this in mind when discussing the probable effect of the war upon America.

Any great sudden change in the productive energies of a nation must inevitably disturb other nations temporarily. It is not "destruction of wealth" that causes such disturbance, however. The real trouble arises from the hesitancy of business men to change their lines of output, or to continue their normal output in the face of uncertainties as to markets. But as time passes, business leaders begin to modify their action to suit the conditions, and "times revive." This revival has been happening in America at a very rapid rate during the past six months.

The textile trades, the metal industries, grain farming, and many other industries have shown marked growth. Consideration makes it apparent that the revival will continue and will spread to other industries.

The war has diverted the energies of millions of men from the production of utilities that were formerly exported to us. America, must, perforce, either go without those utilities or proceed to produce them herself. She has done both. There has been some economizing and there has been some enlargement of home production.

Our exports have necessarily changed considerably in character, but they have grown to such proportion that the ensuing twelve months seem likely to yield a balance of trade amounting to $2,000,000,000 in our favor. The effect of this will be to cause a flow of gold to America, slow at first but greater when the war ends. This will cause a rise of prices in America. It will also result in our purchase of American securities now held by Europeans. Neither of these occurrences spells financial depression. So long as prices are rising it is wise to invest in plants capable of producing income, and it is relatively unwise to invest in bonds. Hence in times of rising prices business men expand their investments in plant, supplies and goods.

The transfer of American securities from Europe to America will itself result in increasing the permanent supply of cash capital, for interest and dividend payments will flow in diminished stream abroad. Our exchange of products for these securities will therefore tend to increase prices here by decreasing the annual flow of gold to Europe. And, as just stated, an era of rising prices is an era of "good times," for it leads to aggressive action by investors and business men.

The close of the war will cause another readjustment, but this time not in an atmosphere of gloom. On the contrary, the spirits of all Europe will rise. Optimism will give impetus to every trade. "But," argues the school economist, "how can there be revival where debts bow men's backs to the dust?" Debts to whom? Mostly those of the government to its own people, and this means the debts of citizen A to his neighbor B, and of B to A. The rich and well-to-do may suffer most as a result of war taxes, but this is by no means certain, for it is they who hold most of the bonds issued by the government. They will have economized during the war sufficiently to have paid a large part of the cost of the war. The instruments of production will have remained uninjured, for the most part. Men will man them, and history will repeat itself in showing "an amazing industrial recovery"—amazing chiefly because we are so accustomed to regard war as a great destroyer of capital, which ordinarily it is not.

Men by the millions will have died. Will this cripple European industry? Not for long. This war, nearly all thinkers agree, is really a struggle for industrial supremacy. If so, it means but one thing—an overcrowding of Europe with workers whose wares do not find ready markets. Already reports are reaching us that English workmen are enjoying prosperity such as few of them have ever tasted. Cruel as the process of extermination of men is, the men that are left are apt to be better off than if no extermination had taken place. This heartless condition is not the ideal toward which the world moves, but is none the less a present fact that we can not ignore.

A great war is a great stimulus to actions of many sorts other than military as well as military. It shakes even the somnolent type of mind into wakefulness. Many it kills but many more it cures. Our own civil war served to develop thousands of young men into self-reliant and ambitious leaders who afterward made their marks in the halls of industry. This is seemingly one of nature's compensations for the sacrifices of battle.

While we do not indorse war as a thing to be desired, as some have claimed it is, we may well take comfort in the compensations that it brings—and they are by no means negligible. To America the gains are, by all odds, greatest. This is bearing home upon our attention already. We shall see still greater commercial benefits with the passage of every month, and they will not cease when the war ends.

WATER WORKS

Design and Construction of the Lake Watrous Dam of the New Haven Water Co.

(Staff Abstract.)

The Lake Watrous dam of the New Haven, Conn., Water Co., impounds a reservoir of 725,000,000 gals. storage capacity. The dam is located on West River. It is shown in plan and profile in Fig. 1 and in section in Fig. 2. The reservoir is about a mile long and averages 1,000 ft. in width; it covers about 109 acres.

DESIGN.

The Lake Watrous dam is of the gravity type and is constructed of cyclopean concrete. The batter on the downstream face is 0.06 to 1.0 and on the upstream face it is 0.5 to 1. The downstream batter runs into a curve of a radius of 47 ft. at a point 26 ft. below the top of the dam, and this curve continues to the under side of the coping. The top width of the dam under the coping is 9 ft. The coping is 18 ins. thick and overhangs 6 ins. on both sides of the dam, making a total width of 10 ft. The height of the dam above the bed of the river is 50 ft., but the maximum height of the dam above the bottom of the foundation is 115 ft., and the maximum width is 55 ft. The dam is on a straight line practically at right angles to the river, except at the westerly end where, on account of the rock, it curves to the south with a radius of 100 ft., to a line which makes an angle of 120° with the main dam. The spillway is located at this westerly end, and has an ogee section with a total length of 70 ft. The average height of the spillway above the rock foundation is about 11 ft. The top of the dam is 5 ft. above the spillway level.

From the spillway, an open channel, 30 ft. in width and about 600 ft. in length, carries the water to the river at a point about 400 ft. south of the line of the dam. A steel footbridge, about 5 ft. in width was erected over the spillway.

At the easterly end of the dam a short section of corewall replaces the gravity section. This corewall is 4 ft. in width on top, and has a batter on its upstream face of .05 to 1, and downstream 0.3 to 1.

The total overall length of spillway, gravity dam, and corewall is about 1,410 ft.

Preliminary test pits and well drill borings on the site of the dam showed a considerable depth from the surface to the rock for a distance of about 650 ft. across the bottom of the valley, and therefore a large amount of earth excavation. It was decided to utilize this excavated material to form an embankment on the downstream side of the dam, this embankment to serve two purposes,—to furnish additional strength to the gravity section, and to cover the concrete and thus avoid excessive expansion and contraction in it.

This embankment was carried up to within 10 ft. of the top of the dam and has a top width of 15 ft. The slope is concave, starting with a 1 on 3 slope for 30 ft. horizontally, then 1 on 4 for 30 ft., then 1 on 5 for 30 ft., and so on to a 1 on 8 slope, or to an intersection with the original surface of the ground.

The dam is divided into sections of an average length of about 48 ft., by joints extending vertically the entire height of the dam. The different sections are joined by tongues and grooves. The grooves were made 2 ft. wide and 12 ins. deep. The sides of the grooves for a depth of 4 ins. are bevelled ⅛ in. to make a slip joint, and then they flare off about 45°. The slight draw in the sides of the grooves is for the purpose of allowing the section to expand and contract without opening a joint for leakage. Adjoining faces of the different sections were coated with form grease to prevent bonding. The allowance for expansion and contraction at these joints will prevent the unsightly, irregular temperature cracks so often seen in concrete construction.

The top of the dam was finished with a granolithic surface, and divided into blocks. A 2-in. wrought iron pipe railing with 3-in. posts spaced 8 ft. apart, and globe fittings, was installed 6 ins. southerly of the northerly face of the coping. The rail is 3 ft. and 3 ins. above the dam. This railing extends from the easterly end of the spillway to the westerly side of the gate house, and from the easterly side of the gate house to the easterly end of the coping. Expansion in the railing is allowed for by reaming out the tees at every sixth post large enough to permit the entrance of the 2-in. pipe.

The gate house was located about 100 ft. easterly of the old river channel. The floor of the gate house well is about 47 ft. below the top of the dam, or the operating floor of the gate house, and the walls below the operating floor are 4 ft. thick. A wall 4 ft. thick divides the well into two separate parts,—an inlet well, and an outlet or supply well. A 3-ft. by 5-ft. opening in this division wall just above the floor of the well, covered by basket screens semi-cylindrical in shape, one on each side of the wall, connects the two wells. These screens are made up of No. 12 gage brass wire cloth, with 9 meshes to the square inch, stretched over a gun metal frame, with roller bearings on the edge of the frame. These screens are operated by hoists in the gate house, and travel in grooves built in the division wall. The screens are in duplicate and one is always in service. The screens were constructed of the basket type rather than flat for two reasons. When the basket screens are being raised for cleaning or inspection, any debris which has collected on the screen will drop to the bottom of the basket and be caught there, and therefore hoisted with the screen. With flat screens the debris would fall off the screen and enter the easterly well of the gate house and then the supply main. The other reason is that a screen with a semicircular cross section makes a stronger and much more durable screen than a flat screen.

The 30-in. city supply main is connected with the easterly or outlet well. Four 24x36-in. sluice gates over openings in the concrete walls, protected by gratings, are set at different levels in the outside walls of the westerly well. The first gate is 6 ft. below the spillway level, and the others are spaced about every 10 ft. below the first. A 30-in. blowoff pipe passes below the floor of the westerly well. The intake of the blowoff is about 110 ft. northerly of the gate house near the river. The intake opening is protected by iron gratings made up of ½x4-in. bars spaced 4 ins. on centers on a 1-in. bar with cast iron spacing thimbles. The outlet of the blowoff is about 250 ft. downstream from the dam at the river, and a concrete apron with sidewalls built at the end of the pipe. The gate house wells may be drained by closing all sluice gates and opening a gate on a 10-in. pipe which connects from the bottom of the well into the blowoff.

The dimensions of the gate house above the operating floor are 28 ft. 7 ins. long by 15 ft. 6 ins. wide. The walls are of concrete 12 ins. in thickness. The roof is of 3-in. cypress plank, tongued and grooved, covered with Spanish tile. The roof is carried by the concrete gables and two steel trusses. The gate house floor is of reinforced concrete and supports floor stands for operating and controlling gates and valves.

Water from the reservoir enters the westerly well of the gate house at any of the four levels where the sluice gates are placed, and from this well passes through the screen into the easterly well and from there into the supply main. The locations of these intakes at the four different levels make it possible always to draw the best water from the reservoir.

Generally, and during the greater part of the year, the best water is a little below the surface of a reservoir. The action of wind and waves on a large reservoir have a powerful effect on oxidizing and purifying the water. On the surface are found floating substances and insects. Algæ that give offensive odors and tastes are generally near the surface, while near the bottom the water is undesirable, as it contains organic matter and is deficient in oxygen.

Usually twice a year, once in late spring, generally May, and in the fall, generally November, waters in a large reservoir turn over, due to temperature changes which alter the relative specific gravity of different strata of water. Algæ are liable to develop from organic matter in bottom waters that come to the top. At such times by drawing from lower levels algæ can be avoided.

The dam for its entire length is founded on solid rock. Three kinds of rock were encountered in the excavation for the foundation,—a slaty schist, trap rock, and sandstone. The rock formations were very interesting, and a careful study of the geological formations has been made by Professor Gregory and his assistants, to whom I am indebted for information concerning the rock.

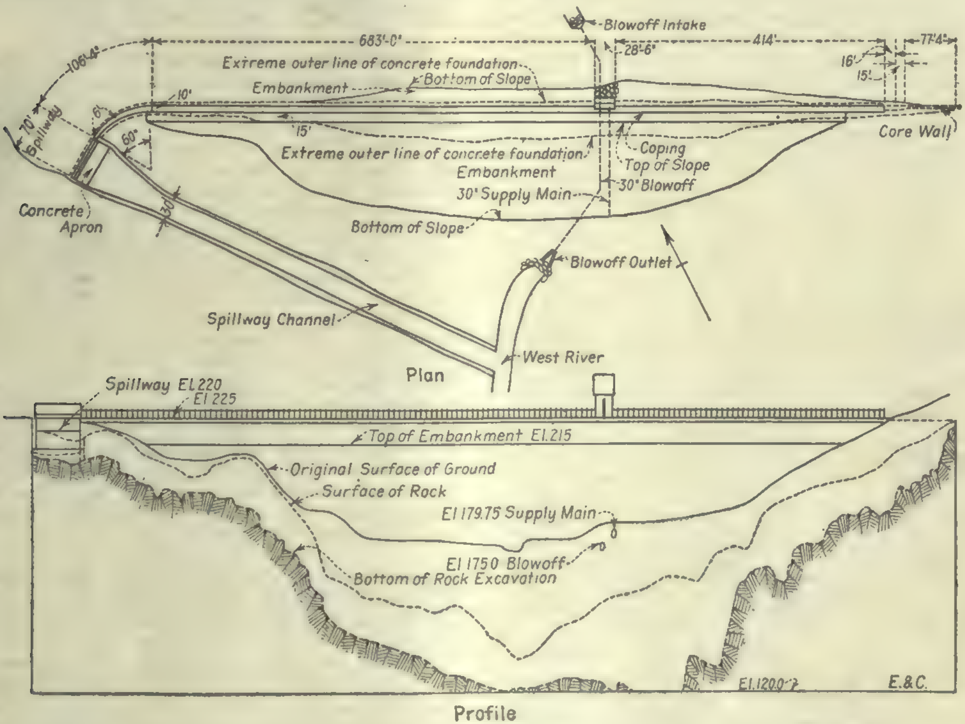
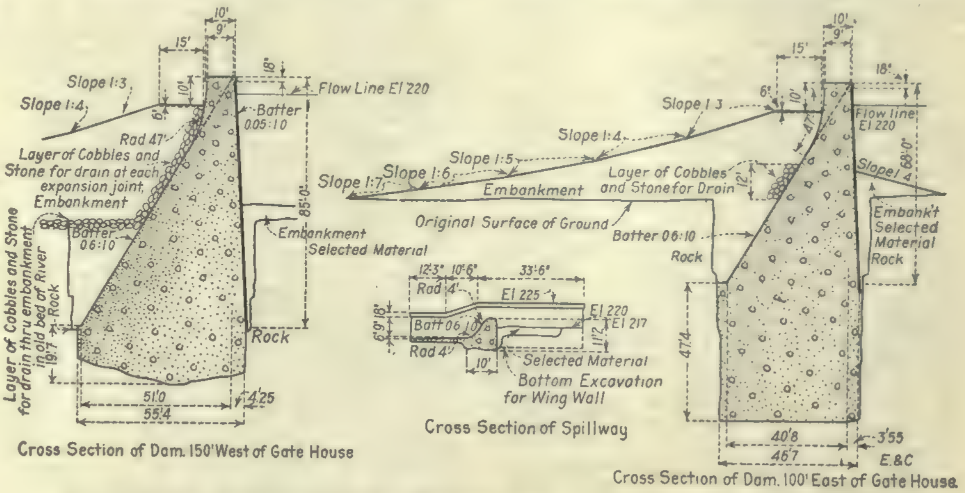


Fig. 1. Plan and Profile of Lake Watrous Dam of the New Haven Water Co.

The earth overlaying the rock is a gravel of glacial deposit, and contains a large percentage of cobbles and boulders.

From the westerly end of the dam to a point just easterly of the river the formation of rock found in the excavation is known geologically as the Orange phyllite. It is a slaty rock with a strike practically at right angles to the dam, and a dip vertically. Several narrow trap rock dikes were found in this rock. At a point just easterly of the river a sandstone was uncovered. This is Triassic sandstone and overlays the slate, with a sharp and clean line of contact between the two. This line of contact has a dip of about 24° to the east. The dip of the sandstone coincides with the dip of this line of contact. The sandstone encountered was white in color, and very soft like kaoline. The explanation of this softness, as given by the geologists, is that the feldspar in the rock has been decomposed and kaolinized by ground-water carrying carbon dioxide in solution. Further toward the easterly end of the dam the sandstone was red in color, and much denser in structure.



Cross Section of Dam. 150' West of Gate House

Cross Section of Spillway

Cross Section of Dam. 100' East of Gate House.

Fig. 2. Cross Sections of Lake Watrous Dam of the New Haven Water Co.

The outcrop of trap rock in the West Rock Range occurs about 500 ft. easterly of the easterly end of the dam.

CONSTRUCTION.

In the slate rock the average depth excavated for foundation of the dam was about 18 ft. The sandstone was so soft, however, that it was necessary to excavate a large amount to secure a solid foundation. From the point where the sandstone was first exposed easterly to the gate house all the sandstone was excavated, and the dam founded on the solid slate rock. From the gate house easterly about 100 ft. the maximum depth of rock excavated to get a suitable base for the dam was about 50 ft. Beyond this point the amount of excavation diminished, and the average depth excavated to get a dense, solid rock was about 20 ft.

West River above the dam has a total watershed of 7 square miles. A watertight plank trough, 12 ft. wide and 4 ft. deep, designed to carry the freshet flows of the river, was built to carry the flow of the river across the trench during the excavation of the earth and rock, and the placing of the concrete foundations. The trough was supported by two wooden trusses, and was used until after the concrete on each side of it was built above the level of the pipes in the gate house, and the blowoff pipe was laid north and south of the dam. The river was then diverted through the blowoff.

As the northerly end of Lake Dawson is only about one-half a mile southerly from the dam, it was necessary to remove the sediment from the water pumped from the excavation. It was naturally expected, from the length and depth of the excavation, that a large amount of water would be encountered. A large amount of ground-water did enter the trench from the sides, but the absence of any springs in the rock bottom of the excavation was noticeable.

All the water from the pumps discharged into a series of settling basins of sufficient capacity to hold the water at least three hours. Water from one basin overflowed to the next, and from that one to a third basin, and then into the river. The sediment was practically all removed in this way.

For construction purposes the contractors built a double-track trestle, about 900 ft. in length and averaging 30 ft. in height, on the northerly side of the trench to be excavated. The bents of this trestle were made up of native wood obtained on the Water company's property near the dam. The track level of this trestle was about 13 ft. below the top of the dam. A battery of guy derricks was installed on the southerly side of the excavation.

Practically all the earth excavation, and part of the rock excavation, was made by two steam shovels. The excavated material was removed from the trench in scale boxes by the derricks on the southerly side of the trench, and by two 15-ton Brownhoist locomotive cranes operating from the trestle. The remainder of the excavation was made bv hand labor. Most of the excavated material was piled on the southerly side of the trench to be used later for the downstream embankment.

The trench was sheathed for a length of about 700 ft. across the bottom of the valley.

The sheathing was 4 ins. and 6 ins. in thickness, grooved and splined, and in 20-ft. lengths. In the deeper part of the excavation for a length of about 300 ft., two courses of sheathing were necessary; 12x12-in. braces and 8x16-in. stringers were used. The number of cobbles and boulders in the excavation made it impractical to drive the sheathing ahead of the excavation, so it had to be dug down with the excavation. All driving was done with a gravity hammer operated on the boom of a derrick or crane.

A total amount of about 86,000 cu. yds. of earth and rock was excavated.

The crushing and concrete mixing plant was located on the westerly side of the valley, about 200 ft. northerly of the dam, with track connections to the trestle, and also to a track laid on top of the excavated material on the southerly side of the dam.

A quarry was opened on the easterly side of the valley about 1,000 ft. northerly of the line of the dam. A fine quality of trap rock, both for crushing and for the cyclopean stone or plums, was obtained here. The quarry level was about 100 ft. above the level of the top of the dam. A single-track, narrow-gage railway was built from the level of the top of the dam to the quarry, and cars were operated on this track by a single drum hoist installed at the top of the incline.

Stone for the crusher was loaded into 3-cu. yd. side-dump cars, and plums on flat cars, by derricks, and were delivered by a locomotive to the top of the incline. The cars were then lowered down the incline, and another locomotive took and delivered them.

Stone was dumped directly into the crushers, of which there were three,—a Kennedy No. 5 gyratory crusher, a 10x20-in. Farrel jaw crusher, and a 10x20-in. Champion jaw crusher. From the crushers the stone was elevated about 35 ft. to the revolving screens. These screens, with ¼ and 2½-in. holes, assorted the screenings and stone. All oversize stone were delivered back to the crusher through a chute and recrushed.

Two belt conveyors, one for screenings and the other for stone, delivered them to the sand and stone bins over the concrete mixers. Movable trippers allowed the stone to be dumped at any point in a storage pile.

Sand, in large quantities, was a scarce article in the neighborhood of the dam, but the contractors finally located a pit about 2½ miles southerly of the dam on the state road. An excellent sand for concrete was obtained here, and was hauled by teams to the sand storage pile near the mixing plant.

All the cement used in the work was the Alsen brand. This cement was delivered by barge to Heaton's wharf in New Haven, and from there carted by motor trucks, a distance of about seven miles, to the storage shed at the dam.

The concrete mixing plant was of the gravity type. The sand and stone bins were about 30 ft. above the ground, and were provided with vertical gates operated from the charging floor. Stone was delivered to the bins by the belt conveyor, from the screens, and also from the storage pile by a clam shell bucket operated from a derrick boom. Sand was also placed in the bins by a clam shell bucket. Cement was delivered to the charging floor on cars which were hoisted from the cement shed on an inclined railway.

Sand and stone were drawn directly from the bins into two measuring hoppers, and the bags of cement emptied by hand into these hoppers. The two hoppers discharged directly into two Chicago Cube mixers, each of 1 cu. yd. capacity. The mixers discharged directly into side dump hopper cars, or into buckets on flat cars, and these cars were then delivered by locomotive, on the trestle, to the cranes, or to hoppers over the chutes. The average day's mixing with the two mixers was about 350 cu. yds.

Concrete was placed in the dam with chutes and also with buckets. Chutes were used up to a level about 15 ft. below the track level on the trestle. Two chutes were generally used to a section. They were hung from guy ropes strung across the trench from the top of the trestle to the sheathing on the southerly side of the trench.

The buckets were lowered to place by the locomotive cranes, and plums were placed by the cranes, and also by the derricks on the southerly side of the dam. All plums were thoroughly cleaned of dust and dirt and were drenched with water immediately before being placed in the concrete.

The percentage of plums placed in the dam averaged about 15 per cent of the total yardage. For the total yardage of concrete of 85,500 cu. yds. the cement averaged 1.20 barrels per cubic yard of concrete. All concrete was mixed in the proportion 1:2½:4½.

Concrete was placed in different sections of the dam on successive days, and at least two days were allowed for setting before any new concrete was added to a section. Where new concrete was joined to old, the surface of the old concrete was thoroughly cleaned of all laitance, by picks and wire brooms, and was thoroughly washed. Immediately before placing new concrete the old concrete was covered with a thin layer of mortar.

Practically to the top of rock the concrete was carried solidly into the rock sides.

Concrete was placed in sections averaging 48 ft. in length, as previously described, and the full width of the dam cross section. Each lift averaged about 5½ ft. In the deeper sections the 48-ft. section was subdivided, as it was not possible to operate the chutes satisfactorily over as large an area as the full section between expansion joints. Wooden keys built to form the grooves in the concrete, as previously described, were placed every 10 ft. on the side bulkheads.

Forms for the concrete were of wood, and the forms for the two faces of the dam were 2x8-in. planed spruce, tongued and grooved, made up into panels 16 ft. long and 30 ins. wide. Each successive set of forms was carried by bolts set in the concrete of the preceding section.

The space between the dam and the line of the excavation on the upstream side was filled with selected material tamped in 6-in. layers. The sheathing was drawn as the backfill was placed. An embankment about 7 ft. above the original surface of the ground, and with a 1 on 4 slope was also built on the upstream side of the dam from the gate house easterly about 200 ft.

The downstream backfilling and embankment was deposited in 12-in. layers and tamped. A stone drain about 3 ft. thick and 12 ft. high was built next to the dam above the level of the original surface of the ground. This drain connected to a stone drain about 12 ft. wide and 4 ft. deep built through the embankment in the old river bed. The drain was also carried about 4 ft. in width practically to the top of the embankment over each expansion joint. These drains were placed to carry any seepage which might occur. The embankment was finished with an 8-in. layer of loam, which was obtained from the reservoir basin. The material for this embankment was handled, principally, by a steam shovel and trains of side-dump cars.

The construction of the dam necessitated the relocation of one highway which would be inundated. This highway was, for a distance of about 4,000 ft., carried along the sidehill to the westward of its old location, and where it crossed West River Valley was carried on a fill about 500 ft. in length and averaging 20 ft. in height. The faces of this embankment were covered with riprap for a thickness of 12 ins. Material for this embankment was obtained in the reservoir basin below the flow line.

At the West River crossing a 12-ft. concrete parabolic arch was built to carry the river under this embankment. One other 4-ft. semicircular arch was built to carry a smaller brook under the road.

The contractor's plant and equipment for the construction of the dam included two 15-ton Brownhoist locomotive cranes, two steam shovels, 15 guy derricks, 19 hoisting engines, 8,000 ft. of narrow and standard gage track, 10 locomotive boilers, 5 vertical boilers, 30 3-cu. yd. side-dump cars, 6 2-cu. yd. hopper cars, 16 Steubner buckets, 6 dinkey locomotives, 4 5-in. Cameron pumps, 3 stone crushers, and 2 1-cu. yd. Chicago Cube mixers. Over 500,000 ft. board measure of squared timber was used for the sheathing and bracing, and on the trestle. All hoisting engines, pumps, and mixers were supplied with steam from one of three batteries of locomotive boilers, set up at different places near the trench.

The unit prices for the more important items in the construction of the dam were as follows:

For earth excavation in trench for the main concrete dam, which included allowance for sheathing and pumping	$1.20 per cubc yard
For earth excavation for corewall	0.50 per cubic yard
For rock excavation for main concrete dam	2.50 per cubic yard
For rock excavation for corewall	2.00 per cubic yard
For concrete masonry	3.50 per cubic yard
For upstream embankment and backfill	0.70 per cubic yard
For downstream embankment and backfill	0.40 per cubic yard
For cement	1.49 per barrel

Very strict sanitary regulations were necessary at the dam on account of the close proximity of Lake Dawson. The labor camps and barns were located just southerly of the Dawson dam. All closets at the dam were provided with watertight metal cans which were disinfected with chloride of lime, and removed twice a day to disposal pits, dug southerly of Dawson dam, and the contents buried.

The construction of the dam was carried out under contract with C. W. Blakeslee & Sons of New Haven. Mr. M. C. Hamilton was their superintendent. All the work was under the direction of Mr. A. B. Hill, Consulting Engineer for the Water Company, the writer being Engineer-in-charge.

ACKNOWLEDGMENT.

This article is the major portion of a paper by Mr. Clarence M. Blair, of the engineering staff of the New Haven Water Co., before the Connecticut Society of Civil Engineers as published in the 1915 Proceedings.

Water Supply of Cartagena.—The water distribution system of Cartagena, Colombia, is controlled by a British corporation known as the Cartagena Waterworks, Ltd. The water is obtained from a creek in the hills about 12 miles in the interior, and is stored in a reservoir which has proved too small. Nine-inch cast-iron pipes conduct the water to the city, practically all of which is piped. There are about 20 miles of pipe in the city. The inside diameters are 9, 6, 4 and 3 ins. for the mains and submains. The lengths are 9 and 12 ft. Cast-iron pipes are used in the mains and galvanized pipe for houses and stores.

The charges for water service are as follows: For a ⅜-in. pipe, $1.80 per month; for a ½-in. pipe, $2.50 per month; for a ⅝-in. pipe, $3.50 per month; for a ¾-in. pipe, $4.50 per month; for a 1-in. pipe, $5.50 per month. Factories pay 10 cts. gold per ton by measure.

The water company, it is said, will soon be in the market for 12 miles of pipe, as the system must be extended.

Loss of Keys and Wedges in Using Steel Forms.—Although steel forms have many advantages over those of wood, the small wedges and keys used with the former are a source of annoyance and loss. On one reinforced concrete job built by the Aberthaw Construction Co., Boston, Mass., three times as many wedges and keys as were needed to set up all of the steel forms were provided. After the forms had been used four times there were scarcely enough wedges and keys left for setting up the forms a fifth time. Although a man was placed on the work whose special task was to collect these accessories, it was necessary to purchase more of them. To give the best service it will be necessary for makers of steel forms to adopt devices which will prevent the loss of the wedges and keys.

Design of 2,500,000-Gal. Steel Standpipe at West Roxbury, Mass.

(Staff Abstract.)

In 1914 the Metropolitan Water and Sewerage Board of Massachusetts built a steel standpipe of 2,500,000 gals. capacity in West Roxbury.

A contract for making the necessary excavation for and placing the concrete in the foundation for the reservoir was made with John E. Palmer of Boston on Aug. 4. The concrete base on which the steel tank rests is 117 ft. 6 ins. in diameter, 2 ft. 8 ins. thick for a width of 7 ft. at the circumference, 3 ft. thick under six columns which support the roof, and 12 ins. thick under the remainder of the tank. The earth below the concrete is a clayey, gravelly hard pan. Work under this contract, which amounted to $6,382.28, was completed on Oct. 7.

A contract for the steel tank for the reservoir was made with Walsh's Holyoke Steam Boiler Works, of Holyoke, on Aug. 7 for $19,397. The work of erecting the tank was begun on Oct. 10 and was practically finished at the end of the year. The tank is 100 ft. in diameter, with bottom composed of steel plates ⅜ in. thick, 20 ft. long and 8 ft. wide. The sides of the tank are 44 ft. 3 ins. high, composed of seven courses of alternating inner and outer plates varying in thickness from ⅜ to ⅞ in. The junction of the bottom and sides of the tank is made with a 6-in. x 3½-in. x ¾-in. angle on the inside, and the top edge of the tank is stiffened with a 3-in. x ⅜-in. Z-bar on the inside. The circumferential joints are double riveted and the vertical joints are butted and secured together with inside and outside straps. The tank is fitted with an overflow weir 5 ft. long and 1 ft. 3 ins. below the top of the tank. The steel plates for the tank were furnished bv the Lukens Iron & Steel Co. under specifications which require a tensile strength of between 57,000 and 62,000 lbs. per square inch, and chemical requirements in accordance with the specifications of the American Society for Testing Materials. All rivet holes in plates more than ⅜ in. thick were punched at least 3/16 in. smaller than the finished diameter, and reamed after the plates were erected and bolted in place. The bottom of the tank and one course of the side plates were erected upon blocking and then lowered into final position by means of screw jacks placed around the outside edge and through five holes cut in the bottom plates. After this was done the space under the bottom of the tank was filled with cement grout mixed in the proportion of 1 part Portland cement, 1 part fine sand and 2½ parts of water by volume. The grout was mixed in steel tanks, stirred with compressed air and poured through 66 1-in. diameter holes in the tank bottom, which were afterward plugged. This part of the work cost $1,053.67 and in doing it 222 bbls. of cement and 33 cu. yds. of sand were used.

The completed reservoir includes a granite masonry tower surrounding and enclosing the tank.

ACKNOWLEDGMENT.

This information is taken from the 1914 report of the Metropolitan Water and Sewerage Board. Mr. Dexter Brackett is chief engineer of water works and William E. Foss is his principal assistant.

Method and Cost of Waterproofing Settling Basin Bottoms at St. Louis.

(Staff Abstract.)

The newer settling basins of the St. Louis water purification works at the Chain of Rocks have, in recent years, given much trouble due to leakage and blowouts. The working depths of these three basins, numbers 7, 8 and 9, vary from 21.2 to 27.5 ft. The natural ground surface was low, and in construction quicksand was exposed in spots in the bottom. The basin floors are concrete, 9 ins. thick, laid in blocks about 8 ft. square, on a puddle base 18 ins. thick. The joints between the blocks are filled with asphalt.

When the basins were first filled leakage developed which finally washed out a large hole under the east, or river side, wall. A steel sheet piling wall, averaging 30 ft. in depth, was then driven to rock along the river side of the basin. This stopped the sand movement but did not materially reduce the leakage.

In 1914 basin No. 9, the most northerly one, was waterproofed with six layers of waterproofing pitch and five layers of long fiber pitch-impregnated felt, pitch and felt alternating, and protected by a layer of concrete in blocks 3 ins. thick, 8 ft. wide and 16 ft. long, separated by joints filled with asphalt, and breaking joints with the blocks under the waterproofing. This effectually reduced leakage. A similar waterproofing was applied to the bottoms of basins 7 and 8 during 1914-1915. The work for basin 8 was let to the Heman Construction Company early in April and completed in July of 1914. The same contractor was the low bidder for the work in basin 7. The contract prices on the waterproofing work all done by the same company are as given in Table I.

The average cost per square of completed waterproofing was $10.18.

The pitch used was a straight run coal-tar pitch, which softened at about 60° F., and whose melting point was about 125°F. The felt weighed between 14 and 16 lbs. per square, contained about 25 per cent long wool fibres, and was seasoned so that the bursting strength was about 25 lbs. per square inch.; the asphalt filler for the joints was one with high ductility and penetration. Approximately 163 lbs. of pitch was used per square of waterproofing.

TABLE I.—CONTRACT PRICES ON WATERPROOFING SETTLING BASINS AT ST. LOUIS.

Description.	Basin No. 9.			Basin No. 8.			Basin No. 7.			
	Final quantities.	Contract unit price.	Average bid unit price.	Final quantities.	Contract unit price.	Average bid unit price.	Final quantities.	Contract unit price.	Average bid unit price.	Average contract unit costs.
Waterproofing (sqs.)....	1,625.1	$ 4.58	$ 5.45	1,655.1	$ 3.00	$ 4.10	2,313.03	$ 2.00	$ 3.16	$3.046
Concrete (cu. yds)......	1,706.7	5.75	6.96	1,632.0	6.50	6.50	2,617.73	6.25	6.70	6.175
Asphalt (tons)..........	23.1	32.00	47.80	15.06	29.00	32.80	32.159	30.00	34.61	30.44
Cost of work...........	$17,995.69	......	......	$16,010.04	......	......	$21,951.64	......	......	......
Extra work.............	7.97	......	......	27.48	......	......	988.87	......	......	......
Total cost.............	$18,003.66	......	......	$16,037.52	......	......	$22,940.51	......	......	......

The concrete was of such proportions that one sack of cement produced 7 cu. ft. of concrete, the sand and gravel being proportioned to make a dense aggregate. It was finished to a smooth surface, an average of two quarts of mortar being used to each block of 128 sq. ft.

ACKNOWLEDGMENT.

This information is taken from the latest annual report of Mr. Gurdon G. Black, Engineer in charge, Supply and Purifying Section of the St. Louis water department.

ROADS AND STREETS

Practice Relating to Patented Pavements in American Municipalities.

(Staff Abstract.)

The title, "Specifying and Adopting Specifications for Patented Pavements and the Methods of Calling for Bids Thereon," expresses the sole functions of this article. In order to obtain all the data possible relative to the practice in the various units of government throughout the United States, letters of inquiry were sent to the highway departments of each state, to the engineers of several of the larger cities, to the technical press, and to a number of men prominent in the Highway Engineering profession, asking information regarding the common practice in their municipality. An expression of the personal opinion of each was also invited. In all, nearly 200 letters were sent out, about 25 of which were not answered. The information presented in this paper is that obtained from these letters of inquiry, from reports on court proceedings, from articles in the technical press, from published specifications of the various municipal units, and from existing conditions with which the writer was personally somewhat familiar.

Each state and the cities therein, are considered separate in the following presentation.

Alabama: "There is no law in this state against the use of patented pavements." The state work "has not yet reached the stage where other than ordinary water-bound macadam roads are constructed, therefore we have had no experiences with patent pavements." The City Engineer of Birmingham reports,

> "that our present practice is to advertise for various kinds of pavements for each job, including any patented pavements which are suitable for the conditions presented by the same. After the bids are received, the material is selected, which may or may not be a patented pavement."

Arizona: There are no laws against patented pavements in Arizona. "The work upon state highways in Arizona consist almost entirely of grading and draining." In the cities practically all street improvement work is done under the "Arizona Improvement Act of 1912." Under this law, a "Resolution of Intention" must be published defining exactly what improvement is to be made, and the particular kind of pavement, pipe, etc., to be used. Section XVIII of Phoenix Specification 19, reads:

> "All fees for any patented invention, article, arrangement, process or mix that is used upon, or in any manner connected with the construction, erection or maintenance of the work or any part thereof that may be done under these specifications shall be included in the prices stipulated in the contract for said work, and the contractor must protect and hold harmless the City of Phoenix or any abutting property owners against any and all demands for such fees or claims."

In case of bitulithic pavement being specified, the city requires Warren Brothers Co. to file with the city clerk, before proceedings are started, a "Bitulithic License Agreement" dated and made to cover whatever length of period is necessary. Such an agreement is made for each separate contract. "This is necessary for full competition under the law."

The agreement specifies that any contractor can secure the bitulithic mixture delivered for a stated sum per square yard, otherwise he pays a stipulated royalty and furnishes all of his material and machinery. The bitulithic specifications are adopted as furnished by the patentees.

Arkansas: There are no laws against patented pavements. The State Highway Department being a new one has no data at hand. The City Engineer of Pine Bluff writes that they have had no experience in that city with bitulithic pavements, it having been the opinion of the council that the payment of a royalty was unprofitable when practically the same pavement could be laid under the Topeka specifications. Some dolarway was constructed in Pine Bluff mostly as private work, with the exception of that in one road district. The Engineer writes, "in handling these pavements it is necessary to submit to specifications furnished by the patentee or contractor. Personally I am not in favor of patented pavements."

California: No report from the State Highway Department, but there are no laws against patented pavements, providing other considerations are complied with. The City Engineer of San Francisco reports very complex conditions from his experience, and that "the city of San Francisco recognizes no patented pavement."

> "Personally I am very strongly opposed to the exclusive use of any particular patented type of pavements the extensive use of which is necessary to the public welfare."
>
> "It is against the principle of the charter which controls the city and which demands an open door for competition."

Colorado: State Highway Engineer reports "there are no statutes in this state which prohibit the use of any patented paving or other device." Personally, as an engineer, I can see no objection to the use of any patented article which would better serve the purpose for which it is desired to use it.

> "I believe, however, that in advertising for bids on structures involving patented articles, that the municipality or state should pay the royalty to the owner of the patent, thus leaving all bidders upon the same footing. If this precaution is taken, I can see no objection to the use of the devices."

Denver has an ordinance providing as follows:

> "No specifications shall name any material from any specified locality, quarry or kiln or of any particular name, make, brand or source." "All specifications shall establish a standard of purity, strength and quality, to be demonstrated by physical or chemical tests, . . . and in every instance, materials shall be described by standard of quality, as will admit of genuine competition between contractors, so that there can be at least two or more bids by individuals or companies in no manner connected with each other, and no material shall be specified which shall not be subject to such competition."

The City Engineer says, "No patented pavement has been specified in this city during the last ten years on account of the above wording of the charter," and presents his personal opinion by a question, "Why should the use of patented pavement be prohibited if the authorities of a city consider it the best for their purpose? We use other patented articles in our work and in almost every business—why not in this?"

Connecticut: The State Highway Commission's entire letter is of interest.

> "It is our practice, in the State of Connecticut, where it is considered wise to use a patented pavement, to advertise for bids on the different patented types under specifications which will allow the use of different patented mixtures. Of course the bids received will vary greatly and it is necessary in canvassing the bids to give considerable thought to the comparative merits of the pavement material, taking into consideration the price bid."
>
> "The experience has shown us that different materials have characteristics suitable for certain conditions and the relative cost, value of the road surface and future cost of maintenance must be compared as carefully as they can before the contracts are awarded. In many instances the awarding of such a contract does not give the work to the lowest bidder, but the competition is open and the reasons for the award are made plain. I think that this method is much better than to pick out the patented pavement and let contracts for that pavement without competition."
>
> "Of course, the companies owning patents on pavement material are willing to sell the right to put the material down, but in almost every instance the company selling the pavement has a material advantage over any other contractor owing to knowledge of the method and ownership of the patent, so that any contracts which are advertised for on one class of pavement material would almost invariably go to the owning company."
>
> "I would be very sorry indeed to be prevented from using patented materials when in my judgment they might be wisely put down. A patent is given, of course, as a protection and a reward to a person who makes material advances in methods or equipment for doing certain work. The giving of patents is a well-established principle in the United States and it doesn't seem to me that any public official should be prohibited from securing the advantage of using the patented materials or equipment when these things will give him better results than others which are not patented."

Delaware: There are no laws absolutely against patented pavements. New Castle County reports that no patented pavements have been constructed, with the exception of 1 mile of amiesite and that this was put down under specifications furnished by the Amiesite Company. It is understood that the cities have used considerable yardage bitulithic.

District of Columbia: The report received says:

> "The District of Columbia does not specify patented pavements in its advertisements, and in its contracts it embodies in the specifications for paving work that the District of Columbia will hold the contractor harmless from all claims for damages on account of patented rights for any process prescribed in accordance with the terms of the specifications, but that this will not relieve the contractor from any claims for the use of patents under any circumstances save as above."
>
> "The only instance in which the District has experienced a presentation from any person claiming a patented right to work specified in our contracts was some three or four years ago when a bituminous concrete specification was objected to by the owners of the so-called Bitulithic patent and at that time our patent clause in our specifications was remodeled as above in order to relieve the contractor from the expense of a possible suit, and when this protection to the contractor had been accomplished the work was prosecuted without change and without result so far as the suggested action by the patentee was concerned."
>
> "It is not unlikely that the circumstance that the work of paving in this municipality involves the expenditure of governmental funds is a legal deterrent from the presentation and prosecution of patent claims which might be determinative in some cases. At any rate, with our specifications formulated as above, no interference has been had on the part of any patentee with any process which we have specified."

The Office of Public Roads reports that it has had no occasion to specify or require patented forms of construction and consequently has no data available.

Florida: No reply received to inquiry.

Georgia: This state has no highway department to furnish the desired information. Patented pavements are used extensively in the cities of the state and are constructed according to the specifications filed by the respective owners of the patented materials.

Idaho: The Idaho statutes have been construed in such manner that the required competition is present if the owner of the patent makes proper arrangements so that all the parties desiring to bid on his pavement may have the license to so bid, a fixed price for the royalty being made to each bidder.

Illinois: A law on the statute books, known as the Local Improvement Act, which permits of roads and street improvements by special assessment, states that patented pavement cannot be specified. Illinois is the only state in the Union which generally prohibits patented pavements on municipal assessment work. There are legal authorities who say that patented pavements can be laid in Illinois even under the laws, and it is known that they have been used there.

Indiana: There is no state highway department. Indiana law is such that when a pattented article is offered at a fair price to any contractor bidding on the work as a whole. the statute requiring competition is complied with. In handing down this decision the court in the case of Monaghan vs. City of Indianapolis, 37 Ind., Appel., 280, expressed one decisive fact:

> "That the rule then adopted did not exclude use of a patented pavement, but did exclude the use where the patentee so held the right to use the process as to enable him to designate the contractor."

The city of Gary has not used many patented pavements, "Granitoid" and westrumite and rocmac being used in a small way. The City Engineer writes:

> "So far as the law is concerned, it is not altogether clear whether we can take bids on patented pavements or not, and we do not desire to run very many chances with our bonds on this account."

Several patented mixtures are being used for repairs. The inquiry to Fort Wayne brought the information that in that city are some 80 miles of paved streets, not a cent royalty ever having been paid, because enough other kinds of paving materials other than patented are available.

Iowa: The Iowa court's view is that the statute does not prevent the use of a patented article if the evidence is such that no other article of the kind is equally good. Chapter 4, Section 1 of the laws relating to roads and bridges is of particular interest.

> "Validity of patents on bridge or culvert construction involved—how paid. The Governor, whenever he deems such action to be in the interest of the public, shall have power to direct the Attorney General to appear for and on behalf of any county, city, town or other municipality of this state or for and on behalf of any officer thereof or contractor therewith, whenever such county, city, town or other municipality or officer or contractor is a party to any action or proceeding in any court wherein is involved the validity of any alleged patent or on any matter or thing entering into highway, bridge or culvert construction, or any parts thereof, and may employ such legal assistance in addition to the Attorney General as he may deem necessary and may pay for the same out of any fund in the state treasury not otherwise appropriated. Whenever the Attorney General is so directed by the governor it shall be his duty to comply therewith."

If this paper had for its object, the compilation of evidence in favor of the patented pavements, the several decisions and the views expressed by the Iowa court would be most valuable.

Kentucky: The road work under the State Department has not yet advanced to the point where it has been necessary to work up or look up specifications for patented pavement processes. The Kentucky statute is satisfied that competition is provided when bids are called for, "Presuming that any article of commerce, whether patented or not, is for sale on the market at some reasonable price." The State Highway Department reports, "We have had no occasion to write specifications admitting their use, and probably will not have."

Louisiana: The State Highway Department reports,

> "This department has not yet advertised for bids for the construction of any particular patented pavements, other than covered under the caption of "Other Bids," embodied in our standard form of contract and specifications, which reads as follows:
>
> "Bids are only invited for any other class of metal surfacing which may be considered equal or superior to the ———, above specified, and which will meet with the approval of the State Highway Engineer. Any such bids must be accompanied by a full description of the proposed material and detailed specifications for the preparations of the foundation course, if any, and surface course."

The name of the type of surfacing usually mentioned in the blank space is not known to the writer. It was reported, however, that under bids submitted on their items that about 10 miles of petrolithic metal surfacing has been constructed in the state.

The city of New Orleans has an ordinance enabling paving proceedings to be started by a petition of the owners of 60 per cent of the real property abutting on any street. Whether the property owners will present petition or action for paving is upon motion of the Commission Council. This latter body invites "bids for as many kinds, characters and types of pavement as are suitable for the proper execution of the proposed improvement." After all bids are opened, the prices bid on various types and the names of bidders are published once a week, in the official journal of the city, for 30 days. At the expiration of this period the property owners have the right by petition "to designate which of the several kinds, characters or types of pavement" they prefer. In the event of the owners of 33 per cent or more of the real property designating a particular type of pavement, this one type is adopted by the commission. If no petition is presented, the commission designates the type of pavement. In either case, contract is let to lowest bidder on that particular type. Where the commission believes that a different type, and more expensive surfacing will best suit the requirements, contract may be let to the lowest bidder on this type and the city pays, in certain cases, an amount approximately equal to the difference in cost.

"The Commission Council, however, shall be the sole and final judges of the said type of pavements, of the difference between the cost of the same, and the necessity for the designation of a more expensive type of pavement." Bids may be invited and received, and contracts may be made, for the use of patented or proprietary articles in any case of paving or repairing of streets, provided the owners of such patented or proprietary articles, shall prior to the adoption of the ordinance directing the preparation of plans and specifications, file with the Commission Council a written agreement to sell their patent or proprietary rights to any and all persons for a fixed royalty, on equal terms and conditions satisfactory to the Commission Council.

New Orleans in its general specifications, which are printed as a part of all other specifications, contains the following clause:

> "In the event that these specifications require the use of any patented, proprietary, trade-marked or exclusively manufactured, owned or sold material, article or device, the bidders are required to agree to pay the royalties, costs, charges or other claims imposed for the right to use and employ such patented, proprietary, trade-marked or exclusively manufactured, owned or sold materials, articles or devices, used and employed in said work, as per the stipulations, declarations or agreements made by the patentees, proprietors or owners, as the case may be, deposited and on file with the City of New Orleans."

Maine: The Highway Department reports that it has never specified or adopted specifications for patented pavements.

Maryland: A communication from the State Road Commission in early April of this year states,

> "At present writing, the Commission has decided to eliminate the use of all patented materials, as it is considered that there could not be the proper competition between bidders on patent materials."

The city of Baltimore some 9 years ago passed through a tempestuous period when the Bruce-Fendall ordinance permitting paving procedure under the form "Alterative Bids" was in vogue. Since 1911, however, the practice has been for the commission to select before hand the material to be used on the street. Secret bids are called for and on opening, the contract is let to the lowest responsible bidder. It is of interest to know that the city has had in the last four years an "Era of remarkable progress in paving and we have gotten work at cheap prices." The city of Baltimore does not call for any specifications of patented pavements, however, in the general specifications the following paragraph is noted:

> "Whenever any material, process, composition or thing called for by these specifications is covered by Letters Patent, the successful bidder must secure, before using or employing such material, process, composition or thing, the assent, in writing, of the owner or licensee of such Letters Patent, and file the same with the chief engineer."

Massachusetts: The State Highway Commission has constructed in only one instance a patented pavement, this having been done at a low price for a test section. The report reads further:

> "There are no statutes in this state covering patented paving materials or construction, but it has been the policy of this Commission not to construct such pavements, as the Commission believes that other pavements of just as permanent nature as the patented can be constructed."

Boston has no ordinance dealing in any way with patented pavements. The Public Works Department uses patented pavements, their practice being in calling for bids, to specify two or more kinds of material, the proprietor of the patented materials stating the prices which they quote to the contractor who desires to bid on this class of work.

Michigan: The State Highway Department advises,

> "That this department thus far, has built no patented pavements and has not been obliged to meet this question." "There are no laws in Michigan regarding patented pavements."

Minnesota: The State Highway Commission reports that their highway works lies almost entirely along the line of earth and gravel roads, and as yet have had very little to do with any patented process. The city of Minneapolis uses no patented pavements.

Mississippi: No information received in response to inquiries.

Missouri: The State Highway Department furnishes the information that practically all road and pavement work is performed either by the cities or counties so that the state does not have to take into consideration the various classes of patented pavements. An extract from a decision of the Missouri Supreme Court some years ago makes clear their situation:

> "The Court will not undertake to interfere with the discretionary powers of its officers (referring to the Board of Public Improvements) within legal bounds; that when a city in the prosecution of a public works finds an article or material which in its judgment is best adapted to such work, it is not debarred from availing itself of it because such material is controlled by one party."

In St. Louis, the Board of Public Improvements determines the kind of paving material by a majority vote of its members. The property owners in a "Taxing District" have the privilege of petitioning for their favored type of paving. If there are no reasons why the petitioned paving should not be used the board passes favorably on the selected type. The board, in all cases, reserves the right to final decisions irrespective of the petitioners. Three days after the petition is presented by the property owners of the "Taxing District" the board must select the type of paving to be used. Eighteen days are then given for the property owners to remonstrate by petition against the selected type. In St. Louis the board has absolute power in practically every selection as the following quotation from their communication would indicate:

> "The Board of Public Service reserves the right to introduce an ordinance authorizing the improvement with the paving material previously determined upon. The Board after reconsideration may order the improvement with a paving material other than first determined upon, or may also reverse its former decision and decide to not recommend the improvement. In the latter case, unless some very obvious reasons be presented or a large majority of the property owners, by petition, request that same be considered, the particular street under consideration cannot again come up for consideration for some time. This has been the tendency of the Board, although no stipulated time interval is specified, and tends to prevent one or two property owners petitioning again for the same improvement."

The bitulithic pavements in the city were laid under specifications furnished by the patentee, the city having no voice in any "except such physical defects as would be apparent to the eye." Further information says that "there seems to be a feeling that patented pavements in general will not be recommended by the present Board of Public Service," and further that "the judgment of a board seems to be of the opinion that a form of 'Bituminous Concrete' specifications, should be prepared to alternate with the 'Bitulithic in future construction of this type."

In Kansas City, Missouri, "the specifications," it is reported from the Board of Public Work,

> "Are all open specifications as nearly as it is possible to make them, leaving the matter of payment of royalty and the use of patented articles entirely to the contractor. If the patented article is equally as good or better than any other we have no objection to its use, but will not pay royalty except as it may be paid by the contractor in open bidding."

Montana: The State Highway Commission reports "there are no peculiar requirements covering the use of patent paving materials." Further that "patent pavings are in use in a number of the cities of this state, but none upon state or common highways outside of corporate towns." The practice in the city of Great Falls is well explained in the following extract of a communication from the Engineering Department:

> "Answering your favor of Feb. 23, relative to our practice in the use of patented pavements, it has been our practice, and I might say, the practice adopted over the whole state, to call for bids on a number of different types of pavements where patented pavements were among the number, for the obvious reason that more competition may be maintained in the bidding.
>
> "The selection of the type to be used is not made until after bids are received and tabulated. After this is done a canvass of the property owners directly interested is made and the election of the type left to them. The engineer's function in this matter is to advise as to what he believes to be the best for the money and it is left to the property owner to say how much he can afford. The type selected is that type desired by the owners representing the greatest amount of frontage in the improvement district.
>
> "A number of efforts have been made in this state to bar the use of patented pavements altogether. This attitude I believe to be wrong, inasmuch as there are a number of these pavements that have decided merit and are protected by patents that have been successfully defended. This would simply bar us from the use of a type that can be used to advantage in a number of instances, and instead of increasing competition as its advocates claim would simply subtract from that which we already have." "If some patented type should meet these requirements as well as those not patented, they should be given a chance. In smaller cities that are not yet able to keep experts and equipment of their own, it seems logical to me that better results can be obtained by the employment of constructors who maintain a complete complement of experts and have their own success staked upon the uniform dependability of the pavement which they build."

Nebraska: No information was received from the State Engineer Department. From the Department of Public Improvements of Omaha was received the following information:

> "It has been held by the legal department of this city that, under the provisions of Section 106-a of the City Charter, copy of which is hereto attached, we are forbidden to specify by name or receive bids for any patented type of pavement."

This section 106-a of the Omaha City Charter provides:

> "In all specifications for materials to be used in paving, curbing and guttering of every kind, the City Engineer shall establish a standard of strength and quality to be demonstrated by physical and chemical tests within the limits of reasonable variation such as rattler, crushing, absorption, chemical and other tests, and in every instance the material shall be described in the specifications either by standard or quality as will admit of genuine competition between contractors, so that there can be at least two or more bids by individuals or companies in no manner connected with each other, and no material shall be specified which shall not be subject to such competition."

New Hampshire: The situation in this state is explained by extracts from correspondence with the Highway Department:

> "The State of New Hampshire has used very little of material which is covered by patent and there is no law that I can find which would positively prohibit such use. As a matter of fact there are only a few specifications used that would come under this head and though my personal opinion is that there should be such regulation adopted, I do not think there is any within the state."

Not much information was obtained relative to the situation in the cities of New Hampshire. Concord, the capital city, has no patented pavements. Manchester has a considerable yardage of rocmac, constructed under specifications furnished by that company.

New Mexico: Information from the State Engineering Department is to the effect that the highway improvement consists entirely of earth and gravel construction work. A number of cities have used bitulithic.

Nevada: This state has no highway department, State Engineering Office reporting "the city of Reno, Nevada, is about the only city in the state which has attempted to follow any standard form of specifications for paving."

New Jersey: No information was received from the State Highway Department. A number of cases involving the question of competition where patented pavements were involved were settled in favor of the bitulithic interests. Paterson, Atlantic City, Newark and Bloomfield were among this number. The New Jersey situation is that good and sufficient competition is allowed if the owner of the patented article agrees to sell it at a fixed price to any contractor desiring to submit bids on the work.

New York: This state being the leader in road improvements of all kinds has naturally had many court cases involving the question of patent pavements. Chapter 30 of the Highway Law of 1909 as amended in 1910-11-12-13 and '14, provides in Section 25, "Patented Materials or Articles. In the construction, maintenance or repair of state or county highway, no patented material or article any other material or article shall be specified, contracted for or purchased, except under such circumstances that there can be fair and reasonable opportunity for competition, the conditions to secure which, shall be prescribed by the Commissioner of Highways. The Attorney General in an opinion rendered June 26, 1913, held that under this section the use of patented material in the construction or improvement of highways was not prohibited, but the provisions of the section to make necessary some prescribed condition that the price of material to bidders must be uniform so that there be no advantage given one bidder over another so far as the patented articles is concerned."

John Cassan Wait, M. C. E., L. L. B., in his Engineering Law Treatise, "Engineering and Architectural Jurisprudence," states:

> "In New York state it has been held that the provisions which entitle the person making the lowest estimates to have the contract awarded to him does not apply to estimates for patented articles or processes.
>
> "Some states hold to the view that such contracts are not prohibited; but the tendency of the courts, according to Judge Dillon, is that the statute prohibits any contract that cannot be advertised or let in the manner it prescribes, and he cites cases in which it has been held that a contract for a patented pavement with a person who had the exclusive right to lay the same was void."
>
> On another page of the volume, the following record of a court decision is of considerable moment. "When the job embraces several kinds of work, some of which are patented, while others are not, it has been held in New York that separate proposals should be invited, one for that part which is not patented and another for that which is patented and for which there can be no competition."

The city of New York probably occupies the most unique position relative to the patented pavements situation of any city in the United States. Although there is no law directly prohibiting patented pavements, yet such are practically unknown in this city, except in some of the parks, and boroughs other than Manhattan. The city charter contains a clause No. 1,554, reading as follows:

> "Except for repairs no patented pavement shall be laid and no patented article advertised for except under such circumstances that there can be a fair and reasonable opportunity for competition, the conditions to secure which shall be prescribed by the Board of Estimate and Apportionment."

That this clause does not prohibit the use of patented pavements is very evident. But competition must be provided between the owners of the patented and unpatented pavements. The Board of Estimate and Apportionment in a resolution soon after Clause 1,554 was passed provided for the required competition by specifying for street paving work three types of asphalt surface, namely, Asphalt Block, Bitulithic and Sheet Asphalt.

Bids were opened and the contract let for bitulithic to the second lowest bidder. The lowest bidder instituted an injunction against procedure with the result that asphalt blocks were used. This case and subsequent decisions by the Appellate Division and the Court of Appeals settled definitely that competition was possible under the plan submitted by the board and that patented pavements could be laid in New York City. Quoting from a communication received from the Bureau of Highways, Borough of Manhattan, "Owing to the high cost of patented pavements it would probably be necessary to obtain permission of the Board of Estimate and Apportionments to award the contract to other than the lowest bidder."

Quoting from correspondence from the Board of Estimate and Apportionment, the status of the patented pavement situation in the city of New York, at the present writing is made very plain,

> "In view of this limitation (Section 1544 of the Charter) the City of New York is obliged when asking for bids for patented pavements, to ask at the same time for bids for some other type of pavement as nearly similar as possible. If the bid for the patent article is the lowest the contract can be made. If it is not the lowest it is still possible to award the contract with the consent of the Board of Estimate and Apportionment. There was doubtless a good reason for placing this provision in the charter at the time it was done, but it has a serious handicap in trying pavements and paving materials which are promising and deserve a fair trial."

The city of Albany, N. Y., has in its General Specifications a clause reading as follows:

> "The contractor hereby stipulates, covenants and agrees for himself, his heirs, executors, administrators, successors and assigns, that he has the right, power, authority and license to furnish all said materials and do all the work required by said specifications, and that he and his heirs, executors, administrators, successors and assigns will, at his or their own cost and charge, defend any and all actions and proceedings that may be brought against the city or its said Board of Contract and Supply, or either of them, for infringement of patents or patent rights by reason of the use of any such material or articles furnished, or work done as aforesaid. And that he and they will indemnify and save harmless the said City of Albany and its said Board of Contracts and Supply, or either of them, from any judgment that may be recovered against them, for infringement of patents or patent rights by reason of the use of said article or materials or the doing of the said work as aforesaid."

In case of bitulithic the usual specifications and agreement are on file in the Albany City Offices.

The Rochester Charter in Section 115 and 230 provides that

> "A majority of the owners liable to be assessed for the cost of paving or repaving a public street, highway or place, owning not less than two-fifths of the feet front of property . . . may at any time within one week after the ordinance for the improvement takes effect, present to the Board of Contract and Supply petition or other writing designating one of the materials specified by the common council as the material to be used in constructing the pavement, but may not designate herein any particular kind, make, style, or brand of material."

In October of last year one other important decision was handed down by the Supreme Court Justice W. W. Clark when he dissolved an injunction restraining the letting of a contract for bitulithic by the city of Rochester. Justice Clark said in his decision,

> "There is nothing in the charter of the City of Rochester which prohibits the common council from adopting bitulithic pavement . . . and there is nothing in the charter which would preclude property owners from designating bitulithic . . ."

This case was another in which the point of argument was that of the legal possibility of obtaining competition on a patented pavement.

Utica provided for the use of bitulithic through the usual procedure of filing the Warren Brothers Mixture Agreement and adopting their specifications.

North Carolina: This state, it is reported, has no "specifications regarding patented pavements or methods of calling for bids," also

> "From a legal standpoint I think North Carolina is very free from anything that would prevent commissioners from utilizing any pavement that they might desire, and the only laws covering this point would be general laws."

North Dakota: "Outside of pavements within the corporate limits of some of our cities, no hard surface roads have been built." The State Engineering Department has not been in a position to do other work than collect data so that detailed information from there is not at hand. North Dakota has no direct laws preventing the use of patented pavements, as they have been used in the cities of that state.

Ohio: No reply was received to inquiries sent to the State Highway Department. A number of decisions in former years have settled that there are no statutes against patented pavements if the prize is fixed uniformly to contractors so that competition is assured.

Cleveland's Department of Public Service reports,

> "That locally we seldom have need for taking bids on patented pavements." "Should patent pavements be desired, it would seem feasible to include in the specifications, the requirement that the contractor shall assume the payment of all royalties, and specifying the work in compliance with the specifications furnished by the patentee. A second method seems possible and that is to obtain competition by specifying several kinds of pavement, amongst them being the patented, which method under the law would certainly bring competition."

Columbus: The Department of Public Service reports,

> " . . . relative to patented pavements, and have to advise that this class of pavements has never been used in this city and it is not the intention to start the practice at the present time."

City of Dayton furnishes a new side of the question by stating that most of the patented pavements being some kind of a combination of broken stone and binder, depend for their wearing quality very largely on the aggregate.

> "Our native stone, a fairly hard crystalline limestone, does not wear satisfactorily under abrasion, and the importing of a harder stone eliminates this class of pavement by reason of the high cost in comparison to other types of pavements that are satisfactory."

Oklahoma: No report was received from the State Highway Department. The courts in this state hold that legal competition is provided if the patented material is furnished at the same price to all parties bidding.

Oregon: No report came from the State Highway Department. The courts of Oregon have decreed practically the same as in the state of Oklahoma. The writer knows from personal experience that in practically every city and town of any appreciable size, and on a number of country roads in Oregon, bitulithic and Warrenite have been used according to specifications provided by the patentee, and meeting material tests almost wholly prescribed and performed by their own laboratories. Uniformly excellent results have been obtained throughout the state.

Pennsylvania: By statutes in this state when contracts must be awarded to the lowest bidder, such statute does not apply to contracts for patented articles and no competition is necessary. The policy regarding patented pavements of the new Highway Commission has not been made known at the time of present writing. The communication from the Departments of Streets and Public Improvements of Altoona is as follows:

> " . . . experience has been that it is unwise for the Engineer to specify a patented article for the work contemplated, and that he should prepare specifications for the class of pavement considered best suited for the local conditions. If it is probable that a patented pavement of the same class would prove satisfactory, he should state in his specifications that proposals for the proprietary or patented pavement to be constructed according to the method and of the materials recommended or specified by the originator or patentee, will be considered when the same is known to have been in satisfactory use for a sufficient period of time to demonstrate serviceability of the same."

Harrisburg's Engineering Department writes, "We have no laws covering the use of patented paving materials or construction. The fact is, this city has no such pavements in use. As a note of information, the eighty odd miles of paving in Harrisburg is almost entirely of sheet asphalt.

The Bureau of Highways, city of Philadelphia, in specifications for all types of pavements so words the various clauses that the bureau has very complete information on all materials at all times whether the pavements are patented or not. The Philadelphia city and county street and road work is all under the bureau. The policy of the bureau is that the responsibility for the work should rest upon the engineer at all times, that he should know the physical, chemical and other properties of all the materials, that he should know what is being constructed, observe all the results, making such suggestions as tend to improve the pavement whether or not it is patented. From a detailed study of the specifications furnished to contractors desiring to bid on Warrenite, Amiesite, or Filbertine in Philadelphia, it is evident that the bureau is more familiar with the patented pavement specifications, methods of construction and materials used therein than are the most of the other engineering departments in the various municipalities of the United States.

Under the caption "General Provisions and Conditions" in the "Notice to Bidders," occur these words

> "Suits and Claims.—The Contractor agrees to idemnify and save harmless the City of Philadelphia and the Director and his assistants from all suits and actions of every name and description brought against them or either of them for or on account of use of patented appliances. . . ."

In another specification

> "The Contractor shall be responsible for any damages . . . by or on account of any claims

> or amounts recovered for any infringement of patent, trade marks or copyrights . . ."

For the various types of proprietary pavements now in use the type of materials and their limits under described laboratory tests are embodied in the detailed specifications for that kind of pavement. To insure that the desired samples are furnished the Bureau Laboratory the contractor is instructed that he shall, when required, furnish samples desired by the chief or the Bureau of Highways.

"The city of Pittsburgh," it is reported by the Bureau of Public Work, "is prohibited, under the laws, from using patented pavements and therefore we never specify or use pavements of this type."

Rhode Island: The State Board of Public Works reports,

> "We have let only one contract for a patented pavement. In this particular case we drew up specifications with the help of the representation of the concern handling the patented pavements."

There is nothing in the Rhode Island laws governing the letting of contracts for patented pavements. Providence uses

> "Such pavements only when patentee is willing to put his pavement in open competition with other bidders. We have never paid any royalties or used them on any condition that would interfere with their use in competition."

South Carolina: The state statute is complied with when all the competition exists which is possible in the given case. Charleston reports, "we do not use patented pavements in Charleston." Some bitulithic has been laid there in the past, but the principal materials used are wood block, granite block, sheet asphalt, asphaltic concrete, vitrified block, macadam, shell and clay-gravel.

Tennessee: When the statute requires that contracts must be let to the lowest responsible bidder, such statute in Tennessee does not apply to patented pavements and competition is not necessary.

Chattanooga: This city reports that the city has not laid any patented pavements, but that several streets have been paved with asphaltic concrete on which the contractor paid a "small royalty," thus avoiding trouble with the Bitulithic Company.

Texas: There are no restricting laws in this state relative to patented pavement. Austin lays bitulithic according to specifications furnished by the patentee, obtaining such results that no guarantee is required, it being the view of the council that the paving company cannot afford to lay a poor pavement. The communication furnishes the following interesting note:

> "We do not advertise for competition bids on this pavement, but get the best price we can on it and contract with the company for its construction just as a private individual would buy a suit of clothes that suited his requirements."

The city of Dallas has over 40 miles of bitulithic, and some petrolithic and westrumite. There are now laws there governing such work, and the specifications are drafted by the engineers of the city and of the paving companies.

Utah: The State Road Commission advises that they have carried on their work almost exclusively by force account and are unable to furnish any information. To the writer's knowledge there are no laws restricting patented pavements in Utah, it being known that Salt Lake City has a considerable yardage of such wearing surface.

Virginia: The State Highway Commission says,

> "Glad to state that up to the present time we have not had this question to contend with, and have not therefore drawn up any specifications and regulations covering the same."

Several cities in Virginia have used patented surfaces.

Washington: No report from the State Highway Commission. Seattle has used some bitulithic, bitucrete, dolarway and hasam. The principal pavements in Seattle are sheet asphalt, brick, wood block, granite block and two-course concrete. The statement from Seattle is to the effect,

> "That there are other pavements not patented which are just as good in their respective classes as the patented pavements.
>
> " . . . Spokane does not specify any one class of pavement on any of its streets. It usually calls for alternate bids, and includes in the several specifications any pavement the engineer thinks adaptable to the conditions of the grade, traffic, etc., that the street may have directly associated with it. It requires any company promoting a patented pavement to submit a royalty agreement with the city so that the city may put this matter up on competitive bids. It also requires the patentees of any pavement to permit the city itself to make all repairs, replacements, etc., on this street, without payment of any royalty, whatsoever. We have found that this works out well and gives us a fair price for all classes of pavement. Pavements carrying a high royalty are usually eliminated in the bidding, since they are not able to put in as low a bid as straight competitive."

West Virginia: This state has only 3 miles of patented pavements outside of the cities, there being, however, considerable in the various cities. It is evident that no prohibitory laws are in effect in the state.

Wisconsin: This state was the last to amend its laws so that patented pavements could be used. The State Highway Department does not have specifications for any patented pavements.

Wyoming: The State Engineer's Office reports,

> "This rtate has prepared no specifications relating to pavements, as up to the present time we have very little road work under state control, none of it being of a kind which could be classed as pavements."

There are no laws in the state or city ordinance prohibiting the specifying of patented articles if they seem to fulfill the particular requirements.

Cheyenne on account of local conditions and materials available has had no experience with patented pavements.

DISCUSSION.

These foregoing paragraphs serve to afford fairly complete information relative to the status of patented pavements in those states having had this question to consider.

To summarize this information the writer extracts the following paragraphs from the lecture delivered by George C. Warren, President of the Warren Brothers Company, before the Engineers in Graduate Highway Engineering at Columbia University, February 12, 1915.

> ". . . cases along this line have been within the past twenty years carried to the highest courts of the States of New York, New Jersey, Ohio, South Carolina, Oregon, Missouri, Maryland, Louisiana, Kentucky, Michigan, Kansas, Iowa, Indiana, Idaho, Oklahoma, Pennsylvania, Tennessee, Massachusetts, California, Montana, Washington, Wisconsin and Illinois.
>
> "With the exception of the two last named, the final decisions in all of the states is to the general effect that where the owner of the patent voluntarily surrenders the exclusive right which the government has given him in granting the patent, and offers to allow any contractor to use the patent by the payment of a reasonable price for that article or portion of the article covered by the patent, which it is necessary to use in the construction of the contract for which bids are called, that all the competition which the law requires has been provided, and that cities need not wait the expiration of the term of years for which the patent is granted before being permitted to use it. Under such regulations, patented pavements may be laid and contracted for my municipalities and any state law which prohibits the adoption of a patented pavement by its municipalities is unconstitutional because it attempts to prevent the exercise of the Federal patent franchise which is based on the United States Constitution and is therefore paramount to all conflicting state laws. Of the two states in which decisions of the final courts have been adverse to patented pavements, the Wisconsin Legislature promptly amended its law so that patented pavements may be used and Illinois stands alone as the only state there is practically a patent prohibition on municipal assessment work."

To give in partial detail the difference in the patent situation in the various states where the court has given a decree, the following extract is taken from "Municipal Powers," a valuable published resume of the many court decisions involving the bitulithic and warrenite,

> "The courts, in holding contracts for patented pavements valid, have taken different grounds for their decisions.
>
> "1. The New York, Pennsylvania, California, Maryland and Tennessee view is that when by statute contracts must be let to the lowest responsible bidder, such statute does not apply to contracts for patented articles and no competition is necessary.
>
> "2. The Missouri and Iowa view is that such statute does not prevent the use of a patented article when it appears that no other article of the kind is equally as good.
>
> "3. The Michigan, Colosado and Kansas rule is that such statute applies to patented article, but that the competition required by the statute is provided when bids are called for, the law presuming that any article of commerce whether patented or not, is for sale on the market at some reasonable price.
>
> "4. The Kentucky rule is that such statute applies to patented articles, but that the competition required by the statute is provided when bids are called for, the law presuming that any article of commerce whether patented or not, is for sale on the market at some reasonable price.
>
> "4. The Kentucky rule is that such statute applies to patented articles, but that the competition required by the statute is provided where the patented article is placed in competition with some other article answering the same general purpose. This method of securing competition has also been approved by the courts of Kansas and New York.
>
> "5. The Idaho, Indiana, Ohio, Lousiana, Montana, Oklahoma, Oregon and New Jersey rule is that such statute applies to patented articles, but that the competition required by the statute is provided if the owner of the patented article offers to sell it to any contractor who may bid upon the work, as a whole at a fixed price.
>
> "6. The South Carolina rule is that such statute applies, but that it is satisfied where all the competition exists which the situation permits of.
>
> "The view of the Federal courts is that the courts have no right to review the discretion of the proper municipal officer in selecting paving materials, even if such materials are patented or the subject of exclusive ownership or monopoly."

Among the many interesting personal opinions received on the subject of this article are a number which are well worth presenting for further consideration and comment of those who either agree or disagree with the attitude taken.

One very prominent highway engineer expresses the view that personal factor cannot be avoided, that the entire authority for decisions as to the proper pavement must rest with the highway official; that this authority should mean that he should be responsible as well, and this responsibility as clear-cut and definite as possible.

A New England Consulting Engineer, himself interested in a proprietary pavement says,

> "The engineer in charge of any proposed work is the authority to determine the type of road to be approved by the commission. If the Engineer determines that any particular road should be built according to a method under patent rights all contractors have equal chance to make a competitive bid. . . . It is perfectly recognizable that if a patented pavement is of no value it will receive but scant recognition."

One of the widest known consulting paving engineers in the country says,

> "It has always seemed to me that if a patented article were best and it was economical to use it, it should be used, irrespective of the patent, and this is true in the case of pavements." He further advises, "that the patentee specify in advance the exact royalty for the contractor to pay or perhaps it would be better for the municipality itself to pay the royalty; then there would be absolute competition among the different contractors."

A firm stand is taken against even the issuing of the patents for pavement or any other engineering construction in the following communication from the head of the highway bureau in one of the largest of our cities.

> "Referring to your letter of Feb. 26, of course my opinion is well known on this subject, I do not, in the first place, believe that a patent should be applied for on materials that are the product of nature, and that Engineers work with day after day. Any such patent retards the advance of science and limits the research work of the engineering profession in connection with these particular types of pavements that are patented. I do not believe that the patent law of this country should allow such patents. It seems absurd if some one finds a new way of using materials, which are constantly being used, to bring about certain results, that he should attempt to patent his theory as is the case with patented pavements, because all engineers know that there are new methods of using materials being put into operation every day by cities, states and public works departments to better the product."

The following argument for alternate bids by a representative of one of the large asphalt companies appeared in a recent issue of the Engineering News.

> "The idea that competition is increased by drawing wide open specifications which admit anything and everything, the higher priced as well as the cheaper materials, is one of the

strangest fallacies that ever entered the human mind. What happens under wide-open specifications is that a monopoly is conferred upon the cheapest, and presumably the most inferior materials. The alternative specifications are growing in favor because of those facts; and if experience counts for anything this form of specifications will be universally used within a comparatively short time."

Some interesting suggestions for the method of bidding is contained in a communication from a gentleman prominent in the paving brick industry. His belief is that the basis of all bidding should be that of unit costs, whether the material is patented or otherwise, for the evident reason that any other form of bidding results in unreliable information as to the cost of any particular road. In his judgment, units of bidding should comprise the separate items of drainage, excavation, fills, curbs, foundation and wearing surface, and in so bidding each would stand on its merit.

One prominent consulting engineer who is an expert in the legal phases as well as the engineering practice involving road and pavement construction, maintains that price and quality should be the sole consideration for competition in selecting any engineering construction, particularly a road or street surfacing material. He advocates also, the practice of filing copies of letters patent together with the specification and license agreements with the municipalities.

SUMMARY.

A short summary, perhaps not entirely complete, of the present methods of dealing with the patented pavements would be about as follows:

The type of pavement or road to be constructed may be selected: First, by petition from property holders, the size of petition being a local problem, this selection being made either previous to calling for bids or after the bids on several types have been opened; Second, by the engineers, acting with their municipal employes (council or commission), specifying a certain type or types, or by the selection of some one type after the bids are in on the several types considered.

The specifications adopted may be:

1st, those drawn entirely by the engineer representing the patentee in which case they usually make possible and embody the benefits derived from the extensive laboratory and practical experience of the proprietor.

2nd, by the mutual co-operation of the engineers representing the patentee and the municipality.

Each of these two sets of specifications should contain same standardized tests of quality of material to be used, in order to give some information for the guidance of the purchasing engineers.

In making provisions for the use of a patented pavement, license agreements should be filed with the municipality. The contractor should possess a somewhat similar licensee agreement before his bid is submitted.

This agreement to permit the city to benefit by the patent should be filed with the specifications for each separate bidding or contract and should stipulate a standard price for some definite quantitative unit measure of material at which price each and every contractor may obtain the article or the rights to construct the same. This price or royalty may be paid to the patentee either by the municipality or the contractor, if in which latter case it would appear as a constant, common to the bid price submitted by each bidder.

The method of calling for bids may be under that of "open specifications," "closed specifications," "alternate bids," or some other method peculiar to a given municipal or private organization.

The letting of the contract should be in accordance with the method of bidding, that is to the lowest responsible bidder, or according to the engineer's conscientious selection in which price and economy, quality and adaptability, are the sole and only influencing conditions.

From a careful study of the information and opinions contained in the communications received in response to the inquiries sent out, it is evident, if the opinions of those replying can be considered as representative of the common opinion of the men in charge of road and street construction in this country, that the greater majority are not opposed to the use of patented pavements, when the particular material is adaptable to the prevailing conditions, and sufficient competition can be had.

It is very certain that few engineers are so prejudiced against patents that they will not use a particular patented article when by doing so they can obtain better results, than with one not patented.

In other words, engineers in both public and private service are desirous of utilizing those products enabling them to secure the most economical and efficient results. This should certainly be the aim of every engineer as it is really the underlying principle of the engineering profession.

If the engineers and those for whom they are laboring are well served and their efforts made to show better results they are probably willing that the patentee as well as themselves should in a measure be benefited, and are in sympathy with the view expressed in the words of our renowned late Efficiency Engineer, Frederick W. Taylor, when he said, "All our inventions and changes are made to produce human happiness."

ACKNOWLEDGEMENT.

Reprint by M. T. Calef from A Thesis Submitted in Partial Fulfillment of the Requirements of the Graduate Course in Highway Engineering for the Degree of Master of Arts in the Faculty of Pure Science of Columbia University in the City of New York.

BUILDINGS

The Designing of Reinforced Concrete Beams: Some Data Tending to Show Errors in Present Theory and Practice.

(Staff Abstract.)

Practically all ordinances of American and European building authorities insist on the following assumptions and requirements for the design of reinforced concrete slabs and beams:

(1). Calculations shall be made with reference to working stresses and safe loads, rather than with reference to ultimate strength and ultimate loads.

(2). A plane section before bending remains plane after bending.

(3). The steel to take all the direct tensile stresses.

(4). The stress-strain curve of concrete in compression to be assumed a straight line.

(5). The ratio of the modulus of elasticity of the steel to the modulus of elasticity of the concrete shall be taken at 15 for a concrete mixture of 1:2:4.

(6). The extreme compressive stress of concrete in bending of a 1:2:4 mixture to be from 600 to 750 lbs. per square inch.

(7). The stress on mild steel in tension to be from 14,000 to 16,000 lbs. per square inch.

Computations according to above principles are not simple for slabs; they are even complicated for T-beams; and are unreliable for nearly all other shapes. The greatest faults, in the opinion of the writer, to be found with the above theory are that the results do not agree with actual tests, that it does not give to the designer any means of knowing what factor of safety his construction has, and that it prevents a sound development of the art of reinforced concrete construction.

The following data show the factors of safety obtained by this theory for three different percentages of reinforcement:

Percentage of reinforcement.	M/bd^2, computed.	M/bd^2, from tests.	Factor of safety.
½	73	209	2.85
1	118	386	3.27
2	140	648	4.63

These differences show that the accepted principles of designing reinforced concrete must be wrong, and, although great discrepancies between theory and test are found by nearly every experimenter, few have had the courage to discard, partially or in total, these theories which were evolved at the time when reinforced concrete was very little understood, and when very few scientific tests on reinforced concrete beams had been made. Many investigators hold that the limit of resistance of a beam is reached when the tensile stress of the reinforcement reaches the yield point of the material, which for mild steel is about 39,000 lbs. per square inch, and yet they advocate a safe unit stress of 16,000 lbs. per square inch on the tension reinforcement, evidently for no other reason than to obtain working formulas somewhat compatible with the results of their tests.

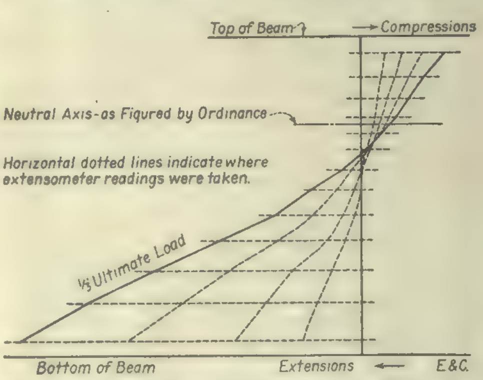


Fig. 1. Graphical Representation of Extensometer Readings Across Crack in a Reinforced Concrete Beam.

ERRORS IN THEORY.

This theory is wrong because:

(1). A plane section before bending is greatly distorted after bending. This was first discovered by Prof. Schule, of Zurich, in 1901, and later by other investigators by means of extensometer readings between horizontal points 2 to 6 ins. apart and at 5 to 13 positions in a vertical line on the height of the beam. These investigators found that the extension of the steel fibers was a multiple of that which it should be on the plane section theory. Figure 1 shows the deformations of the compression and the reinforcement fibers in a concrete beam 8 ins. deep, 15 ft. span, reinforced with 0.45 per cent of mild steel, the deformations being measured in a length of 2.4 ins. across a crack in the beam near its center. The test was made by R. Miller, of Leipsic, Germany.

(2). The ratio of the moduli of elasticity is 10 to 20 when no crack appears in the concrete, but where a crack is present (which is practically identical with the assumption of allowing no tensile stress in the concrete) the ratio varies and may be as low as from 1 to 1/10 near the ultimate load. That this is true becomes apparent by inspecting the stress-elongation curve for mild steel shown in Fig. 2. It will be noted that an increase in stress from 40,000 lbs. to 45,000 lbs. produces an elongation of 0.02 in., corresponding to a modulus of elasticity of $\frac{5{,}000}{0.02}$ = 250,000 lbs. per square inch, while the modulus of elasticity of concrete in compression near the ultimate load varies from 2,000,000 to 3,000,000 lbs.

(3). The stress diagram for concrete in the compression part of a beam is in most cases a parabola, and it often approaches a rectangle or a trapezoid. In every report on the tension failures of tests of reinforced concrete beams we find that the approaching failure was marked by vertical cracks, gradually increasing in width and height, thus diminishing the compression zone, but only rarely is the proper conclusion added that the beam really failed finally by compression in the concrete and at a stress in the reinforcement which is about a mean of the elastic limit and the ultimate strength.

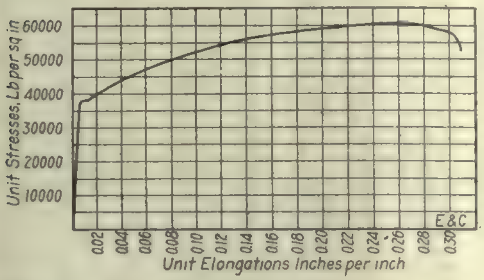


Fig. 2. Stress-Elongation Curve for Mild Steel.

THEORY BASED ON ULTIMATE STRESSES AND PARABOLIC DISTRIBUTION.

Adopting the parabolic stress diagram for concrete near the ultimate load; taking an ultimate stress in mild steel reinforcement of 45,000 lbs. per square inch, in commercial high carbon steel of 72,000 lbs. per square inch, and in high carbon drawn steel wire of about 110,000 lbs. per square inch; and, of course, disregarding the tensile strength of the concrete, the writer proposes to show that the formula derived from the *equilibrium conditions at the moment of failure* are very simple and agree exceedingly well with tests made both in this country and abroad.

Let f_c = ultimate strength of concrete in pounds per square inch, as shown in cylinder tests, and

f_s = ultimate stress of reinforcing steel in the sense explained above, all other notations being as given by the Joint Committee.

From Fig. 3 it is seen that:
Total compression = $\frac{2}{3}\,bkdf_c$.
Total tension = $pbdf_s$.

Since total compression and total compression are equal,

$$\tfrac{2}{3}bkdf_c = pbdf_s,$$

from which,

$$k = 1.5\,p\,\frac{f_s}{f_c} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$M = pbdf_s(d - \tfrac{3}{8}kd) = pbd^2f_s(1 - \tfrac{3}{8}k),$$

or,

$$\frac{M}{bd^2} = pf_s\,(1 - \tfrac{3}{8}k) \;\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

If f_c is taken from cylinder tests, k and M can immediately be found. In Table I and Table II the values of k and $\frac{M}{bd^2}$ for ultimate loads are given according to this theory for mild steel and for high carbon steel reinforcement, respectively.

The writer wishes to repeat that the yield point in the reinforcing bars is considerably exceeded at the ultimate load, and, therefore, in beams having several layers of reinforcing bars, the reinforcement stress will vary only very little, although the bars are placed at different distances from the neutral axis, and this requires that the theoretical depth of such a beam should be assumed as the distance of the center of gravity of the reinforcing bars from the top of the beam.

COMPARISON OF THEORY WITH RESULTS OF TESTS.

We shall now compare the ultimate coefficients of resistance given in the tables with the results of careful tests made by well known investigators, where the failure was clearly a tension failure without suspicion of approaching bond or diagonal tension failure. Technologic Papers of the Bureau of Standard, No. 2, contain the result of tests made by Richard L. Humphrey on 333 beams, 8x 11 ins. in cross section, reinforced by percentages of mild steel varying from ½ to 2, 13 ft. long, and tested on a 12-ft. span with symmetrical loads placed at one-third points. In some of the beams two layers of reinforcing bars were used, and, therefore, it will be necessary to use the distance of the center of gravity of the reinforcement from the top of the beam in order to obtain the correct percentages of the metal.

Although cinder concrete has a modulus of elasticity of about one-third that of gravel concrete, the cinder concrete beams were just as strong as those of gravel concrete of the same compressive strength, proving that the carrying capacity of a beam depends nearly entirely on the compressive strength and not on the value of n (see Table III). There are very few test data published showing pure tension failures, and lack of time compels the writer to confine the proofs to the tests he has at hand.

E. Mörsch, in his "Eisenbetonbau," 4th Edition, 1912, gives, on page 167, a test on a beam of 80 ins. span reinforced with 1.4 per cent of mild steel. The compressive strength of the concrete was exactly 2,000 lbs. per square inch, and the beam failed at a value of M/bd^2 = 528, while the table gives M/bd^2 = 506.

In 1910, A. N. Talbot made tests on 8x12-in. beams, 6 ft. 6 ins. long, tested with symmetrical loads at one-third points of a 6-ft. span. The beams were reinforced with 1.61 per cent of high carbon corrugated bars, portions of which were bent up and connected to a vertical and inclined stirrup system. The center of gravity of the reinforcement was 10 ins. below the top of the beam. The beams 284.1, 284.3, 284.5, 284.6, 284.7, failed at an average ultimate load of 52,400 lbs., or a moment of $\frac{52{,}400}{2} \times 24$ = 628,800 in.-lbs., or M/bd^2 = 786, while the table for 2,000-lb. concrete gives 780.

In Bulletin No. 29 of the University of Illinois, on page 69, beam No. 223.1, 8x11 ins., reinforced with 1.25 per cent of high carbon steel, span 6 ft., loaded at one-third points, failed in tension at a load of 43,300 lbs., corresponding to a moment of $\frac{43{,}300}{2} \times 24$ = 519,600 in.-lbs., or M/bd^2 = 649.5, while the table gives 670.

At the Massachusetts Institute of Technology tests were made in 1901 on beams 8x12 ins. in section, on a 11-ft. span, loaded at the one-third points. The reinforcing consisted of twisted bars, and varied from 0.31 to 3.9 per cent; only a few tension failures were recorded, and these are shown in Table IV. It is clear that the trap rock concrete must have been of excellent quality, and it is probable that the smaller sized twisted bars had a much higher yield point and ultimate strength than ordinary high carbon bars.

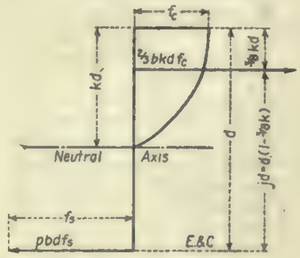


Fig. 3.

TABLE I.—ULTIMATE VALUES FOR M/bd² AND k FOR HIGH CARBON STEEL.

Ultimate strength of concrete	1000		1500		2000		2500		3000		3500		4000		4500		5000	
k=p times	108		72		54		43.25		36		31		27		24		21.6	
Per cent of steel—	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k
.25	162	.270	168	.180	171	.135	173	.108	174	.090	175	.078	175	.068	176	.060	176	.054
.30	190	.324	198	.216	203	.162	206	.130	207	.108	208	.093	210	.081	210	.072	211	.064
.35	216	.378	228	.252	234	.189	238	.151	240	.126	242	.108	243	.095	244	.084	245	.075
.40	242	.432	258	.288	264	.216	270	.173	272	.144	275	.124	277	.108	278	.096	279	.086
.45	265	.487	285	.324	294	.243	301	.195	305	.162	307	.140	310	.121	312	.108	313	.097
.50	287	.540	311	.360	323	.270	330	.216	336	.180	339	.155	342	.135	344	.120	345	.108
.55	308	.594	338	.396	352	.297	361	.238	366	.198	371	.171	374	.148	377	.134	379	.119
.60	327	.648	362	.432	380	.324	390	.260	397	.216	402	.186	406	.162	409	.144	412	.129
.65	345	.702	385	.468	406	.352	419	.281	426	.234	432	.201	438	.175	441	.156	443	.141
.70	361	.756	409	.504	433	.378	446	.303	456	.252	463	.217	468	.189	472	.168	475	.151
.75	377	.810	431	.540	457	.405	474	.325	485	.270	493	.233	499	.202	504	.180	506	.162
.80	390	.865	453	.576	484	.432	502	.346	515	.288	522	.248	530	.216	535	.192	539	.173
.85	....	....	472	.612	507	.459	528	.368	542	.306	552	.264	560	.230	566	.204	570	.184
.90	....	....	491	.648	530	.486	553	.389	570	.324	581	.279	589	.243	596	.216	601	.194
.95	....	....	509	.684	553	.513	580	.411	596	.342	609	.295	619	.256	625	.228	631	.205
1.00	....	....	526	.720	575	.540	603	.432	622	.360	636	.310	647	.270	655	.240	661	.216
1.10	....	....	558	.792	616	.594	651	.476	675	.396	691	.341	704	.297	713	.264	722	.238
1.20	....	....	585	.864	655	.648	696	.519	723	.432	748	.372	760	.324	770	.288	780	.259
1.30	....	....	....	....	690	.702	741	.562	773	.468	795	.403	815	.351	827	.312	838	.281
1.40	....	....	....	....	722	.756	780	.606	819	.504	845	.434	865	.378	882	.336	891	.310
1.50	....	....	....	....	753	.810	819	.649	863	.540	894	.465	915	.405	935	.360	950	.324
1.60	....	....	....	....	780	.864	857	.682	904	.576	939	.496	965	.432	990	.384	1004	.345
1.70	....	....	....	....	....	....	886	.736	945	.612	983	.527	1015	.459	1039	.408	1057	.367
1.80	....	....	....	....	....	....	920	.779	985	.648	1028	.558	1064	.486	1088	.432	1110	.389
1.90	....	....	....	....	....	....	946	.822	1018	.684	1065	.589	1105	.513	1132	.456	1158	.411
2.00	....	....	....	....	....	....	975	.865	1052	.720	1105	.620	1150	.540	1182	.480	1209	.432
2.25	....	....	....	....	....	....	....	....	1130	.810	1195	.698	1250	.608	1290	.540	1325	.486
2.50	....	....	....	....	....	....	....	....	....	....	1276	.775	1345	.675	1395	.600	1435	.540
2.75	....	....	....	....	....	....	....	....	....	....	1348	.853	1428	.743	1490	.660	1540	.596
3.00	....	....	....	....	....	....	....	....	....	....	....	....	1505	.810	1580	.720	1640	.648
3.50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1725	.840	1810	.755
4.00	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1950	.864

TABLE II.—ULTIMATE VALUES FOR M/bd² AND k FOR MILD STEEL.

Ultimate strength of concrete	1000		1500		2000		2500		3000		3500		4000		4500		5000	
k=p times	67.5		45		37.5		27		22.5		19.3		16.875		15		13.5	
Per cent of steel—	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k	M/bd²	k
.25	105	.168	108	.112	108	.095	109	.067	110	.056	110	.048	111	.042	111	.038	111	.034
.30	124	.202	128	.135	129	.112	131	.081	132	.067	133	.058	133	.051	133	.045	133	.041
.35	143	.236	148	.1575	149	.132	152	.094	153	.079	153	.067	154	.059	154	.053	155	.047
.40	161	.270	168	.180	170	.150	173	.108	174	.090	175	.077	175	.068	176	.060	177	.054
.45	179	.304	187	.202	190	.168	193	.125	195	.102	196	.087	197	.076	197	.068	198	.061
.50	196	.337	206	.225	209	.187	213	.135	216	.1125	217	.096	218	.084	219	.075	219	.068
.55	213	.372	224	.247	228	.206	233	.148	236	.123	238	.106	239	.093	240	.083	241	.074
.60	229	.405	242	.270	247	.225	253	.162	256	.135	258	.116	260	.102	261	.090	261	.081
.65	245	.439	261	.292	266	.244	274	.176	277	.146	279	.126	281	.110	282	.098	283	.088
.70	259	.473	278	.315	284	.262	292	.189	296	.157	298	.135	301	.118	302	.105	303	.095
.75	273	.506	295	.337	302	.281	312	.202	315	.169	320	.145	322	.126	324	.113	325	.103
.80	287	.540	311	.360	319	.300	330	.216	335	.180	339	.155	341	.135	344	.120	345	.108
.85	300	.574	328	.382	337	.319	349	.230	355	.191	359	.164	362	.143	364	.128	366	.115
.90	313	.608	343	.405	349	.337	368	.243	374	.202	379	.174	382	.152	384	.135	386	.122
.95	325	.642	358	.427	370	.356	386	.257	394	.214	399	.184	401	.160	406	.143	407	.128
1.00	338	.675	375	.450	386	.375	404	.270	412	.225	418	.193	422	.169	425	.150	427	.135
1.10	358	.742	403	.495	420	.412	440	.297	450	.247	455	.213	461	.186	465	.165	467	.149
1.20	376	.810	431	.540	449	.450	475	.324	485	.270	493	.232	498	.203	504	.180	506	.162
1.30	393	.878	457	.585	478	.487	507	.351	521	.292	530	.257	537	.219	542	.195	546	.176
1.40	....	....	481	.630	506	.525	540	.378	562	.315	565	.270	575	.236	580	.210	585	.189
1.50	....	....	505	.675	533	.562	573	.405	590	.337	602	.290	612	.253	617	.225	625	.202
1.60	....	....	526	.720	558	.600	603	.432	623	.360	637	.309	647	.270	655	.240	663	.216
1.70	....	....	546	.765	583	.637	635	.459	656	.382	671	.328	682	.287	693	.255	700	.230
1.80	....	....	565	.810	605	.675	663	.486	686	.405	705	.347	719	.304	728	.270	735	.243
1.90	....	....	580	.855	628	.712	690	.513	719	.427	736	.367	751	.321	756	.285	773	.251
2.00	....	....	....	....	648	.750	719	.540	748	.450	770	.386	784	.337	798	.300	809	.270
2.25	....	....	....	....	693	.843	782	.608	822	.505	850	.435	870	.380	885	.338	900	.304
2.50	....	....	....	....	....	....	840	.675	888	.562	920	.483	948	.422	966	.375	935	.338
2.75	....	....	....	....	....	....	894	.743	940	.617	990	.531	1025	.464	1047	.412	1065	.372
3.00	....	....	....	....	....	....	940	.810	1020	.675	1060	.580	1095	.506	1122	.450	1145	.405
3.50	....	....	....	....	....	....	....	....	1120	.784	1180	.675	1225	.590	1265	.525	1295	.473
4.00	....	....	....	....	....	....	....	....	1191	.900	1280	.772	1345	.674	1395	.600	1438	.540
4.50	....	....	....	....	....	....	....	....	....	....	1365	.868	1450	.758	1520	.675	1560	.607
5.00	....	....	....	....	....	....	....	....	....	....	....	....	1540	.842	1620	.750	1680	.675
5.50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1720	.825	1790	.742
6.00	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1880	.810
6.50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1965	.878

Comparing the data in the two tables we find that for the same percentage of reinforcement and for the same compressive strength of concrete the ultimate M/bd^2 is over 50 per cent greater for high carbon steel than for medium steel. All specifications calling for the use of medium steel invite, therefore, a considerable waste of money, and granting even that high carbon steel is not as reliable as mild steel, the chances are very remote that one-third of the steel rods are faulty and that all faults should occur at the same point in the beam. The old theory leads us to believe that beams reinforced with more than 1 per cent of high carbon steel, or 1½ per cent of mild steel, failed in compression and that the steel stress at failure did not reach even the elastic limit. The new theory claims that all beams designed according to Tables I and II will fail in compression and tension simultaneously, although the deformation of the steel fibers is much greater than that of the compression fibers, making observers liable to call all failures tension failures.

When the reinforcement greatly exceeds the percentages given in the lower portion of the tables, the steel will no longer reach the stresses of 45,000 or 72,000 lbs., at the time of failure, and we will have a true compression failure, viz.: a failure of a concrete beam where nearly the entire portion of the beam above the tension reinforcement is in compression and where crushing of the compression part will take place before the steel fibres indicate approaching failures. The limiting amount of reinforcing between a simultaneous compression and tension failure and a true compression failure, we call the *balanced reinforcement*, and we claim that the carrying capacity of a beam cannot be increased by increasing this balanced reinforcement, as such an increase has only the effect to decrease the steel stress, but cannot in the nature of the case increase f_c nor can it increase kd because balanced reinforcement is reached when $kd = d$, which is the maximum possible value, as shown in Fig. 4. From equation (1), $k = 1.5pf_s/f_c$. Here $k = 1$; hence the balanced reinforcement p is expressed by the equation:

$$p = f_c/1.5f_s \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

and

$$M = \tfrac{2}{3}bdf_c \times \tfrac{5}{8}d = \frac{10}{24}bd^2f_c,$$

or

$$M/bd^2 = f_c/2.4 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

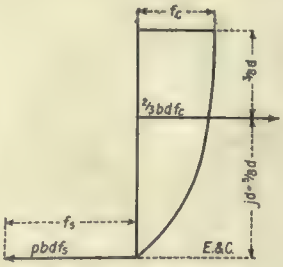


Fig. 4.

TABLE III.—COMPARING TESTS BY RICHARD L. HUMPHREY WITH TABLE II.

Nominal reinforcing, per cent	½	¾	1	1¼	1½	1¾	2
Number of ½-in. round bars	2	3	4	5	6	7	8
Number of layers	1	1	1	2	2	2	2
Theoretical d	10.00	10.00	10.00	9.4	9.25	9.35	9.25
Actual per cent	0.49	0.74	0.98	1.30	1.59	1.84	2.13
fc for limestone concrete at 13 weeks	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Average ultimate load	6,150	8,640	11,700	13,260	15,130	18,060	20,670
Max. M/bd² from test	208	284	375	476	560	647	753
Max. M/bd² from Table II	213	315	410	530	633	717	810
Variation, per cent	2.3	10.	8.5	10.	11.5	10.	7
fc for gravel concrete at 4 weeks	2,567	2,567	2,567	2,567	2,567	2,567	2,567
Average ultimate load	6,140	9,220	12,450	13,760	15,490	17,890	20,070
Max. M/bd² from test	208	301	397	494	572	640	733
Max. M/bd² from Table II	209	308	397	507	600	673	750
Variation, per cent	0	2.3	0	2.4	4.7	4.7	2.3
fc for cinder concrete at 26 weeks	2,525	2,525	2,525	2,525	2,525	2,525	2,525
Average ultimate load	6,460	9,450	12,810	13,600	15,320	17,180	19,810
Max. M/bd² from test	213	303	406	483	560	610	716
Max. M/bd² from Table II	209	308	397	507	600	673	750
Variation, per cent	1.9	1.6	2.3	4.7	7.	9.4	4.8

Prof. Mörsch made a companion test to that previously mentioned, which differed only in the percentage of the reinforcement, the latter being 3.3 per cent. The moment at failure was 97,000 in.-lbs.; $b = 9.8$ ins., $d = 3.55$ ins., $M/bd^2 = 784$, while, according to formula (4), $f_c/2.4 = \frac{2,000}{2.4} = 833$.

It may be expected that formula (4) gives higher values, because k really can never reach the value 1.

We can obtain a better agreement with tests by assuming for balanced reinforcement,

$$M/bd^2 = f_c/2.6 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

which corresponds to $k = 0.84$ and a balanced reinforcement,

$$p = f_c/1.78f_s \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

For this rule in the above case $M/bd^2 = 780$.

Prof. Mörsch also mentions, on page 172 of his book, tests made by Prof. Bach, of Stuttgart, on beams reinforced with 7.1 per cent of concrete having a compressive strength of only 1,620 lbs. per square inch. The balanced reinforcement in this case would be, according to formula (6), only $\frac{1,620}{1.78 \times 45,000} = 0.02$; and if our theory is correct this highly over-reinforced beam should not carry any more load than if reinforced with only 2 per cent; and indeed we find that this beam failed at an ultimate $M/bd^2 = 644$, while, according to formula (5), for balanced reinforcement, $M/bd^2 = \frac{1,620}{2.6} = 680$.

Replacing in formula (5) f_c by the tensile strength of the concrete f_t, we obtain an expression for the ultimate bending moment of a plain concrete beam,

$$M = bd^2f_t/2.6 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

while the commonly quoted expression for this moment, using the so-called modulus of rupture S (which should be the tensile strength of the concrete) is $M = \frac{bd^2}{6}S$; on the other we know that for a good grade of concrete $M/bd^2 = 100$, hence $f_t = 260$ lbs. per square inch, and $S = 600$ lbs. per square inch.

TABLE IV.—DATA ON TESTS AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Beam.	3	4	5	6
Per cent of reinforcement	.31	.70	.96	1.25
Ultimate moment (1,000 in.-lb.)	268.4	470.5	549.3	580.8
M/bd² from test	335	587	686	725
M/bd² from Table I	213	456	601	748

Inasmuch as the value f_t obtained by for-

TABLE V.—RESULTS OF TESTS OF BEAMS HAVING DOUBLE REINFORCEMENT.

Beam.	Reinforcement—Top—Bottom.	Ultimate moment (1,000 in.-lbs.).	Increase of ultimate moment over "a." (1,000 in.-lbs.).	Unit stress in top reinforcing.
a	none 4-3 cm. round mild steel	342.5	0	.....
b	2-1 cm. round mild steel 4-3 cm. round mild steel	419.5	77	41,500
d and e	2-2 cm. round mild steel 4-3 cm. round mild steel	577.5	235	31,500
f	2-2 cm. round high carbon 4-3 cm. round mild steel	717.5	375	50,400

mula (7) agrees with direct tension tests, formula (7) should be accepted as a proper rule for the design of plain concrete beams.

We will now further check our theory by tests made on reinforced concrete beams, having also compressive reinforcement. Again inspecting Fig. 2, we find that after mild steel is stressed beyond the yield point, the modulus of elasticity decreases very rapidly, and n approaches the value 1, very soon after the yield point is acceded. Therefore, we cannot expect that compression steel will take up at the ultimate load a higher stress than the yield point of the material. This is clearly shown by the tests, mentioned by Prof. Mörsch, on page 174 of his book on beams reinforced with 7.1 per cent in tension and with ⅝-in. and ¾-in. bars of mild and high carbon steel in compression, as shown in Table V.

Often the bars of small diameter have a higher yield point, which explains the higher steel stress in beams b than in beams d and e. It also shows that we can safely figure for mild steel on an ultimate stress in compression of 32,000, and for high carbon steel of 50,000 lbs. per square inch.

Bearing in mind that the mild steel reinforcing at the time of failure is stressed to about 32,000 lbs., we obtain from Fig. 5 the following equilibrium conditions for the beams reinforced also on the compressive side at the ultimate load,

$$\tfrac{2}{3}bkdf_c + A_c 32{,}000 = pbdf_s$$

or,

$$k = 1.5\frac{f_s}{f_c}p - 48{,}000\,\frac{A_c}{f_s bd} \;\ldots\ldots\ldots\ldots\ldots(8)$$

and

$$M = \tfrac{2}{3}f_c bkd\,(d - \tfrac{3}{8}kd) + 32{,}000\,A_c d' \,..(9)$$

In Bulletin No. 2, Vol. 4, Engineering Series, University of Wisconsin, M. O. Withey gives, on page 89, the results of four beams reinforced with 2.9 per cent on the tension side, and with 1 and 1½ per cent of mild steel on the compression side. Beams W failed at an average ultimate moment of 814,500 in.-lbs., and their concrete test cylinders failed at 2,600 lbs. per square inch.

$A_c = 0.784$ sq. in., $f_s = 45{,}000$ lbs., $f_c = 2{,}600$ lbs.

$b = 8$ ins., $d = 9\tfrac{3}{4}$ ins., $d' = 8\tfrac{1}{2}$ ins.

From formulas (8) and (9) we have:

$$k = 1.5 \times \frac{45{,}000}{2{,}600} \times \frac{2.9}{100} - \frac{48{,}000}{2{,}600} \times \frac{0.784}{8 \times 9\tfrac{3}{4}}$$
$$= 0.753 - 0.185 = 0.568,$$

and

$$M = \tfrac{2}{3} \times 2{,}600 \times 8 \times (9\tfrac{3}{4})^2 \times 0.568\,(1 - 0.213) + 32{,}000 \times 0.784 \times 8\tfrac{1}{2}$$
$$= 588{,}000 + 213{,}000 = 801{,}000 \text{ in.-lbs.}$$

showing a very close agreement.

Beams X had 1½ per cent top reinforcement and were of poorer concrete, having an average compressive strength of only 1,515 lbs. per square inch.

From formulas (8) and (9) we have again:

$$k = 1.5 \times \frac{45{,}000}{1{,}515} \times \frac{2.9}{100} - \frac{48{,}000}{1{,}515} \times \frac{1.176}{8 \times 9\tfrac{3}{4}}$$
$$= 1.293 - 0.477 = 0.816,$$

and

$$M = \tfrac{2}{3} \times 1{,}515 \times 8 \times (9\tfrac{3}{4})^2 \times 0.816\,(1 - 0.306) + 32{,}000 \times 1.176 \times 8\tfrac{1}{2}$$
$$= 433{,}000 + 320{,}000 = 753{,}000 \text{ in.-lbs.}$$

while the average moment of both beams is 808,000 in.-lbs., or a difference of only 7 per cent.

In regard to the design of T-beams, the latest European tests made by Prof. Bach, in behalf of the German *Jubiläum's Stiftung*, indicate that we can safely count on the flange acting together with the stem, when the width of the flange is less than about one-third of the span of the beam and when the projection on one side is less than seven times the slab thickness; only for such high ratios of projection to flange thickness it is absolutely necessary to provide reinforcement in the slab at right angle to the span. Where the value of kd of the inclosing rectangle of flange and stem is less than the thickness of the flange, our tables directly apply; for larger value of kd, it is common and safe practice to assume that the compressive stress is uniformly distributed over the flange and that the ultimate load may be found by multiplying the entire tension (steel area times 45,000 and 72,000 lbs. respectively) by the distance from the center of reinforcing to the center of flange.

It must be borne in mind that this theory assumes only pure tension and compression failures, which as a rule can be always counted upon in beams, where the shearing values at the ultimate load are not larger than about 150 lbs. per square inch. Where the ultimate shear values much exceed 150 lbs., it is absolutely necessary to make ample provision to overcome premature bond and diagonal tension failures; this is best done by bending up one-half the number of bars in various planes and by using an ample number of stirrups; and in case of non-continuous beams, by providing large hooks at the end of the bars.

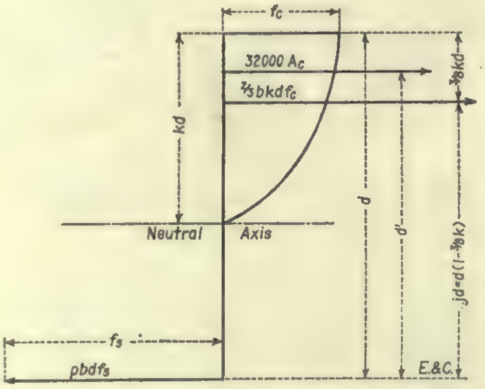


Fig. 5.

Where a high percentage of reinforcement is used, the table shows that there is quite a great difference in the carrying power of the beam for the various grades of concrete, and the writer advises not to count a higher ultimate strength, under expert supervision, than: 2,000 lbs. on well graded 1:2:4 concrete; 3,000 lbs. on well graded 1:1½:3 concrete; 4,000 lbs. on well graded 1:1:2 concrete; 5,000 lbs. on well graded 1:1:1 concrete; while 25 per cent less should be used where the concrete materials are not so well graded.

ACKNOWLEDGMENT.

The foregoing data and discussion were taken from a paper by L. J. Mensch, in Journal of American Concrete Institute for December, 1914. A number of errors in the article as originally printed have here been corrected.

Design, Construction and Cost of a 137-ft. Reinforced Concrete Chimney at Coldwater, Mich.

(Staff Abstract.)

The following data refer to a reinforced concrete chimney built at the plant of the Municipal Light and Waterworks, Coldwater, Mich. Before deciding upon the type of chimney, an investigation was made to determine the first cost, the cost of repairs, and the durability of chimneys constructed of brick, steel and reinforced concrete. As time was an important factor the following bidding requirement was made:

> The successful bidder shall ship tools within ten days after signing the contract, the unloading of tools and material to be done by the purchaser on arrival. Forty days will be allowed for the completion of the stack after the arrival of tools, due allowance being made for weather when it will be impossible to work; $15 per day will be deducted from the amount of the contract for each and every day over and above this time until the stack is completed.

DETAILS OF DESIGN.

As built, the chimney has a total height of 137 ft., an inside diameter at the top of 6 ft., an outside diameter at the top of 6 ft. 10 ins., and an outside diameter at the bottom of 10 ft. The reinforced concrete lining extends to a height of 40 ft. 6 ins., the thickness of this lining being 4 ins., with an air space of 4 ins. between it and the chimney proper. The reinforced concrete foundation has a thickness at its center of 3 ft. 6 ins. and at its outer edge of 1 ft. 6 ins.

The reinforcement in the foundation consists of two layers of bars. The lower layer is placed 4 ins. about the base of the footing, and the upper layer 10 ins. above the lower one. The ¾-in. square twisted bars in the lower layer are placed diagonally, the bars being spaced 12 ins. on centers. The bars in the upper layer are of the same size, these bars being placed parallel to a side on 24-in. centers.

The vertical reinforcement of the chimney consists of ¾-in. square twisted bars, the first set of bars being bent to hook outward under the lower layer a distance of 12 ins. Different lengths of bars were used, and the joints were broken so that the splices did not all come in one form. Beginning at the base, the length of each section and the number of bars used in each are as follows: 7 ft., 72 bars; 12 ft., 62 bars; 15 ft., 52 bars; 15 ft. 42 bars; 18 ft., 32 bars; 20 ft., 22 bars; and 50 ft., 12 bars. The circular reinforcement consists of the American Steel & Wire Co.'s No. 23 triangular mesh, extending the entire height of the chimney.

The shaft around the smoke opening, which is 5 ft. wide by 7 ft. high, is reinforced above and below with three extra rings of ½-in. round bars and on each side with four extra ¾-in. square twisted bars. The head is reinforced with four additional rings of ½-in. round bars. At the top of the lining a shoulder was cast on the outer shell, which projects inward over the top of the lining and 4 ins. above it. This was built to prevent soot from filling the air space, the shoulder being reinforced with two extra rings of ½-in. round rods. The concrete lining is reinforced with twelve vertical ½-in. round bars extending the entire height of the lining.

CONSTRUCTION FEATURES.

The bottom of the footing is 7 ft. below grade, the excavation extending about 4 ins. into a bed of gravel, which was found to give sufficient bearing power.

A 1:3:6 concrete was used in the foundation, and a 1:2:4 concrete in the chimney proper. Pit-run gravel was used, as an excellent quality was obtainable. An inspector was constantly on the work, and care was taken to exclude all stones larger than a small egg, especially those of irregular shape. The inspector was furnished with tabular data giving the quantities of materials required for each form, and rigid inspection was insisted on.

The outer surface of the chimney was made smooth by the constant use of a spading bar. At the start the men were required to repair several rough places on the outside of the chimney, which resulted in a proper use of the spading bar thereafter.

The concrete for the chimney shaft was mixed by hand, while that for the foundation was machine mixed. In hoisting the concrete a rope and bucket were used, a horse being used for power.

All scaffolds were built inside of the chimney. They consisted of four upright posts, each made of two 2 x 4-in. x 16-ft. timbers. The ends were butted together and were nailed with 16d spikes, the joints being broken. Around the outside of the four posts, level with the top of the form to be filled, 2 x 4-in. pieces were spiked, the working platform resting on these. Another set of 2 x 4-in. pieces were placed at a sufficient height to support the sheaves, in order that the concrete could be placed by means of short chutes.

The bucket in which the concrete was hoisted was filled by means of a chute through the clean-out door, the mixing platform being just outside and level with this door.

The forms were constructed of 2-in. lumber, in sections 6 ft. high, the sections being raised to position with ropes.

The chimney was completed in 32 days from the time the foundation was started.

COST DATA.

The following data give the approximate cost of the chimney to the contractor, the wages of the foreman and the assistant foreman being estimated at $6.00 per day each:

Foreman, 29 days at $6.00	$174.00
Assistant foreman, 35 days at $6.00	210.00
Common labor, 410 hrs. at 20 cts.	82.00
Material: Sand, gravel, cement and reinforcing steel	350.00
Lumber	30.00
Pouring of foundation	25.00
Freight on tools	52.02
Use of horse for hoisting concrete, 23 days at $1.00	23.00
Total	$946.02

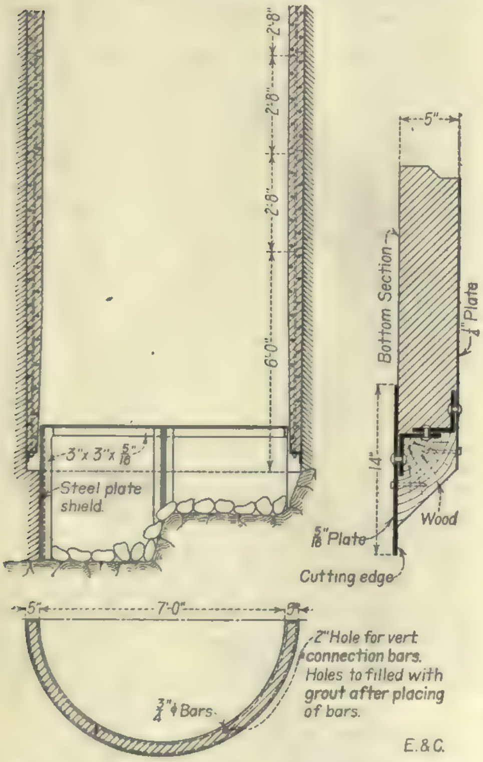


Fig. 2. Details of Reinforced Concrete Well Used in Constructing Foundation for Bank Building in Stockholm, Sweden — Note Steel Shield Used Where Rock Surface Was Uneven.

The above data do not include transportation for the men, insurance, or depreciation on forms or tools, the total cost of which did not exceed $100. The contract price of the chimney was $1,725.

ACKNOWLEDGMENT.

The foregoing article is based on data contained in a paper by Keller E. Morton, presented before the annual meeting of the Michigan Engineering Society.

Novel Method of Excavating for the Foundation of a Bank Building in Stockholm, Sweden.

Contributed by K. P. Billner, Chicago, Ill.

The following data refer to some interesting and novel methods used in constructing the foundation for the Private Bank of Stockholm's new building in Stockholm, Sweden, the data being taken from the engineering publication, "Tecknish Tidskrift."

Careful test borings were made at the site of the building, and along the south boundary bedrock was found at a depth of from 10 to 12 ft. below the street level. In other places, however, solid rock was found at a depth as great as 60 ft. below the street level, or 45 ft. below the ground water level. The rock surface sloped off from the south boundary, the slope in some places being as steep as 2 to 1. It was originally planned to found the structure on concrete piles, but this plan was abandoned due to the fear that piles might slip. It was finally decided to carry down a foundation wall of concrete where bedrock was close to the surface and to use concrete piers resting on bedrock for the remainder of the foundation. Figure 1 is a foundation plan of the building showing contour lines of the underlying rock surface.

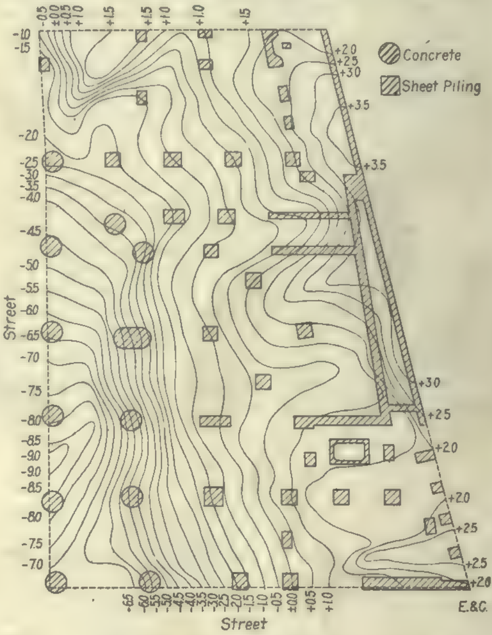


Fig. 1. Profile of Rock Surface and Plan of Foundation for Bank in Stockholm, Sweden.

Where the depth to bedrock was not greater than 15 ft. below water level the common method of excavating within sheet piling, and pumping out the water, was employed. At depths greater than 15 ft., however, it was found impossible to pump out the water, as the foundation material consisted principally of water-bearing sand and gravel. Moreover, it was deemed unsafe to lower the natural water level for fear of settlement of the adjacent property.

For the deep piers, 13 in number, it was first proposed to sink concrete wells and to employ divers for excavating. Another method considered was to sink caissons and to use compressed air in excavating. As it was decided that both of these methods would prove slow and expensive, the following method was adopted:

Sectional wells of reinforced concrete were constructed, circular in form, each section having an inside diameter of 7 ft., a height of 2 ft. 8 ins., and a thickness of 5 ins. The sections were provided with recesses and with vertical bars for fastening them together. The bottom section was provided with an inside lining of ¼-in. sheet iron, to protect it while the rock surface was being leveled by blasting. Figure 2 shows details of a reinforced concrete well and of the cutting edge for same. The drawing also shows the steel shield which was used where the rock surface was uneven.

While the wells were being lowered the material (which consisted mainly of sand and gravel, although clay and boulders were encountered), was pumped by means of a centrifugal pump and a suction hose, the material at the bottom being loosened at the same time by means of a water jet, the pipe for which was connected to a water main in an adjoining street. Both the suction hose and the water jet were operated by a diver at the bottom of the well. The excavated material was delivered from the centrifugal pump to a settling basin, from which the water was drained off over weirs and conducted back through a flume to the well. Figure 3 shows a plan and elevation of the equipment and illustrates the procedure used in excavating for the deep piers.

The sinking of the wells was facilitated by the piling up of a number of sections, but it was found that shaking the sections gave far better results. This shaking effect was accomplished by setting a motor-driven air compressor on top of the well. This compressor, which was used to furnish air for the drilling machines, vibrated considerably, and the results obtained by its use in this manner were gratifying.

The material to be excavated was impregnated with stones and boulders, the volume of some of which was 2 cu. yds. The large stones and boulders were hoisted, but stones as large as 4 ins. in diameter were brought up in large quantities through the suction hose and pump, the latter withstanding this severe test surprisingly well.

When the lower edge of the caisson had encountered rock, careful soundings were made to determine the shape and slope of the rock surface, and a plate shield (see Fig. 2) was cut to the shape of the rock profile. This shield was bent to fit the inside of the concrete well and was driven down as the excavation proceeded.

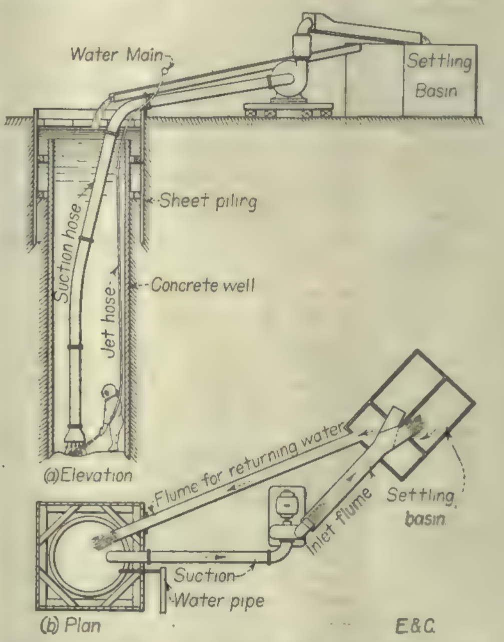


Fig. 3. Plan and Elevation Showing Arrangement of Equipment Used in Excavating Deep Foundations for Bank Building in Stockholm, Sweden.

The exposed rock was drilled by divers, using "Atlas" pneumatic drills, and a foundation of horizontal steps was obtained by blasting. The wells were then filled with 1:2:3 and 1:3:3 concrete, deposited under water. The methods used for this work proved to be both rapid and economical.

GENERAL

Cost, Appearance and Wearing Qualities of Various Methods of Surface Finish for Concrete.

(Staff Abstract.)

The following data on the cost, appearance and wearing qualities of various methods of surface finish for concrete were compiled by Sub-Committee D of the Committee on Masonry of the American Railway Engineering Association. Requests for information on this subject were sent to the various railway companies, and the data are based on 52 replies received.

A review of the answers received gives the following methods as most generally used:

(1) SPADING, TO WORK COARSE AGGREGATE AWAY FROM FORM AND BRING MORTAR AGAINST IT.

This method is the one generally used, and where decorative treatment is not necessary furnishes the best finish at the least expense. The surface is generally smooth and nearly impervious to moisture, and its wearing qualities are equal, if not superior, to those of any other method.

(2) COATING WITH A WASH OF CEMENT.

A wash usually of 1 part cement and 1 part sand is applied with a brush after the forms are removed. This fills up the pores and covers the small inequalities and wood grain marks and gives a smooth surface of even finish and uniform color. This film of mortar, however, is liable to become checked and hair-cracked and often scales; for this reason it is not generally used.

(3) RUBBING.

There are several methods of treatment, as follows:

(a) The forms are removed as early as practicable, prominent joint marks chipped off, and the surface thoroughly wet and rubbed with a cement mortar or carborundum brick.

(b) After the forms are removed, the surface is rubbed with wooden floats, keeping the surface well flushed with water during the rubbing and thoroughly washing after the rubbing is completed. The earlier the rubbing is done the better the results. The rubbing removes most of the inequalities; it fills the pores and small cavities, and gives the surface a uniform finish and appearance, and does not flake or scale.

(4) REMOVING OUTSIDE MORTAR TO EXPOSE COARSE AGGREGATE.

There are several methods of accomplishing the result, all dependent on the use of a surface finish or coating at least 1 in. thick, composed of prepared aggregate, which coating is deposited as the placing of the concrete proceeds:

(a) Wash the surface immediately after the forms are removed, exposing the aggregate, which is usually done by scrubbing with stiff brushes of either bristle or wire, and water, rinsing the surface clean, keeping it moist and protected from the sun for about three days.

(b) Treat the surface with an acid, usually commercial hydrochloric and nitric. The acid attacks the cement and exposes the aggregate. The amount of dilution of the acid is usually obtained by experiment and varies with the age of the concrete.

(c) Removing the outer skin by means of a sand blast: This method has not generally proven successful, as it is very difficult to obtain a uniform surface.

(5) TOOLING SURFACE OF CONCRETE WITH CRANDALL, BUSH-HAMMER, ETC., AFTER REMOVAL OF FORMS.

This method, applied to the extent of cutting slightly into the aggregate, produces a very attractive surface, and it is the experience of many engineers that for work in which the best possible appearance is desired, bush-hammering provides the desired results at a minimum cost. The best results are produced with spaded surfaces or those composed of special aggregate.

(6) SCORING.

Scoring the surface by means of a system of horizontal and vertical V-shaped battens placed on the forms to break up the flat appearance, to make a line designating the completion of the days' work, to indicate expansion joints or to produce the effect of courses.

(7) METAL FORMS.

Forms of metal or wooden forms lined with metal give a smoother surface than bare wood. The spading is done in the same manner as with wooden forms to push the aggregate back from the face. In doing this an excess or thin skin of rich mortar is brought to the surface of the concrete, and is liable later to develop checks and hair-cracks and become unsightly.

ABSTRACTS OF REPLIES.

The accompanying data are abstracts of some of the replies received, the replies being based on the following requests:

(1) What methods of finishing surfaces of concrete work have you used? Give specifications of each method used.

(2) State object desired in finishing and results obtained as to appearance and wearing qualities.

(3) State the cost of the work per square foot (labor and material) for each method.

(4) Please state your opinion as to the best manner of finishing a concrete structure. Do you believe the concrete surface should be left untreated, or should it be tooled, scraped, or treated with an acid?

(5) Is it your experience that where the natural surface of concrete is treated it is more susceptible to discolorations from smoke and the weather?

(6) Remarks.

In these abstracts, reference numbers refer to the above six items.

A. W. BUEL, CONSULTING ENGINEER, NEW YORK CITY.

(1) (a) Rice water wash: 1 bbl. lime, slacked, making 3 bbls. slacked + 25 lbs. salt + 10 lbs. rice, boiled and strained. Add chrome and ochre to give desired tint and put on like whitewash. It will not rub off.

(b) Carborundum wheels: Carborundum wheels on a mandrel driven by electric motor will duplicate six-cut work or four-cut work. If worked on concrete three to six days old can be done very rapidly.

(2) (a) Gives uniform surface of pleasing appearance.

(b) Gives a cut-stone appearance, not imitation stone, but artificial stone, removes surface defects, gives square arrises and brings out color of ingredients.

(3) (a) About the same cost as ordinary whitewash, but more uniform and attractive in appearance and will not rub off.

(b) About one-third or one-fourth the cost of tool dressing.

(4) Bridge masonry in country generally left untreated. For ordinary work in towns I prefer rice water wash. For buildings in towns of first class I would dress trim, corners and arrises with carborundum wheels.

C. H. CARTLIDGE, BRIDGE ENGINEER, C., B. & Q. R. R.

(1 and 2) In the beginning of our concrete work in 1889, it was our practice to face the concrete against the form boards by working the grout against the forms. A great deal of rough lumber was used in the early work, and as we enlarged the use of concrete we tried to improve its appearance by depositing the mortar against the form and filling in back of it with concrete. Another method was to leave the concrete rough and plaster it. In the 25 years that have elapsed since these experiments it has become evident that the original method is by far the best of the three, and that the more nearly homogeneous the concrete can be maintained the better will be the wearing qualities of the surface and even of the concrete itself. In later work we have adopted the same principle, but have used surfaced forms, even lining them with sheet steel to obtain smoother surface.

(3) The cost of the spade finish is practically nothing; it takes a little more labor to confine the greater part of the puddling to the concrete on the outside than it does to have the same men do all the puddling in the mass. The cost of bush-hammering will run from ¾ ct. to 2 cts. per square foot, depending on the age of the concrete, amount of work, accessibility of work, etc.

(4) The writer believes that this working the grout against smooth forms gives the best results for the cost, but at the same time there is formed by this process a thin skin of rich mortar or grout against the form and on the outer surface of the work, and this checks up with minute cracks and in the end will probably be more or less unsightly. It is true that these cracks are very small and there is not the tendency for the film of rich mortar to scale off, which is exhibited in every case in the thicker mortar facing used in earlier work. In 1900 an experiment was made with bush-hammering some concrete which had been faced in the most careful manner by spading against the form; a portion only of the work done at that time was bush-hammered so that there is an excellent chance to judge of the relative merits of the two finishes. As the result of this it is the writer's opinion that for work in which the best possible appearance is desired bush-hammering provides the desired result at a minimum cost. In a good deal of the work finished by spading against the forms improvement on the surface obtained was made by rubbing with carborundum brick; this gives a good surface and pleasing appearance temporarily, but it has been found that it is difficult to obtain a uniform texture by this means and that exposure, while it does not affect the material itself, causes the washing away of the fine particles of concrete ground off by the carborundum, and the work is really not very much better than ordinary spade finish work, unless the grinding is carried to an extreme. Considerable experience with plastering leads to the belief that, while it is not impossible to make a good finish thereby, it is very expensive and extremely difficult, with the chances all against a good job.

(5) It is evident that the rougher the completed surface, the darker it will naturally become by exposure, smoke and weather, as every identation must receive and retain some coloring matter from the smoke. On the other hand, such a thing as an absolutely plane surface is a practical impossibility. There will be slight waves, small ridges, etc., left by the seams in their forms and their slight distortion, and where a spade finish alone is used the contrast between the dark markings in the seams and the lighter places in the smooth surface is disagreeable in effect, while by bush-hammering an effect of uniformity of texture is obtained, which is much more pleasing to the eye. The bush-hammering has also the effect of cutting away the rectangular markings of the face, which are particularly objectionable from the standpoint of appearance.

W. C. CUSHING, CHIEF ENGINEER, MAINTENANCE OF WAY, PENNSYLVANIA LINES WEST OF PITTSBURGH.

(1) (a) Acid treatment at Columbus, O., 1909-10. In 1909, surface was rubbed with carborundum bricks until aggregate was exposed, and washed thoroughly with solution of muriatic acid to remove all lime. In 1910 surface was rubbed with emery wheels operated by electric power, and then treated with the acid solution.

(b) Float finish, at Pittsburgh, Pa., in 1912, and at Cincinnati, O., in 1913 and 1914. Forms removed as soon as possible and ridges chipped off. Surface then sprinkled with water and rubbed well with pine wood floats. Surface and washed down with water after rubbing was completed.

(c) Rubbed finish, at Indianapolis, in 1914. As soon as forms were removed the surface was first rubbed with carborundum brick to remove rough spots; then rubbed with mortar brick made of 1 part cement and 2½ parts sand.

(2) (a) At Columbus, acid treatment was used in work on concrete encasement of bridge girders and columns in city streets where ornamentation was desired. The acid treatment finish was used to avoid the occurrence of hair cracks, checking and efflorescence in surface of the concrete, and was successful.

(b) At Pittsburgh and Columbus, a smooth and nice-appearing face was desired at the minimum cost, and the same was obtained. The surfaces of the copings and parts most exposed to action of weather have hair-cracked and checked slightly, but greater part of work is wearing well.

(c) At Indianapolis, the masonry abuts streets and a neat finish was desired.

(3) (a) At Columbus, cost in 1909, with rubbing done by manual labor 12 cts. per square foot; cost in 1909, with rubbing done by electric power, 6 cts. per square foot.

(b) At Pittsburgh, average cost of float finish was about 4 cts. per square foot.

(c) At Cincinnati, average cost of float finish was 3 cts. per square foot.

(d) At Indianapolis, the cost to contractor was about:

Plain walls, 4½ cts. per square foot.
Paneled portals, 6½ cts. per square foot.
Octagonal columns, 7 cts. per square foot.

GEORGE W. KITTREDGE, CHIEF ENGINEER, N. Y. C. & H. R. R. R.

(1) (a) On the face and back of all concrete structures above foundations, fine stone forks or spades shall be used to work the coarser part of materials back into the mass, to allow the mortar or finer parts to occupy the space adjacent to the forms in order to secure a smooth, even surface. Immediately after the forms are removed, surfaces that are to be exposed in the finished structure shall have all projections and irregularities carefully removed and all cavities neatly filled with mortar. Unless otherwise required, the faces shall then be rubbed to a smooth, uniform finish, with a flat stone or other acceptable device, using as little mortar as possible. Enough 1:2 cement and sand mortar shall be used to fill the pores, but no "plastering" will be permitted. For a period of ten days after the surfaces are thus finished, they shall be protected by moist canvas or other suitable material. When so indicated on the drawings, surfaces shall be tooled or treated by sand blast.

The following specification is used in the Electric Zone:

The outer exposed surfaces of concrete work shall be made dense and as impervious to water as possible, by carefully working the coarser materials back from the face of the form by means of a shovel, bar or other tool, so as to bring a layer of mortar to the face, or by depositing next to the form and simultaneously with the concrete a 1-in. layer of facing mortar. The rear faces of all structures shall have the finer portions of the mixture worked to the face by means of spading with shovel, bar or other tool, so as to secure a dense, impervious, smooth surface that will exclude water. Any holes or voids remaining after the removal of the form shall be struck smooth with pointing mortar. The molds shall be removed from the face of the concrete, and the exposed surface is then to be rubbed to a smooth or sandpaper finish with carborundum brick or other suitable device. In no case shall the imprint of any joint of the mold or of the grain of the wood be visible on any exposed surface of the concrete. If any defective work is found, such work must be cut out and replaced by rich concrete or mortar in such proportions and in such manner as directed by the Engineer. It is important to obtain uniformity of surface and color in the exposed portions of the work, and all work shall be finished free from discolorations, streaks, cracks, checks and other imperfections injuring the appearance or the life of the work. To obtain this result the same kind and quality of material shall be used throughout the structure. The exposed surfaces of all bridge seats and copings shall be floated and troweled smooth and hard and true to line and grade.

The general field practice for finishing surfaces in the Electric Zone is to remove the forms while the concrete is still green, and float the surfaces with a wooden float and clean water, until the board marks are removed and a uniform surface is obtained. When the concrete is harder, as in reinforced structures, where it is advisable to leave the forms in place for a longer time, a cement brick, made of 1 part cement and 2 parts sand, is used, with clean water, applied with a brush. When the concrete has become very hard, a carborundum brick is used instead of a cement brick. Additional mortar or cement is not applied, except where there are open or porous places, the idea being to rub down the body of the concrete rather than to add thereto in order to avoid "plastering," which in time is liable to peel off. Structures finished by above methods may be viewed at Yonkers, White Plains, Ossining and at various other points.

Other methods for finishing concrete surfaces have been used particularly in connection with building work. Our general standard specifications for first-class passenger stations and minor buildings provide as follows:

Smooth Concrete Facing.—Where concrete is shown marked or specified as "Faced," such surfaces shall be painted with one thin coat of pure cement and water of the consistency of cream, applied with a brush.

Rough Concrete Facing.—Where concrete is specified on the plan as "Rough Faced," such surfaces shall have a full depth of at least 1½ in. of concrete deposited simultaneously with the backing, and made with selected gravel pebbles, crushed marble or crushed granite, as selected by the Engineer, that will pass over a No. 3 sieve, meshes ⅜x⅜ in., and through a No. 1 sieve, meshes 1x1 in., set at an angle of 45°. The forms shall be removed from this surface before the concrete is set hard, and the face shall be brushed with wire brushes until the stones have clean faces and project ¼ in. from the cement binder.

A good example of the rough facing can be seen on the Scarsdale passenger station.

The following clause is given in specification for our standard brick freight house and the former Schenectady improvement:

After the molds are removed, any open or porous places shall be neatly stopped with pointing mortar, and if so directed by the engineer, the exposed face of the work shall be washed with neat Portland cement to give a uniform, smooth finish to the exposed surfaces.

The specifications for the Buffalo grade crossing improvement, dated March, 1907, contain the following clause for granolithic face:

The network of walls, abutments, piers and copings shall have a granolithic surface 1 part Portland cement, 2 parts sand and 2 parts granolithic grit made into a stiff mortar. Granolithic concrete shall be granite, trap rock or limestone, crushed to pass a No. 1 sieve and screened of dust.

For vertical surfaces the mixture shall be deposited against the face forms to a least thickness of 2 ins. by skilled workmen as the placing of the concrete proceeds, and thus form a part of the body of the work. Care must be taken to avoid the occurrence of air spaces or voids on the surface. The face forms shall be removed as soon as the concrete shall be sufficiently hardened, and any voids that may appear shall be filled with the mixture. The surface shall then be immediately washed with water until the concrete is exposed and rinsed clean and protected from the sun and kept moist for three days.

For bridge seat courses, pedestals or column bases and copings and other horizontal surfaces, the granolithic mixture shall be deposited on the concrete to a least thickness of 1½ in. immediately after the concrete has been tamped and before it has set, and shall be troweled to an even surface, and after it has set sufficiently hard shall be washed until the grit is exposed.

(2) The object of finishing is to improve the appearance of wearing qualities of structures. When the float finish is given, the surface becomes dense and more impervious to moisture. The tooled finishes are used principally for artistic purposes, or when required by local municipal authorities. It is our experience that smooth finishes are less liable to catch dirt and become discolored than tooled surfaces.

(3) The cost of finishing surfaces with a wooden float while concrete is green is about 10 cts. per square foot. After the concrete has hardened somewhat, and the use of a cement or a carborundum brick is necessary, the cost is increased to about 20 cts. per square foot.

The above average prices are for all labor and material, including any scaffolding required.

(4) As a general proposition, I think the best manner of finishing a concrete structure is by the wooden-float method, as it leaves the concrete in a more natural state, it is cheaper, and has a better appearance in the long run.

Application of cement on the surface or the use of a cement brick generally makes a white finish, which is more susceptible to discoloration and liable to wear away unevenly.

I think concrete surfaces should be finished in above manner whenever they are exposed, or where it is desired to obtain as much density as possible for waterproofing purposes. I do not think surfaces should be tooled, scraped or treated with an acid, except where the surfaces have been specially prepared and artistic finishes are required.

(5) I think surfaces finished smooth are less susceptible to discoloration from smoke and the weather than when untreated. However, tooled surfaces, I think, have the opposite effect.

R. H. FORD, ENGINEER TRACK ELEVATION, ROCK ISLAND LINES.

(1) (a) Painting concrete placed in cold weather with a 1:1 cement and sand grout, mixed with water to a creamy fluid.

(b) Thoroughly wetting the concrete face and rubbing with carborundum brick.

(2) To fill visible voids and give uniform surface.

(3) Costs taken from actual cost sheets, where the record has been carefully kept and given per hundred square feet. (Form asks for cost per square foot.)

By method (a): Material, 2 cts.; labor, 38 cts.; total, 40 cts.

By method (b): Material and supplies, 2 cts.; labor, $3.00; total, $3.02.

(4) (a) We are making an extended investigation of the best and cheapest method of finishing concrete, and the answer to this question must be considered tentative. So far, however, I am strongly in favor of the rubbing. The item of expense can be reduced immeasurably by the application of power. The prices given above are based entirely upon manual labor.

(b) Our investigations so far are not sufficient to determine this question. It is my opinion, however, based upon information which we have, that painting is, as a rule, undesirable. We have been very successful, however, on some work that was done two years ago with this method. I attributed it, however, to the fact that the surface was rough and porous, and that the painting was done while the concrete was comparatively green. I do not believe in treating it with acid.

I believe that there is a large field for investigation in this particular line.

(5) I do not think that finished concrete (in the sense above used) is more susceptible to discolorations than unfinished concrete, although it may have that appearance. This, however, I think, is due to the fact that the contract is much more sharp on the finished work than on the unfinished.

The above information is based upon our

investigations and studies of the work that this company is doing on track elevation in Chicago, extending over the past 14 years, and compared with an enormous amount of similar work being done by all other roads for the last 10 years. A critical analysis, however, is being made on all work of this character, which is now being done by the Rock Island Co., as unusual opportunity is now afforded for these studies from the fact that the matter is entirely within the hands of the railway company, both in design and execution."

L. D. HADWEN, ENGINEER OF MASONRY CONSTRUCTION, C., M. & ST. P. RY.

(1) We have used, in addition to the ordinary surface obtained by spading, a surface finish obtained by using a sand blast, as was done at Columbus depot.

A treatment of the surface with dilute acid to remove the surface mortar, as was done in the Missoula depot foundation.

A brushed surface to remove the mortar and show the rough aggregate.

Removal of the mortar skin by bush-hammering.

Treatment of the mortar surface obtained by spading, chiseling off board marks and rubbing the entire surface with emery.

A special mortar surface was formerly obtained by the use of a steel gage with angle-irons fixed to create a space about 1½ in. deep between the form surface and the body of the concrete. This space was filled in with mortar and the gage removed. This method is unnecessary, as an equally good mortar surface can be obtained by spading the aggregate back. The use of this practice, in order to place specially prepared material of different composition from the balance of the concrete to form a special surface for the finish, is undesirable, and there is danger of the surface material being of different composition from the balance, eventually checking and losing its bond with the body of the wall.

In building the Miles City depot foundation, the forms were lined with building paper with a view to getting a smooth finish, free from all board marks. The wrinkling of this paper caused a wavy finish and the surface approximating that of bridge stone, but this, in my estimation, has produced a freak appearance and is not a desirable finish.

Whitewashing surfaces with a liquid grout, or with a cement wash, is contrary to our practice and undesirable. It is only a matter of time before any such wash will check and scale.

Some experiments have been made with coloring matter, both lampblack and ochre, with the idea of getting a surface of a definite tint. The addition of any coloring ingredient to an aggregate is to be deprecated, because it is very difficult to insure uniformity in the mixture, and the result is liable to be a surface that is blotchy.

(2) The general object on most structures is to obtain a uniform surface with a dense coat impervious to moisture, and as good results as any can be obtained by careful spading without any special treatment of the surface. For wearing surfaces, such as floors with heavy trucking, the use of a special aggregate may be desirable. On some of our shop floors, granite screenings have been used for this purpose to give a granitoid surface. We have also used finely divided iron in some experimental sections of freight house, and a hard-wearing surface seems to be obtainable by incorporating such material or other patented preparations in the wearing coat. Except where especially dustless floors are desired, it does not appear necessary to go to additional expense for this purpose.

(3) It is difficult to separate the actual cost of finishing the concrete surface from the balance of the cost of concreting, but the cost of tooling the board cracks and rubbing down a concrete surface on ordinary subway work, using emery, will run about ½ ct. per square foot. The cost of sand blasting depends on whether there is enough work to justify the installation of a plant, and at Columbus was about 2 cts. per square foot.

(4) The best manner of finishing a concrete structure, in my estimation, is to use an ordinary spaced surface, and where special finished work is desired, is to use special care in the construction of the forms to get close joints and true surfaces, and after the removal of the forms to go over the work and chisel off any joint marks and then rub down the surface with emery to secure uniform tint. Where appearance is important concrete structures should be designed with panels to break up the large dead surfaces; the use of delicate mouldings and ornamentation should be avoided.

(5) In general, the smooth, natural surface of concrete will be less liable to discoloration than any form of treated surface.

(6) A great deal of effort is often made to remove board marks and the marks in the grain of the wood on finished concrete structures. To me the appearance of slight marking from the boards is more pleasing than the dead surface which shows absolutely no joints. This is noticeable where an opportunity occurs of comparing work built with steel forms and work built with wooden forms, the latter being less lifeless in appearance. The treatment of a concrete surface should not give the impression that it is an effort to conceal the mode of construction of the work.

WILLIAM HUNTER, CHIEF ENGINEER, PHILADELPHIA & READING RAILWAY.

(1) The following methods have been used: (a) Plain spaded face; (b) washed surface, with face coating of (1) pebbles, (2) granite or trap rock grit; (c) patent hammered surface, with face coating of granite or trap rock grit; (d) sand-blasted surface, with face coating of granite or trap rock grit; (e) use of metal-lined forms. In all of the above we have used a system of horizontal scoring to break the surface and to make a line designating the end of the day's work. The specifications for the above follow:

(a) Spaded Face.—All other showing surfaces shall be prepared by keeping the stone well back from the face, as the concrete is placed, by "spading," thus bringing the mortar against the face. After the forms are removed, the surfaces shall be pointed where necessary, and washed with neat cement applied with a brush. Plastering the face after removing the forms shall not be permitted.

(b) Washed Surfaces.—Washed surfaces shall be composed of 1 part cement, 2 parts coarse sand or gravel and 2 parts granolithic grit, made into a stiff mortar. Granolithic grit shall be granite or trap rock crushed to pass ¼-in. sieve and screened of dust. For vertical surfaces the mixture shall be deposited against the face forms to a least thickness of 1 in., by skilled workmen, as the placing of the concrete proceeds, and thus form a part of the body of the work. Care shall be taken to prevent the occurrence of air spaces or voids in the surface. The face forms shall be removed as soon as the concrete has sufficiently hardened and any voids that may appear shall be filled up with the mixture.

The surface shall then be immediately washed with water until the grit is exposed and rinsed clean and protected from the sun and kept moist for 3 days. For horizontal surfaces the granolithic mixture shall be deposited on the concrete to a least thickness of 1½ in. immediately after the concrete has been tamped and before it has set, and shall be troweled to an even surface, and after it has set sufficiently hard, shall be washed until the grit is exposed.

All concrete surfaces exposed to the street shall be marked off into courses in such detailed manner as may be directed by the Chief Engineer.

The same specification applies to the use of selected pebbles.

(c) Patent Hammered.—Showing faces of concrete shall have a granolithic finish, prepared by depositing with the concrete, a front surface of at least 1 in. in thickness, composed of 1 part cement, 2 parts sand and 2 parts clean granite or trap rock grit. The surface shall be scored and patent hammered; when exposed to running water, floating ice, etc., the face coating shall be 2 in. thick.

(d) A sand blast surface is prepared as in "c," and the sand blast is used in place of the patent hammer to give a surface finish. This has not proved successful in our experience, as it is very difficult to obtain a uniform surface.

(e) Metal Lined Face.—The same specification for the granolithic grit, as in "b," excepting that no washing is done, and upon the removal of the forms, the imperfections of the surface are touched up.

(2) The object desired is to have the surface presentable and uniform in color, as well as durable. A reasonable score breaks up a large surface, hides construction marks and the washing or other treatment, because uniform in color and texture.

(3) It has been our experience that the cost of patent hammering varies from 5 to 7 cts. per square foot. We have had no contract prices on the question of washing, but our experience would indicate an increase in price over the plain spaded work of about 25 cts. per cubic yard. We have no figure which would show the cost per superficial foot for this class of work.

(4) The best manner of finishing concrete structures depends on conditions in which the location of the construction plays a very important part. For structures which are not readily seen, it would be ill-advised to use any other than a spaded surface, or such surface as can be obtained by the use of metal-lined forms. If, however, the work is in such a location as to be readily visible, and exposed to the public, we believe that the best for really satisfactory results is by the use of a granolithic surface, scored and patent hammered, or a face coating of pebbles, washed and scored.

JOS. O. OSGOOD, CHIEF ENGINEER, CENTRAL RAILROAD OF NEW JERSEY.

(1) At the time of depositing the concrete, the surfaces to be exposed are thoroughly spaded next to the forms and the coarser aggregate worked back in the concrete, leaving a surface of cement mortar next to the forms. After the concrete has sufficiently hardened, the forms are removed. The surface to be finished is then thoroughly wet with a brush and rubbed with a coarse carborundum brick, forming a lather. This process is continued until the form marks are sufficiently removed. The lather is then washed off and the concrete surface again wet. A float finish is then applied with a brush consisting of a liquid grout of the same mixture as the concrete and rubbed into the face with a wooden float. In many cases where it is only desirable to remove the form marks, the liquid grout finish is omitted.

(2) The surface obtained by the use of carborundum stone is comparatively smooth and even colored and form marks are indistinguishable from a short distance. The floated finish of grout develops a surface with a sanded appearance. Both of the above surfaces weather satisfactorily and are used extensively for the finish of piers and abutments of bridges where the surface finish is not subjected to close inspection.

(3) The cost of the above finishes depends upon the amount of scaffolding necessary, including scaffolding and supervision; the cost runs from 1 to 3 cts. for the rubbing with carborundum stone. Including the float finish, the cost is from 2 to 4 cts. per square foot.

(4) In structures where the appearance of the surface of the concrete is not important and it is not necessary to provide decorative features, the above methods are satisfactory. It is practically impossible, however, to remove all of the form marks by these methods, and if this is desired, some other method of treating the surfaces should be used, preferably tooling. We do not believe that the surfaces should be treated with acid.

(5) Surfaces of concrete which have been treated by any process, by means of which the surface is roughened and the aggregate exposed, soon present a very dirty appearance, due to the collection of dust on the projections. For outdoor structures, a smooth finish of concrete presents a much neater appearance.

ARTHUR RIDGWAY, ASSISTANT CHIEF ENGINEER, D. & R. G. R. R.

(1) In our own work we have made use of but three methods of finishing, viz.: (a) Leaving the natural surface made by the forms; (b) rubbing down the surface with carborundum blocks; (c) rough cast finish made by throwing various mixtures of cement and aggregate onto the surface.

(2) Aside from æsthetic considerations, there would be no object in making any change in surface left by forms (except for waterproofing or wearing qualities), as I believe that finish to be the most durable and satisfactory from a practical standpoint. Of course, in the case of horizontal surfaces, to stand abrasive action, a coat of mortar can be applied to surface before the mass sets, with satisfactory results.

In case of other surface work, which had been poured in forms and set, we should not attempt to apply a trowel coat if it could be avoided, but have sometimes gone over an imperfect surface with a coat of mortar and immediately scraped all material from surface, leaving voids filled.

We have about arrived at the conclusion, even from the point of view of appearance, about the best results are obtained by spending the money available in careful workmanship in erecting forms and thorough spading of the concrete against them. It is a perfectly natural way to use the material at hand, and in accordance with accepted principles of design should give artistic results. We have made some efforts to so arrange the joints in forms as to give character and design to the resulting lines left on the structure. This would apply, of course, to the larger masses, such as bridge abutments, portals of tunnels, etc.

We have only tried rubbing down the surface in one case, and results were not satisfactory, so that only a portion of the work was completed. The forms were rather well fitted and I think that the natural surface is more satisfactory in this case. We use the dash coat on plastered surfaces, such as depot and other walls, and it is satisfactory on account of appearance, stability, resistance to defacement by marking with crayons, and because cracks are not so apparent on a surface of this texture.

(3) It would be hard to say as to cost of producing a good surface by careful form building and spading, but it is obvious that better results can be obtained at less cost than by other methods. The cost of rubbing down with abrasives would hardly be less than 5 cts. per square foot at the time forms would ordinarily be removed. The cost of a dash coat should not be more than 15 to 25 cts. per square yard aside from scaffolding.

(4) Strictly, we think the best method is
natural surface, as stated above. It may
That the material is not adapted for use as
shall be where great refinement in detail is
as possible; much depends on the experience
materials back of the mechanics employed in
means of a shovel, bu Surfaces having a fine,
bring a layer of mortar to able on account of
positing next to the form aterial and conse-
with the concrete a 1-in. layer een overcome
tar. The rear faces of all structureing of the
the finer portions of the mixture work not gen-
face by means of spading with shove
other tool, so as to secure a dense, impeed by
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then to be rubbed to a smooth or sandpaper
finish with carborundum brick or other suitable
device. In no case shall the imprint of any
joint of the mold or of the grain of the wood
be visible on any exposed surface of the con-
crete. If any defective work is found, such
work must be cut out and replaced by rich con-
crete or mortar in such proportions and in such
manner as directed by the Engineer. It is
important to obtain uniformity of surface and
color in the exposed portions of the work, an-
an

be made to satisfy all reasonable practical and æsthetic considerations with little other work than the careful building of forms and proper attention to placing the material. One advantage of this work is that it is now generally understood by mechanics and can be obtained anywhere without undue attention or high-class supervision, which cannot be said of the more complicated methods of treatment.

F. L. STUART, CHIEF ENGINEER, B. & O. SYSTEM.

(1) Two methods: One, rub surface upon removal of forms; second, bush-hammer the entire surface.

Under method No. 1, where forms can be promptly removed, excellent finish may be had by rubbing the fresh concrete with a wooden block, using enough water to keep the surface saturated while rubbing is being done. When surface has become hard, after general irregularities have been removed with chisel or bush-hammer, entire surface may be rubbed with cement or carborundum bricks, the surface being kept thoroughly saturated with water. To insure uniformity of color, grout wash may be applied while the rubbing is being done.

Under method No. 2, the entire surface may be dressed with bush-hammers, operated by hand or by air, all form marks and other irregularities being removed, except the construction joints. This method is not desirable, however, unless the concrete is very dense and excellent quality, for the reason that exposure will result in final damage to the surface.

(2) The purpose of treating the surface of concrete is to improve the appearance of the work. The wearing qualities will not be affected favorably or adversely by being finished according to method No. 1. The surface may be seriously affected where method No. 2 is resorted to, especially if the quality of the concrete is not first class. Concrete which has been dressed or bush-hammered is less impervious to moisture, which in freezing weather will cause the surface to scale.

(3) The cost of finishing the surface by method No. 1 depends largely on the care exercised in casting. If the surface is reasonably smooth and the rubbing is done promptly before it becomes hard, the cost should not exceed 1 ct. per square foot. The cost of bush-hammering will vary from 3 to 3½ cts., depending on how the same is done.

(4) In our opinion, the surface of a concrete structure, where the forms have been properly constructed, should not be treated, except to remove the lipping caused by the joints in the forms. The natural surface with good forms, and when properly spaded, we believe will be more durable if left untreated.

(5) From recent examination of several large structures, where certain portions were treated and others left untreated and which have been exposed to the weather for periods ranging from four to eight years, it was found that the natural surface of the concrete is not as susceptible to discoloration from smoke and weather as surfaces that have been bush-hammered, the same being true in the case of discoloration due to seepage of water through construction joints of porous portions of the structure.

(6) In our judgment, the surface of poor concrete should not be treated, as the surface obtained in casting is more impervious to moisture than if treated. The absorption of moisture and its liability of freezing may in time injure poor concrete seriously."

Cost of Depreciation, Operation and Maintenance of Automobiles in San Diego Water Department.—Mr. H. L. Worthen, chief clerk of the Department of Water of San Diego, Calif., reports the following cost per mile, for the year 1914, for depreciation, operation and maintenance of the motor vehicles in the department:

Locomobile (Model 1911)	$0.12
Federal truck (Model 1913)	.24
Ford cars, each (Model 1914)	.055
Motorcycles, each (Model 1914)	.051

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Progress on Alaska Railway.—Actual construction on the Government railway in Alaska is now under way. The preliminary base of operation is at Ship's Creek on Cook Inlet. The Alaska Engineering Commission, according to a press dispatch, already has contracted with about 400 stationmen and is employing some 100 men in handling the terminal work and in building roads. Plans are being prepared for a dock, machine shop and warehouse at Seward. It is expected that the Alaskan Northern R. R. will be open to Kern Creek by fall and will be kept open all winter for the conveyance of supplies to men working on rock cuts. Grading on the 8-mile span from Anchorage to the main line was 50 per cent complete on June 15. Supplies are being transported by barge from Ship Creek to the advance construction camp on Eagle River, 20 miles north.

The New Equitable Building.—The new Equitable building, which replaces the one destroyed by fire, was opened on May 1. Its total value is about $29,000,000, of which about $14,000,000 represents the value of the land. The building occupies an entire block, about 50,000 sq. ft., and is bounded by Broadway, Pine St., Nassau St. and Cedar St. Its total height is 545 ft., its cubic contents is about 26,000,000 cu. ft., and its rentable floor area is about 1,200,000 sq. ft. The structure is equipped with 53 elevators, and contains about 32,500 tons of structural steel. It is divided into four fireproof zones by means of fireproof walls and doors, and all steelwork is fireproofed with concrete or terra cotta tile, designed to withstand 1,800° F. The interior finish is mahogany and marble, and it is estimated that the structure will house 15,000 people. The architects are D. H. Burnham & Co., Chicago, and the general contractor, the Thompson-Starrett Co., New York.

CURRENT NEWS

11-19-23. 11

The Doings of the Week.

General business conditions received no setback during the past week. Activities in industry and commerce were well sustained, and the progress made was fully in line with expectations. According to a special report of the Chamber of Commerce of the United States, made public on Monday, the former feeling of apprehension of "something is going to happen" because of the European war, has almost entirely disappeared, and confidence in the future has grown apace with the steady progress of the crops and the slow but continual improvement in industrial affairs. The excessive rains of the past weeks have had their effects on crops, but the benefit has far exceeded the damage. The Government crop report for August is expected to show a probable yield of around 975,000,000 bus. of wheat as compared with a total of 891,000,000 bus. last year. Corn is expected to show about 2,972,000,000 bus.; last year the final yield was 2,673,000,000 bus. In the construction field the amount of new work coming up for bids has been well up to the average of previous weeks. In railway construction there has been some signs of activity, contracts having been awarded on several good sized jobs. Reports for the entire country on building construction probably will show a slight improvement over June. One feature of this field is the considerable amount of work now being undertaken in smaller industrial cities. Highway construction, bridge building, street paving and water works and sewerage developments continue to furnish many bidding opportunities. In the iron and metal market one of the principal developments was the increased activity in pig iron. The output is now close up to high record figures, and production is at the rate of 32,000,000 tons per year. Export trade in steel products aside from war orders, was moderately active. Additional foreign orders are being circulated, their acceptance depending in great measure upon satisfactory arrangements as to payment. *The Iron Age* prices for finished iron and steel are for sheets, nails and wire for the week ending Aug. 4 were as follows:

Finished Iron and Steel.	Aug. 4.	July 28.
Per lb. to large buyers.	Cts.	Cts.
Bess, rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia	1.25	1.30
Iron bars, Pittsburgh	1.25	1.25
Iron bars, Chicago	1.20	1.20
Steel bars, Pittsburgh	1.30	1.25
Steel bars, New York	1.469	1.469
Tank plates, Pittsburgh	1.25	1.25
Tank plates, New York	1.419	1.369
Beams, etc., Pittsburgh.......	1.30	1.25
Beams, etc., New York	1.469	1.419
Skelp, grooved steel, P'gh.....	1.25	1.25
Skelp, sheared steel, P'gh.....	1.30	1.30
Steel hoops, Pittsburgh........	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.75
Galv. sheets, No. 28, P'gh...	4.00	4.00
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, P'gh........	1.40	1.40
Barb wire, galv., P'gh........	2.50	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.30 cts.

Railways.—There were some indications during the past week of a coming improvement in the railway construction situation. Several good sized contracts were awarded and there were reports that a number of other good jobs might come up late this summer or early in the fall. The Southern Ry. let 35 miles of second track work to the following: H. H. Thrasher, Knoxville, Tenn.; Cornell Young Co., Somerset, Va.; Morrow Construction Co., Atlanta, Ga. J. H. Maxey, Yuma, Ariz., was awarded the contract for grading, bridging and track laying for the 38 mile line of the Tucson, Gila Bend & Arizona Ry. in Arizona. J. D. McArthur, Winnipeg, Man., secured 100 miles of grading for the Canadian Northern Ry. It is rumored the Delaware, Lackawanna & Western R. R. may ask bids soon on its $10,000,000 Poconos cutoff.

Roads and Streets.—Numerous contracts in the state and county highway field reached the call for bids stage during the past week. Ohio is asking proposals on a state highway letting; Washington is calling for bids on several contracts; New York is advertising two lettings, one covering 100 miles of new road and several repair jobs, the other covering 82 miles of new road and a number of resurfacing jobs. Street paving contracts include a considerable amount of work for Tallahassee, Fla., 30,000 sq. yds. for Fort Meade, Fla., 32,000 sq. yds. for Bozeman, Mont. California has sold $2,500,000 of state highway bonds and shortly will advertise a number of sections of road. The contracts let include an $84,000 job at Stockton, Cal., a $43,500 job at McGregor, Ia., 23,900 sq. yds. of asphaltic concrete for McKinney, Tex., $400,000 worth of work for Philadelphia, Pa., a $95,000 job for Port Angeles, Wash., and 6 miles of the T. Coleman Dupont road in Delaware.

Bridges. — A considerable amount of bridge construction is being advertised. Among the larger undertakings are a $200,000 reinforced concrete arch bridge at Lawrence, Kan., and three concrete steel arch bridges at Greenville, N. Y. In Illinois 15 jobs, mostly for small structures, are ready for bids. Ohio counties also are displaying considerable activity in this line. The contracts let include a $76,000 lift bridge at Crown Point, Ind., a $109,000 bridge at Red Bluff, Cal., a $65,000 bridge at Minetto, N. Y., and two bridges at Philadelphia to cost $43,335 and $34,300.

Water Works.—A fair amount of water works construction came up for bids during the past week. Many of these developments were for smaller municipalities and will involve no great expenditure. Brewster, O., opens proposals Aug. 20 for constructing water works; Windsor, Conn., is asking bids for improvements to include 34,500 ft. of 6 in. and 10 in. mains; Hatfield, Pa., opens proposals Aug. 16 for laying 2 miles of mains; Charitan, Ia., is asking bids for an earth dam, filter plant, pumps, etc., and 12,800 ft. of 10 in. force main. The contracts let include the compensating reservoir for Hartford, Conn., a $350,000 job; a $78,875 intake for Kenosha, Wis.

Sewerage.—One of the larger undertakings reaching the call for bids stage this week is the sewage pumping stations for Albany, N. Y. This includes 5,000 cu. yds. of concrete and the furnishing of equipment, including three 10,000,000 and three 15,000,000 gal. pumps. The contracts let include a $296,500 main trunk sewer at Salt Lake City, Utah, and a $96,500 sanitary sewer job at Baltimore, Md.

Rivers and Harbors.—Bids have been opened recently on numerous government contracts in the rivers and harbors field. Great Lakes Dredge & Rock Co. was low bidders for the rubble mound breakwater at Chicago Harbor, Ill.; Coast & Lake Contracting Corp., Cleveland, O., at $99,000, was low bidder for repairing rubble mound breakwater at Lorain, O. The Standard American Dredging Co., Oakland, Cal., was awarded contract, at $179,000, for dredging and rock removal in St. Johns River, Fla. Two levee contracts aggregating over 700,000 cu. yds. were let. The State Board of Engineers, New Orleans, La., is asking bids on over 1,000,000 cu. yds. of levee construction.

Sewer Contracting.

The sewer contractor has a joyous life. His work is full of surprises. His profits are as certain as dividends from a wild-cat gold mine. Rock, water, quick sand, cave ins are just hazards of the job. The following illustrates the number of things that can happen on an ordinary sewer contract: The contractor started the excavation with a trenching machine and it mired the first day. The trenching was continued by hand labor until more solid ground was reached. A month after work started a cave in occurred killing a laborer and frightening many others of the men so they quit the job. Next underground water was encountered and then the machine struck quick sand on high land where the material was least to be expected. It was necessary here to put in sacks of sand and concrete the pipe. On one day only four lengths of pipe were laid in this section. Solid rock was next encountered at a locality where it was supposed that only sand existed. And then when only about 1½ days of work were required to complete the contract it began to rain, and the weather was such that it was 6 weeks before the job could be finished. As the contractor carried several high salaried men who were paid whether or not they worked, this rain cost him more than $1,500. Is it any wonder that the bids on sewer contracts often exceed the engineer's estimate?

High Priced Highways.

A highway contract, out of the ordinary, both on account of the expenditure required and the difficult constructional features involved, was let a few days ago by the State Highway Commissioner of New York. The work calls for the construction of a road around the face of the Storm King Mountain north of West Point. The highway practically will be hewn from the rocky sides of the mountain. There will be many difficulties in carrying out the work. At the base of the cliff are railroad tracks which must be kept clear of rock and debris. One $10,000 item in the contract provides for installing and operating equipment for removing the rock from the railway right of way. On certain portions of the cut it will not be possible to remove the rock in the ordinary way by blasting, because of the danger of hurling bowlders on moving trains or of blocking traffic. At these points the rock will be quarried and used in fills. The section covers 4.03 miles and the contract price is $395,176, making it probably the most expensive short link of highway ever built in this country. In passing it may be noted that 15 firms submitted bids on the work and that the difference between the high and the low figures was only about $122,000.

Labor Supply.

Complaints already are coming from certain sections of the country regarding the scarcity of unskilled foreign labor. The European war has made large drains on the supply of aliens and immigration from the same cause also has fallen off. Some interesting figures on this latter point are given in a recent government report. This shows that the net increase in population for the year ended July 1 was about 50,000, the lowest number since 1899. During the year 326,700 immigrant and 109,544 non-immigrant aliens were admitted. But on the other hand 204,074 emigrant and non-emigrant aliens departed. The principal decreases for immigration were from the races that usually furnish the labor for construction work. Over 238,000 fewer Italians arrived here than in the previous year.

The Lighter Side of Engineering and Contracting

Phoebe Coughed.

A LEVEE contractor had a mule that answered to the name of Phoebe. This title probably was bestowed upon the animal because of her lovely disposition. At any rate Phoebe was greatly beloved by the Skinners. They curried her with a pick handle and put on her harness with a pitchfork. One day this pet fell ill with the distemper or "epizootic" or something, and the foreman decided that a dose of powdered borax was advisable. He put some of the borax inside a paper tube. Then he inserted one end in his mouth and pushed the other end down the mule's throat as far as possible, so that he could blow the medicine into Phoebe's interior. Up to now the animal had been very meek and humble and seemed to appreciate what was being done for her. But just as the foreman was taking a long breath to get sufficient wind power to blow the stuff where it would do the most good, Phoebe coughed and blew the entire dose down into the foreman's thorax. And the mule got well without any further medical attention.

Why He Enlisted.

MIKE FARRELL at one time had in his employ a hobo skinner nicknamed the Big Dutchman. Now this man had a very quiet disposition. If he couldn't lie down he preferred to sit down. Most of his time as well as his employer's was spent in one of these positions. One day the foreman told him to take a mule down to the blacksmith's to be shod. The blacksmith was making an S—link, so while this was being done the Big Dutchman wandered over to the commissary to try to make a touch for tobacco. The blacksmith finished the link and tossed it into the sand to cool and then started to heat a U-shoe for the mule. The shoe after he had heated it did not suit him, so he threw it down into the sand beside the link. The link and the shoe had turned black, but were still sizzling hot when the Big Dutchman returned and squatted down in the sand right on top of them. He arose immediately and sat down in a tub of water. But the damage was done. He bore the government brand U. S., so there was nothing left for him to do but join the army.

Away Went Pat.

D. D. STREETER in his early days as a contractor bit off a small job on a piece of new railroad through a section of country where men were scarcer than hen's teeth. The contract included a rock cut, and neither the contractor nor any of his men knew anything about rock work. The greatest difficulty, however, was not the work, but the scarcity of men. Streeter went up and stood in the highway hoping that he might hold up any hobo straying that way and lure him into his camp. After a time along came a man. D. D. hailed him: "Are you looking for work?" "Yis," said Pat. "Well, I have some fine work and can give you a good job," said Streeter. "Have you rock work?" asked Pat. "Yes, yes; fine rock work." "And do you give the min tints to shlape in?" continued the Irishman. "Yes, I give them fine tents." "And do you furnish thim ticks?" "Yes, I furnish ticks." "Well, shure it's very koind of ye; how fur is it to Johnnie Scott's contract?" And away went Pat.

What They Don't Know.

MANY stories are told of former members of the Board of Local Improvements of a large western city. Many of these members, being appointed through political favor, have little idea of the practical features involved in the work under their supervision.

On one occasion a newly appointed member came out on the street which was being concreted, after having the sub-grade rolled. Noticing the idle roller, he loudly exclaimed, "Better get the roller on that concrete before it gets too hard!"

The matter of opening a new street in a thickly settled part of the west side came up. The engineer reported there existed no apparent need of a street at this time and advised that the matter rest until the property and population developed to a point where a street was needed. The member having this department in charge insisted a street should be opened across this prairie since there would be a public school on this street "some day," and further, to cinch the argument, "there is *plenty of room here* for a street!"

On another occasion a serious question arose as to the proper thickness of the concrete base which was being laid on a certain street. Complaint had been made to the Board, and the newest member sent out to investigate. The specifications called for 6 ins. of concrete and the claim was made by some one that less was being put in. The "investigator" failed to provide himself with a "rule," and on inquiry was told the foreman would send for a new one. The new rule was soon at hand and the "investigator" had many "holes" opened in the concrete and found the thickness to average well over 6 inches. He wrote a glowing report on the generosity of the contractor in laying more than the "law" required. He does not know to this day that a good half inch had been cut off the end of the "new" rule.

Huh! What's Dat?

A COLORED MAN applied for employment as laborer in the new tunnel being constructed under compressed air for the Boston subway. After having answered the usual questions as to age, residence, etc., he was asked, "In case of accident, who do you want notified?" "Huh!—what's dat, boss?" "In case of accident, who do you want notified?" "Why, boss, you jes notify *me—me*, yo' understand. If der's any accident I want to get out of 'dere."—W. L. R. H., Pittsburgh, Pa.

A Limit to Trenching Machine Usefulness.

IN ONE of the large mid-west cities, some 25 years ago, there held forth a certain Mike Flynn, sewer contractor and politician. Mike was "some" contractor and "some" politician, and if there were any sewer lettings which he did not pull down it was because he did not want them. Those were the days before grab buckets, steam shovels, trenching machines and other labor-saving equipment, now so common, were in general use, and as Mike used only hand labor and from time to time had many large contracts, he often had many hundred laborers on his pay roll—and, incidentally, these laborers to a man could be counted on to vote "Mike's way."

At a certain sewer letting on which Mike was, as usual, low bidder, there was present a Mr. Conner, sales representative of a then almost unknown trenching machine. Mr. Conner lost no time in collaring Mike and in placing before him the many advantages of his machine. Mike was a good listener and Conner drove home his points, one by one, and as he thought with telling effect. Mike finally conceded that he could save money by using the trenching machine and Conner decided that the psychological moment for closing had come. "I have a contract with me for one of these machines, Mr. Flynn; let me fill it out, and you can sign it up right now and get it out of the way." Mike shook his head. "No," says he, "I couldn't do that Mr. Conner." "Why, what's the matter, Mr. Flynn? You acknowledge yourself that you can save a lot of money by using the machine." "Yis," says Mike, "ye have a foine machine, and it would save me money, but Oi can't use it—it's no good to me—the domn thing can't vote."

H. K. R., St. Louis, Mo.

TWO contractors were walking up Michigan boulevard, Chicago. As they approached the Auditorium Hotel, one of them said, "Let's go and look over the place, and if I like it I will buy it for you." The other contractor, amazed at this outburst of generosity, stopped, and then said: "Come on; if I was half as drunk as you are I'd sell it to you."

Skinner Mulvey says: Every rosebud has its rosebug, which reminds me that you can niver tell a mule's disposition by her complexion.

DRAINAGE DEVELOPMENTS TO COST $260,000.

Work to be Done for Burt-Washington District.

Bids Asked on 1,000,000 Cu. Yds. of Ditches and Levees.

Developments estimated to cost $260,000 are to be carried out by the Burt-Washington Drainage District of Tekamah, Neb. This work will include the construction of ditches, levees and settling basins, and the cleaning out or reconstruction of existing ditches. Bids are now being asked for constructing diversion ditches and levees requiring about 1,000,000 cu. yds. of excavation. Other work will be let at a later date. The estimated cost of the improvement is as follows:

Tekamah Creek ditch and outlet to river, 675,000 cu. yds., at 8 cts.	$ 54,000
Silver Creek ditch and floodway along combination ditch to junction with Tekamah Creek outlet, 365,000 cu. yds., at 8 cts.	29,200
Right of way, bridges, etc.	60,000
Dams, culverts, spillways, etc.	10,000
Lone Tree Creek diversion	2,500
Cleanout and reconstruction work—	
Extension of Peterson ditch	2,150
Reconstruction of Peterson ditch and Combination ditch to Morrow Spur	8,600
Cleanout of Combination ditch and spurs	11,520
Cameron ditch	21,120
Adams Spur	4,320
Fish Creek ditch	3,600
Silt basins, if leased for 10 years	14,100
Additional cost of condemnation of lands for silt basins where leases may not be granted	16,000
Levees and control works for silt basins	10,000
Engineering and legal expenses	12,890
Total	$260,000

The district is in Burt County and Washington County, and its eastern boundary is a short distance from the Missouri River. It extends from Blair on the south to Decatur on the north. The Chicago, Milwaukee & St. Paul Ry. follows the western boundary of the district from Blair to Tekamah.

The plan of drainage contemplates the provision of settling basins on nearly all streams to remove mud and debris before flood waters are allowed to enter the main ditches. All existing ditches will be either cleaned out or reconstructed, so as to secure subdrainage and adequate relief. The new work includes the diversion of Tekamah Creek, Mud Creek and Silver Creek to the Missouri River east of the town of Tekamah, with an outlet through the "Arizona Slough" to a chute of the river. Where the flood waters from these creeks are carried across the valley to the river the ditch crossings will be made with reinforced concrete culverts. Spillways also will be provided at the points of diversion and at the crossing of the Combination Ditch.

Bids on the 1,000,000 cu. yds. of diversion ditches and levees will be received by J. J. Breckinridge, Secretary, Burt-Washington Drainage District, at the Court House, Tekamah, Neb., until noon, Aug. 14. The Towl Engineering Co., 1122 City National Bank Bldg., Omaha, Neb., is engineer for the district.

Sale of Long Term Bonds in South.

Recent sales of bonds by Southern railways are an encouraging development in the investment situation. During the month of July over $8,500,000 of long term bonds secured by railways in Georgia were sold. The Southern Ry. marketed a $3,500,000 bond issue for the Atlanta & Charlotte Air Line Ry. The Macon Terminal Co. disposed of $1,600,000 of bonds. The state of Georgia sold $3,500,000 of refunding bonds. The latter securities were secured to a large extent by the state's property, the Western & Atlanta R. R. During the past year the demand for long term securities has been very slight. The easy manner in which the recent sales were made is a good indication of the growing spirit of optimism among investors.

Progress on Rogers Pass Tunnel, British, Columbia.

Excellent progress has been made in driving the Rogers Pass tunnel for the Canadian Pacific Ry. The following tabulation shows footage during the first seven months of 1915:

Month.	Pioneer Heading.	Main Heading.	Enlargement for Double Track
EAST END.			
January	592	443	443
February	620	440	422
March	595	196*	379
April	751	442	553
May	658	417	718
June	776	471	659
July	682	538	726
WEST END.			Timbered.
January	932	699	210
February	650	634	247
March	617	752	413
April	569	741	588
May	730	618	685
June	808	393	729
July	731	969†	812

*Half month. †Two headings.

The Pioneer Heading has been completed and there remain to drive 2.05 miles of main heading and 3.31 miles of double track tunnel enlargement. Concrete lining of the earth section is nearing completion and it is expected that concreting of that portion of the rock section which requires lining will be finished this year. The completed tunnel will probably be ready for operation in September, 1916. Foley Bros., Welch & Stewart are the contractors. A. C. Dennis, Glacier, B. C., is their superintendent in charge of the work.

Co-operative Sewerage for Borough in Delaware County, Pennsylvania.

Plans are being developed for a co-operative sewerage scheme for six boroughs in Delaware County. These towns are located near the southwestern boundary of Philadelphia. It is likely that a plan along similar lines will be adopted ultimately by most of the other suburban districts of Philadelphia that are now without sewers. The six boroughs now considering the project of installation of a joint system are Lansdowne, East Lansdowne, Yeadon, Clifton Heights, Alden and Collindale.

Under the development each borough will pay the cost of putting in its own local system. These systems will have their outlets in main collectors, the proportionate cost of which will be paid for by each borough. The main sewer will lead to a disposal plant to be erected near Fernwood cemetery at a cost of about $30,000. The entire undertaking will involve an expenditure of several hundred thousand dollars. Details of the plan are now being worked out by A. F. Damon, Consulting Engineer, Darby, Pa.

Double Track Contracts for Southern Ry.

The Southern Ry. is about to let additional contracts for double-tracking its main line between Washington and Atlanta. At present 306 miles of a total of 649 miles between these two cities has been double-tracked. The company recently sold $3,500,000 of bonds secured by a first mortgage on the property of the Atlanta & Charlotte Air Line Ry. This latter railway is operated by the Southern under perpetual lease and constitutes that part of the main line extending from Charlotte, N. C., to Atlanta, Ga., a distance of 263 miles.

It is understood that the proceeds of the above sale are to be used for double-tracking below Charlotte, N. C. The sections thus financed are stated to extend from Spartanburg to Central, 58 miles; and from New Holland to Cornelia, 21 miles. Contracts were let last week for double-tracking from Spartanburg Junction to Greenville, 29 miles. This section was divided into two contracts, one covering that portion of the line from Spartanburg to Greer and the other that portion from the latter place to Spartanburg. Contracts also have been let for second tracking a section of the line from Rocky River to Concord, 6 miles.

Building Construction for Bureau of Yards and Docks.

A considerable amount of building construction is now being advertised for bids by the Bureau of Yards and Docks of the Navy Department. One of the larger of these contracts calls for the erection of buildings and a garbage incinerator at Naval Disciplinary Barracks, Paris Island, Port Royal, S. C.

The structures to be built include the following: A guard house, 53 ft. by 79½ ft. in size; a stable, 40 ft. by 92½ ft.; six double quarters for non-commissioned and petty officers, each building to be 26 ft. by 51 ft. 8 in.; a brick wall 62 ft. wide by 50 ft. high at ridge for command barracks, garbage incinerator, and nine sleeping porches.

The guard house, stable, and officers' quarters will be covered with drop siding on frame construction set on concrete foundations and footings. All roofs will be covered with ready roofing. The sleeping porches will be semi-inclosed and will have sliding sash and fixed screens. The garbage incinerator will be of brick built-up construction. It will be of the one-furnace, secondary-grate, coal-burning type.

Another contract on which the Bureau is now asking bids provides for improvement of the U. S. naval magazine at Fort Mifflin, Pa. The work here includes the construction of a shell house, a fixed ammunition storehouse, a magazine building and an extension of the reforming plant. All these buildings are to be of brick, concrete and steel construction. Their general dimensions are as follows: Fixed ammunition storehouse and magazine, 50 ft. wide by 100 ft. long outside brick walls and about 15 ft. 8 in. from grade to eaves line. Shell house, 50 ft. wide by 200 ft. long outside of brick walls, and about 14 ft. 10 ins. from grade to eaves line. Reforming plant extension, 60¼ ft. long by 40½ ft. wide and 17 ft. 1½ ins. high from ground to eaves.

The extension to the reforming plant will be one story, constructed with brick walls, reinforced concrete floor, covered with tar and gravel, steel columns, steel roof beams, plain concrete foundations, and wood piles, ventilators, copper gutters and down spouts. The end wall of present building is to be taken down. The shell house, fixed ammunition storehouse and magazine will be one story, constructed with brick walls, reinforced concrete floor slab carrying a wood floor, reinforced concrete piles, steel roof trusses and purlins carrying wood sheathing and built-up asbestos roofing, lightning aerials and conductors, ventilators, copper gutters and down spouts. The appropriations now available for the buildings are as follows: Shell house, $25,000; fixed ammunition storehouse, $13,000; magazine, $13,000; reforming plant extension, $7,000.

The Bureau of Yards and Docks, Washington, D. C., will receive bids for the work at Fort Mifflin until Aug. 21, and for the work at Port Royal, S. C., until Aug. 28.

A $1,425,000 Water Storage Project Contract.

The contract for the first water storage project of the Streams Commission of the Province of Quebec, Canada, was awarded recently. This development, as noted in our June 16 issue, provides for a storage reservoir of a capacity of 160,000,000,000 cu. ft. The primary object is the regulation of the flow of the St. Maurice River. Bids on the work were opened June 15 and the contract awarded to the St. Maurice Construction Co., Ltd., at about $1,425,000. It is reported that the actual construction will be done by Fraser, Brace & Co., Ltd., Montreal, Que.

The storage dam will be of the gravity type constructed of mass cyclopean masonry. It will have a total length of about 1,720 ft., a maximum height of 80 ft. and a width of 20 ft. at the crest. The spillway portion will have a total length of 865 ft. The bulkhead section of the dam will be about 435 ft. in length with a base width of 60 ft.

GRADE CROSSING ELIMINATION AT LOS ANGELES, CAL.

Construction of 6 Viaducts of Total Length of 35,550 ft. Suggested.

Total Cost Estimated at $4,260,000.

The construction of six viaducts of an aggregate length of 35,550 ft. is recommended by Franklin D. Howell, Chief Engineer of Board of Public Utilities of Los Angeles, Cal., in a report to the board on grade crossing problems of the city. The suggested locations of these structures and their approximate lengths, including approaches, are as follows:

	Length, Ft.
Main St.	6,700
Macy St.	4,150
First St.	6,100
Fourth St.	6,750
Seventh St.	6,050
Ninth St.	5,800

These viaducts would give access, free of industrial district dangers, to Pasadena, Huntington Drive, Mission Road, El Monte Road, Monterey Pass Road, Whittier Road and Anaheim Road. It is stated that this would cover the whole territory east and southeast of the city, not only of Los Angeles County, but San Bernardina, Orange, Riverside and Imperial counties as well.

The report states that these viaducts should give a minimum of 22 ft. clearance for all railroad tracks now crossing them, and should carry this clearance throughout their length to admit other crossings where required. The suggested minimum clearance under all cross girders for longitudinal vehicle traffic under the viaduct is 14 ft.; when street railroads are to run longitudinally under the structure the clearance would be 15½ ft. For substructure a two column bent is suggested, the column to be located on the curb line on 60 ft. streets, and 10 ft. from the curb on 80 ft. streets. Spans of 40 ft. to 50 ft. are recommended in the report.

A uniform width of 50 ft. was assumed for all viaducts. This would give a 5 ft. sidewalk on each side and a 40 ft. roadway carrying a double-track, narrow gage street railway. Longer spans are proposed for the structures where they cross railroad yards. For these locations deck plate girders encased in concrete with concrete floor to blend with the rest of the structure are suggested.

The estimated cost of the improvement is $4,260,000. This includes, in addition to the viaducts, three 100 ft. spans across the Los Angeles River, removal of Los Angeles Ry. tracks and replacing them on the viaducts, widening of streets for approaches, engineering, advertising and 10 per cent additional for contingencies. This cost would be borne by the city, county, Los Angeles Ry., Industrial Districts 3 and 4, Southern Pacific R. R., Atchison, Topeka & Santa Fe Ry. and the Salt Lake Route. The design and construction would be carried out under the direction of the City Engineer and Board of Public Works of Los Angeles.

A $350,000 Dam at Hartford, Conn.

One of the largest dam construction contracts let in New England for several months was awarded last week by the Board of Water Commissioners of Hartford, Conn. The improvement is Contract 10 of the new water supply system of the city. The structure will be erected at New Hartford, 17 miles west of Hartford, on the east branch of the Farmington River. It is being built to provide a compensating reservoir for the mill owners on the Farmington River, whose power will be affected by the diversion of water by the Nepaug reservoir.

The contract comprises the construction of an earth dam 70 ft. high and 800 ft. long with concrete core wall. There will be a diversion conduit, gate house and 300 ft. spillway. The principal approximate quantities include 165,000 cu. yds. of earth excavation, 24,000 cu. yds. of rock excavation, 300,000 cu. yds. refill and embankment and 20,000 cu. yds. of concrete masonry.

Bids were opened Aug. 2, 15 proposals being received. These ranged from $357,766 to $723,860. C. W. Blakeslee & Sons Co., New Haven, Conn., was the low bidder at the first mentioned figure. The work will be carried out under the supervision of Caleb Mills Saville, Chief Engineer of the Board of Water Commissioners of Hartford, Conn.

The $250,000 Lake Quinsigamond Bridge, Worcester, Mass.

A bridge involving some interesting constructional features will be erected soon at Worcester, Mass. The structure will be built across Lake Quinsigamond and its cost will be borne by the city of Worcester, the county, the town of Shrewsbury and the Worcester Consolidated Street Ry. Co.

At the site of the proposed bridge there is now a fill across the lake. This embankment was constructed in 1857-8 and evidently was made wholly of gravel. It is approximately 48 ft. wide at the level of the roadway. The greatest depth of water in the vicinity of the bridge location is 56.5 feet below elevation. 356.82; high water is 358.5.

It is planned to construct the bridge on the fill and after construction is completed remove the fill to a depth sufficient to give proper depth of water under the arches. The part of the fill taken out will be dredged into deep water at either side of the bridge. It is believed that the existing fill will provide suitable foundation for the arches without the necessity of driving pile foundations. Tests, however, will be made to determine this.

The bridge as proposed will be an open spandrel arch, reinforced concrete structure. It will have twin piers and common footings. Its total length will be 850 ft. and its width 60 ft. There will be one span of 120 ft., two spans of 90 ft., two spans of 70 ft. and one span of 60 ft. The preliminary approximate source of the supply are as follows:

Reinforced concrete	4,500 cu. yds.
Mass concrete	11,500 cu. yds.
Steel reinforcement	395,000 lbs.
Excavation	16,500 cu. yds.
Steel sheet piling	1,000,000 lbs.

The appropriation for the work is $250,000. The Samuel H. Pitcher Co., 418 Main St., Worcester, Mass., is in charge of the design and construction.

Municipal Water Works and Sewerage Construction in Iowa.

A considerable amount of municipal water works and sewerage construction is now being undertaken or is planned by smaller municipalities in Iowa. Figures compiled by Lafayette Higgins, State Sanitary Inspector, show that during the year ending June 30, 1915, 17 towns or cities undertook the installation of water works. Some of these systems are now completed and others are in process of construction. These places, their population, and some of the supplies are as follows:

Place.	Population.	Supply.
Crawfordsville	322	Deep well.
Dixon	198	Deep well.
Edenville	448	Deep well.
Goldfield	681	Deep well.
Knoxville	3,190	Des Moines river.
Lowden	584	Deep well.
Maynard	382	Deep well.
Morning Sun	897	Deep well.
Northwood	1,264	Deep well.
Onslow	207	Deep well.
Orange City	1,374	Deep well.
Osceola	2,416	Deep well.
Riverside	652	Deep well.
Sanborn	1,174	Deep well.
Sioux Rapids	868	Deep well.
Stanton	653	Deep well.
Yale	273	Deep well.

In addition improvements are completed or in process of construction to the present systems of Humeston, Parkersburg and Grand Mound. Chariton also is now calling for bids for construction of water works, the supply for which will be obtained from a reservoir. During the year ending June 30, 1915, 15 Iowa cities or towns began construction of sewer systems or sewage treatment works. These places are as follows: Audubon, Decorah, Garner, Hartley, Jewell, Keota, Lake Mills, La Porte City, McGregor, Mount Ayr, Onawa, Postville, Tripoli, What Cheer and Woodbine. Improvements to present sewerage were undertaken by Algonia, Carroll, Creston, Denison, Grinnell, Holstein, Newton and Spencer.

New Railroad in Washington.

Construction work, according to advices from the coast, will be started soon on the first section of the Bellingham, Mt. Baker & Spokane branch of the Puget Sound & Hudson Bay R. R. A British syndicate is understood to have undertaken the financing of the railroad, and it is reported that much of the capital necessary for the building of the entire line is already in sight. Surveys for the first 16 miles of the branch are now being made. The contract for this secton, which extends from Bellingham, Wash., to Deming, has been let to Marsh, Hutton & Powers, New Westminster, B. C. The Deming section will tap the Glacier coal fields. Further extensions east through the Methrow Valley are in contemplation. The company has taken options in Bellingham on 480 acres of tide lands with 3,000 ft. of water frontage, and on 1,000 acres of inland property. Capt. E. J. Fader, New Westminster, is representing the syndicate.

Pan-American Road Congress.

The advance program of the Pan-American Road Congress, to be held at Oakland, Cal., Sept. 13 to Sept. 17, schedules 21 papers open to discussion. In all 10 sessions of the congress will be held. The first session, Monday morning, will be taken up by the opening exercises. Six educational addresses are scheduled for Monday afternoon. Both morning and afternoon sessions on Tuesday, Wednesday and Thursday, and that of Friday forenoon, will be devoted to the presentation and discussion of papers for bringing out the latest and most approved ideas in road and street construction and maintenance. Friday afternoon will be given to committee reports, business and resolutions. Acceptance of the subjects assigned by the program committee have already been received from about 40 of those designated, and others are constantly being received. These acceptances cover practically all phases of road and street construction, maintenance and administration.

PERSONALS

Dr. William R. Phillips of the Bureau of Economic Geology and Technology at the University of Texas will assume the presidency of the Colorado State School of Mines at Golden on September 1.

Mr. Lewis Littlepage Holladay announces that henceforth he will be associated in his practice of consulting engineering in the field of power plants, utilities and industries with Mr. Henry Negstad, under the corporate name of Holladay, Negstad & Co., 109 N. Dearborn street, Chicago.

Mr. Theodore E. Seelye has resigned as division engineer in charge of dam design and construction for the Water Supply Commission of Pennsylvania to become associated with Mr. Farley Gannett, formerly engineer of that commission, who has opened an office in the Telegraph Building, Harrisburg, Pa., for consulting engineering practice.

Mr. H. S. Philips has recently been granted leave of absence from his duties with the city of Toronto Department of Public Works to accept a position as assistant engineer in the Buffalo Office of the International Joint Commission which, under the direction of Prof. Earle B. Phelps of the U. S. Public Health Service, is studying means for the control of the pollution of the Niagara River.

Mr. Paul Nash has again been chosen as city engineer of Stamford, Conn., and has appointed Mr. Leon E. Tuttle as assistant city engineer. Mr. Nash is a graduate of Sheffield Scientific School at Yale, class of 1890. He has been with the city of Stamford for 13 years, for six years as city engineer and seven years as director of public works. At the present time there is but one office, that of city engineer, the two having been combined.

Mr. John A. Bruce has been appointed city engineer of Omaha, Neb., succeeding Mr. Watson Townsend. Mr. Bruce is a graduate of the University of Nebraska, and is a member of the American Society of Civil Engineers. For five years he was with various railway companies, including the Illinois Central and the Union Pacific, as engineer on construction. From 1907 to 1911 Mr. Bruce was in the employ of the city of Omaha as engineer on pavements and sewers. Since 1911 he has been in private practice as senior partner in the firm of Bruce & Standevan at Omaha.

Mr. H. D. Dewell has opened offices at 58 Sutter street, San Francisco for general consulting engineering practice. He is also acting as engineer of service water supply and distribution for the Panama Pacific Exposition. Mr. Dewell has been chief structural engineer for the exposition since August, 1912. Prior to that he was with Galloway & Markwart, consulting engineers, San Francisco, as principal assistant engineer. From 1907 to 1908 he was in charge of structural design on all buildings of the Alaska Yukon Pacific Exposition. Mr. Dewell is an associate member of the American Society of Civil Engineers.

Mr. R. T. Stull, E. M. Cer., has become associated with the Dunn Wire-Cut-Lug Brick Co. of Conneaut, Ohio, as its ceramic engineer. His special duty will be to advise with the licensees of the Dunn Co. and help them with their brick-making problems. Mr. Stull is a gradaute of the Department of Ceramic Engineering at Ohio State University, class of 1902. For five years following he was connected with various ceramic industries as superintendent, and in 1907 became instructor in ceramics at the University of Illinois. In 1913 he was made acting director of the department. He is a member and vice-president of the American Ceramic Society, a member of the American Chemical Society, the American Society for Testing Materials, the National Brick Manufacturers' Association and the Illinois Clay Manufacturers' Association.

CONTRACTORS.

Mr. James A. Pringle, of 1241 Fillmore street, Topeka, Kan., who has been awarded the contract for the east side sewer at Topeka, has been in the contracting business in that city for the past twenty years. He has constructed many of the larger sewers in that vicinity, including the Topeka west side sewer, $85,000; Kansas City steam and conduit lines, $200,000; Monroe City, Mo., Paris, Mo., Centralia, Mo., and Salina, Kans., sewer systems, a water supply system at Chapman, Kan., and many other smaller contracts. Mr. Pringle is undertaking the laying of the Topeka east side sewer in spite of discouraging experiences on the west side sewer of that city, during the construction of which he encountered quicksand, solid rock, underground water, a cave-in and severe rain. It was on this job, which barely missed being disastrous to his profits, that Mr. Pringle used the first Austin trenching machine and the first back-filler used in Topeka. His present contract comprises 22 miles of 27-in. to 8-in. sewer and 6 miles of water connections covering the entire east side. The depth will be from 8 ft. to 25 ft., averaging about 12 ft. The contract price is $125,835.

OBITUARIES

Arthur R. Pardington, vice-president and secretary of the Lincoln Highway Association, died in a hospital in Detroit, July 28. His death was the result of a complete breakdown after months of hard work on plans for the great trans-continental highway.

NEW CATALOGUES

Bar Benders.—Paper, 3¼x6 ins.; 4 pp. Koehring Machine Co., Milwaukee, Wis.

Brief description of the Koehring bar bender and bar cutter, with halftone illustrations and tables of weights and capacities.

Drag-Line Buckets.—Paper, 6x9 ins.; 12 pp. The Brown Hoisting Machinery Co., Cleveland, Ohio.

Describes Brownhoist Shnable Patent dragline bucket, giving numerous views of operation and summarizing its advantages.

Enameled Conduit.—Paper, 4x9 ins.; 4 pp. Sprague Electric Works, 527 W. 34th St., New York City.

"Spragueduct," black enameled conduit is described with cut, price list and table of sizes. Also gives prices and sizes of couplings and elbows.

Cast Iron Soil Pipe.—Paper, 3½x6¼ ins.; 8 pp. Central Foundry Co., 90 West St., New York City.

Cast Iron Soil Pipe vs. Wrought Pipe for waste and vent lines in modern buildings is the subject discussed and illustrated in this booklet.

Air Lift Pumping.—Paper, 6x9 ins.; 16 pp. The Gardner Governor Co., Quincy, Ill.

Bulletin A-C 12, consisting of condensed suggestions for the installation of an air lift system of water pumping, tables of efficiency, and descriptive data on various standard types of Gardner air compressors. Illustrated.

"National" Products.—Paper, 8½x10¾ ins.; 32 pp. National Tube Co., Pittsburgh, Pa.

Bulletin No. 20, an index to "National Bulletins Nos. 1 to 20. It is extensively cross-indexed and should be very useful to those requiring information on any of the big list of "National" products. Illustrated.

Disc Crushers.—Paper, 7x9 ins.; 24 pp. Chalmers & Williams, Chicago Heights, Ill.

Bulletin in Spanish (Sección U-Cuarta Edición) describing the Symons disc crusher, designed for the South American trade. Describes the crushers in detail with half-tone illustrations, list of accessories and general specifications.

One-Fire Asphalt Plant.—Paper, 10½x7¾ ins.; 24 pp. The One-Fire Asphalt Plant Co., Chattanooga, Tenn.

Describes and shows numerous views of an asphalt plant which produces the steam for power and heats the mineral aggregate and the asphalt with one fire. Construction, operation, appurtenances and advantages are explained in detail, with half-tone illustrations.

Dump Wagons.—Paper, 5x8 ins.; 32 pp. Studebaker, South Bend, Ind.

Catalogue No. 1005 devoted to Studebaker bottom dump wagons and dump boxes. Illustrations show many styles of wagons, also road oilers, sprinklers and sweepers. Construction details and extra equipment are described with price list.

Building Construction.—Board, 7¼x6 ins.; 32 pp. Stone & Webster Engineering Corporation, Boston, Mass.

Describes pictorially numerous shops, factories, warehouses, mills, office, educational buildings, power stations, etc., erected by the company. The work includes a wide variety of construction problems and gives data showing material, sizes, etc.

Asphalt Roadways.—Paper, 9x6 ins.; 16 pp. The Barber Asphalt Paving Co., Philadelphia, Pa.

"Asphalt Roadways for Private Estates, Club Grounds and Parks" is the title of a handsome little book of views of roads on large estates, country clubs and parks. The text consists of a discussion of the best types of roadway for these purposes.

CATALOGUE REVIEWS

Lakewood Line.—Paper, 6x9 ins., 162 pp. The Lakewood Engineering Company, 506 S. Canal Street, Chicago.

The latest Lakewood publication, Book No. 17, with the title, "The Lakewood Line," shows notable Lakewood installations and many varieties of equipment. The line includes concrete mixing and distributing plants, steel cars, track layouts, concrete chuting systems, steel buckets, hoists, handling equipment, etc.

The first section is devoted to batch and paving mixers. Following, the subject of gravity distribution is discussed and the Lakewood chutes, towers, hoists, buckets and hoppers described. A large section is devoted to clam shell buckets and miscellaneous buckets. Contractors' cars are given nine pages. All of these sections contain numerous halftone illustrations, diagrams, tabular data, specifications, etc.

The last 56 pages are devoted to photographic illustrations of Lakewood installations, showing the equipment previously described on a great variety of construction work throughout the country. Some interesting structures are shown, such as the Princeton Stadium, the Yale Bowl, the new Lincoln Memorial, the piers for bridge over Hell Gate, said to be the largest concrete piers in the world, and numerous other large bridges and buildings. The concreting equipment is clearly shown in these photographs and data relative to plant and operations are given in the accompanying tests.

The catalogue is handsome in appearance with an attractive cover design showing the large concrete piers of the New York Connecting Railroad. It is mailed in a strong lockfold carton, and will be sent on request to those interested.

INDUSTRIAL NOTES

The Waterbury Co., manufacturers of manila, sisal and wire rope, has removed its general offices from 80 South Street, New York City, to 63 Park Row.

The DeLaval Steam Turbine Co. will build an addition, about 80 ft. by 120 ft., to the machine shop at its Trenton, N. J., plant. John W. Ferguson Co., Paterson, N. J., are the contractors.

C. G. McMurty, head of the advisory board of the American Sheet & Tin Plate Co., died suddenly in Atlantic City on Aug. 6. Up to 15 years ago Mr. McMurty was one of the most prominent factors in the industrial life of the Pittsburgh district, where he was active in the iron and steel business. He was the founder of Vandergrift, Pa.

The Gardner Governor Co., Quincy, Ill., recently has secured orders for three carloads of pumps ranging in sizes from the very smallest to some of the largest water works types. These have been ordered by three dealers in the United States, two located in the West and one located in the East. Orders for two small water works pumps have also been received from Indo-Burma.

The Dunn Wire-Cut-Lug Brick Co., of Conneaut, O., has engaged R. T. Stull, E. M. Cer., as its ceramic engineer. In taking this step the Dunn Co. was influenced by a desire to gives its licensees the benefit of the highest scientific assistance in perfecting the quality of their brick. This is an extension of the policy of the company as already developed in the maintenance of a corps of expert engineers who are supervising the constructional work.

The MacArthur Concrete Pile & Foundation Co., New York, N. Y., has been awarded following contracts recently: Concrete piles foundation and walls of the coal bunkers, trackways for coal handling bridge, etc., at the plant of Western Fuel Co., Oakland, Cal. H. S. Howard, Engineer, San Francisco, Cal. Pedestal concrete piles for the new Union Station and power house of the Canadian Pacific Ry. in Quebec. Downing, Cook Co., Ltd., general contractors, Montreal. Pile foundation of barrel storage warehouse at the Pratt Works of the Standard Oil Co., Long Island City. Turner Construction Co., general contractor.

RAILWAYS

PROSPECTIVE WORK

Georgia:

Macon, Ga.—Macon Terminal Co. has arranged for sale of $1,600,000 of bonds for construction of new terminal. Total cost of project, which involves yards and trackage, will be about $2,850,000.

Illinois:

Chicago, Ill.—Chicago & Western Indiana R. R. has sold $13,000,000 of 2-year 5 per cent notes. Proceeds will be used to retire $10,000,000 of notes and party for capital for improvements to property.

Aurora, Ill.—Chicago, Burlington & Quincy R. R. has started track elevation work at Aurora. Work will cost about $3,500,000 and will include numerous viaducts and bridges. Two 3-track street bridges will be erected over Fox River.

Iowa:

Dubuque, Ia.—Illinois Central Ry. is considering feasibility of enlarging East Dubuque tunnel.

Maine:

Lewistown, Me.—Project is under consideration for construction of 33 miles of electric railway from Topsham to Monmouth. Fred B. Teeling, Litchfield, Me., is interested.

Montana:

Helena, Mont.—Reports from this place state that construction will be started at once on railroad from Three Forks to Radersburg. Julius Rosholt, Fairmount, N. Dak., President of the Fairmount & Veblen Ry., is interested.

Nebraska:

Omaha, Neb.—It is reported here that the Chicago, Burlington & Quincy R. R. will resume work about Aug. 15 on construction of the Chalco cut-off, connecting up the Omaha and Sioux City lines.

North Dakota:

Fargo, N. D.—Representatives of Chicago, Milwaukee & St. Paul Ry. are reported to be securing right-of-way in Cass county, and it is said that the company contemplates extending its Ortonville-Fargo branch to Grand Forks, and possibly to Winnipeg.

Ohio:

Cleveland, O.—Nickel Plate R. R., it is reported, will start actual work on grade crossing elimination on West Side about Sept. 15. Improvement will cost about $3,000,000, of which one-fourth will be paid by city.

Oklahoma:

La Kemp, Okla.—Le Kemp & Northwestern Ry. Co. has been chartered with capital stock of $100,000, and propose 125 mile line across northwestern corner of state. George C. Warlick and L. N. Edwards, La Kemp, Okla., are incorporators.

Oklahoma City, Okla.—Central States Construction Co. has been incorporated with capital stock of $100,000 and will build system of interurban lines to connect Tulsa, Collinsville, Miami and Joplin. Incorporators include John R. Rose and J. R. Eldridge, Oklahoma City.

Pennsylvania:

Wilkes-Barre, Pa.—New company, of which F. A. Sawyer, of Towanda, is president, has acquired the Pittsburgh, Binghamton & Eastern R. R. Co.'s property and probably will complete the line. A considerable portion of the roadbed and bridges along the proposed route across Bradford and Susquehanna counties has already been built.

Bedford, Pa.—Right-of-way is being secured for a new railway. It is reported that the line will be built from Mt. Dallas on through "Black Valley" to Chaneysville and then to Little Orleans, Md. New York Central is reported back of the project.

New Castle, Pa.—Pittsburgh & Lake Erie R. R. is reported to be contemplating double-tracking Erie R. R. line from New Castle to Sharon.

South Carolina:

Columbus, S. C.—Southern Ry. has asked bids for remodeling and enlarging one of its passenger stations, at Spartansburg, including rearranging of tracks, paving, umbrella shed, underpass and underground waiting room; also bridge to carry Church St. across Pass.

South Dakota:

Mitchell, S. D.—Mitchell St. & Interurban Ry. Co. has been incorporated, capital stock of $200,000, and proposes street railway system for Mitchell and vicinity. Incorporators include O. E. Cassem and A. N. Hill.

Huron, S. D.—Contract may be let in the near future for construction of Duluth, Huron & Southern R. R., proposing line from Huron to Waubay and thence to Hankinson and Wahpeton, N. D. Work involves 3,700,000 cu. yds. of earth excavation and 5 post pile bridges, 3,100 lin. ft. in all. F. W. Henderson, Waubay, S. D., is President; Willard Richards, Waubay, Engineers in charge.

Utah:

Bingham, Utah.—Electric railway franchise here has been asked by Harry S. Joseph.

BIDS OPENED; CONTRACTS LET

Arizona:

Gila Bend, Ariz.—J. H. Maxey, Yuma, Ariz., has been awarded contract for grading, bridging and tracklaying for 38 miles of standard gage railroad from Gila Bend south to Ajo for Tucson, Cornelia & Gila Bend R. R. Grading will run about 6,000 cu. yds. per mile. There will be no concrete work or steel bridges. R. H. Jones is Chief Engineer of railroad.

New York:

New York City, N. Y.—Public Service Commission has awarded contract for Section 2 of routes 34 and 36 to Holbrook, Cabot & Rollins Corp. at $3,740,916. Contract for Section 3 of Eastern Parkway subway in Brooklyn was awarded to Rogers & Haggerty, Inc., at $2,170,652.

New York, N. Y.—Snare & Triest Co., New York, at $609,885, was low bidder on station finish on Sections 1 and 3 of Routes 36 and 37 and on Road 50 of rapid transit system. Charles Meads & Co., at $268,102, was low bidder on station finish of Section 2 of Routes 36 and 37.

New York, N. Y.—Bids were opened last week by Public Service Commission for furnishing 350,000 cu. yds. of ballast, consisting of trap rock, hard limestone and field stone. Calvin Tompkins was low bidder on two classes, and the Upper Hudson Stone Co. was low bidder on the other class.

South Carolina:

Greenville, S. C.—Southern Ry. has awarded double track contract as follows: Between Rocky River and Concord, N. C., H. H. Thrasher, Knoxville, Tenn.; Hayne to Greer, S. C., Cornell Young Co., Somerset, Va.; Greer to Greenville, S. C., Morrow Construction Co., Atlanta, Ga.

Tennessee:

Oneida, Tenn.—Harriman Const. Co., Harriman, Tenn., has been awarded contract for extension of main line of Tennessee Railway from Oneida toward Peters, 8 miles, with branch 3 miles in length.

Washington:

Bellingham, Wash.—Surveys for first section of Bellingham, Mt. Baker & Spokane branch of Puget Sound & Hudson Bay R. R. are now under way. Contract for first 16 miles of line between Bellingham and Deming has been let to Marsh, Hutton & Powers, New Westminster, B. C. Capt. E. J. Fader, New Westminster, B. C., is representative of English syndicate financing the project.

West Virginia:

Fairmont, W. Va.—A. L. Anderson & Bros., Altoona, Pa., have been awarded contract for constructing the Fairmont Helen's Run Ry., a 6 miles line, to be built for the Western Maryland Ry. It will extend from point near Chieftain, W. Va., on the B. & O. R. R. and will take coal fields of Consolidation Coal Co.

Wyoming:

Guernsey, Wyo.—Sprague & Nicely have moved their outfit here and are now working on the Burlington yards and round house.

Alberta:

Edmonton, Alberta.—Canadian Northern Ry. has awarded contract to J. D. McArthur, Winnipeg, for grading on line from Edmonton N. E. to St. Paul de Metis. Contract covers about 100 miles of grade.

New Brunswick:

Moncton, N. B.—John W. McManus Co., Ltd., Memramcook, N. B., has been awarded contract for 2 mile spur line from main line of Intercolonial to point near Bathhouse Lumber Co.'s mill.

ROADS STREETS

BIDS ASKED.

Alabama:

Geneva, Ala.—Until Aug. 27, by County Commissioners, for sand-claying roads; work to cost $4,616.

Thomasville, Ala.—Until Aug. 31, by County Commissioners, for sand-clay road construction, to cost $15,600.

California:

Eureka, Cal.—Until 10:30 a. m., Aug. 16, by County Supervisors, for constructing about 5,600 ft. of new road along the Mattole River, near Ettersburg. Fred M. Kay, Clerk.

Eureka, Cal.—Until 10 a. m., Aug. 16, by County Supervisors, for constructing about 2,850 ft. of new road along Honeydew Creek, in Road District No. 1. Fred M. Kay, Clerk.

Florida:

Tallahassee, Fla.—Until 4 p. m., Sept. 9. by A. H. Williams, city clerk, for paving, curbing, grading and storm drainage, in various streets. Isham Randolph & Co., consulting engineers, Heard Bldg., Jacksonville, Fla.

Fort Meade, Fla.—Until 7:30 p. m., Aug. 17, by Board of Trustees, J. J. Singleton, secretary, for 30,000 sq. yds. of paving with vitrified brick, asphaltic concrete, or bitulithic. H. S. Jaudon Eng. Co., consulting engineers, Savannah, Ga.

Illinois:

Champaign, Ill.—Until 4 p. m., Aug. 17, by Board of Local Improvements, F. C. Lohmann, Secretary, for 11,200 sq. yds. brick pavement.

East Dubuque, Ill.—Until 8 p. m., Aug. 16 by J. E. Heffron, City Clerk, for paving on Sinsinawa Ave. with bituminous macadam.

Chicago, Ill.—Until 11 a. m., Aug. 17, by Dept. of Public Works, for furnishing 475,000 paving bricks.

Cicero, Ill.—Until 8 p. m., Aug. 16, by Board of Local Improvements, James Ryland, Secy., for cement sidewalk on S. 60th Ave., and other avenues.

Chicago, Ill.—Until 11 a. m., Aug. 18, by Board of Local Improvements, for 21 contracts for street paving.

Chicago, Ill.—Until 11 a. m., Aug. 17, by Board of Local Improvements, for six contracts for street improvements.

Indiana:

Winamac, Ind.— Until Sept. 7, by County Commissioners for 3 miles of gravel road in Tippecanoe Township. Estimated cost $9,721. C. E. Paul, County Surveyor.

Greensburg, Ind.—Until 7:30 p. m., Sept. 6, by C. E. Patton, City Clerk, for curbs, gutters, sidewalks, etc.

Brazil, Ind.—Until 10:30 a. m., Sept. 7, by William O. Graeser, County Auditor, for two gravel roads and one stone road.

Angola, Ind.—Until 1 p. m., Aug. 26, by F. C. Dewey, County Auditor, for four roads.

Plymouth, Ind.—Until 1:30 p. m., Sept. 3, by County Commissioners, for two roads, one 2.67 miles, estimated cost $7,139; the other 2.09 miles, estimated cost $8,425. Both roads have 20 ft. subgrade with 9 ft. gravel pavement. Arthur W. Thomson, county surveyor.

Iowa:

Dubuque, Ia.—Until 8 p. m., Aug. 19, by J. J. Shea, City Recorder, for 7,430 sq. yds.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS
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The International Engineering Congress at San Francisco.

The directors of the engineering congress to be held next month at San Francisco ask the co-operation of American engineers. Because of the European war and its consequences the congress will be deprived of much of the attendance from abroad that was anticipated. By active work, however, it is asserted that insofar at least as number and quality of technical papers are concerned this drawback has been largely overcome. It is known to us that some of these papers are of very high quality and of exceeding interest and they, we are assured, are not exceptions. Membership in the congress does not involve attendance, nor without attending is one deprived of material return for his membership fee. Membership brings any selected volume of the proceedings which is a book in size and character well worth the sum represented. It also gives the privilege of purchase of other volumes at the same reasonable price. Engineers should not neglect consideration of this request of the congress for support.

Public Buildings and the "Pork Barrel."

A heavy blow to the "pork barrel" system of Federal appropriations has been struck by the Secretary of the Treasury. By recent action he has classified public buildings according to the amount of business to be done—a $10,000 building and not a $100,000 building will be built in a $10,000 town. Obviously this scheme is only common business sense and should have been made years ago, yet so accustomed have we become to contrary provisions that the change strikes one as surprising and deserving of exclamatory appreciativeness. The public building pork barrel has for years been only less capacious than the rivers and harbors pork barrel and Congress has fed its constituents as poorly from it. For two years now a handful of men in Congress has, by bitter struggle, kept the river and harbor barrel from becoming a hogshead. This has meant no more than that as much rich grabbing as they would like has been denied the majority of Congressmen. There has been no change of heart or sudden conversion on the part of this majority. It will seek to remedy the dearth of fat the moment those who stand in the way of plenty move aside. It has been within the power of the Secretary of the Treasury to rule in a measure against it—this commission of Congressional extravagance in Federal building construction. In the matter of river and harbor works there is, we believe, no such possible curb on Congress, and we can have little hope that Congress as a whole will develop any such ecstacy of common sense as to curb itself without coercion. No engineer and no contractor desires to see expenditures for public works placed on a basis of parsimony. It is better to err toward liberality. Nevertheless no engineer or contractor can or will defend a policy of allotment of expenditure based on no sounder basis than the cupidity of a Congressman wishing to make good with his constituents. A $100,000 improvement of a $10,000 creek is just as indefensible as a $100,000 post office in a $10,000 town. The ruling of the Secretary of the Treasury is encouraging. Perhaps in time we shall attain to the eminent intelligence of having a Department of Public Works which will take buildings from the treasury department, and rivers and harbors from the war department and roads and drainage from the department of agriculture and some dozen other types of engineering construction from other departments and finally take the whole task of allotment of funds for public works from Congress.

A Novel Method of Excavating for Caisson Foundations.

In our issue of Aug. 11, 1915, we published an article on the methods and equipment used in constructing the caisson foundations for a bank building in Stockholm, Sweden. The excavating methods used proved so effective and were so unusual as to warrant special mention. At one side of the building site the depth to bedrock was only about 10 ft. The rock surface shelved rapidly, however, and at the opposite boundary rock was encountered at a depth of about 60 ft. below the street level, or about 45 ft. below the ground-water level. The subsoil consisted principally of water-bearing sand and gravel, mixed with clay and boulders, in which the flow of water was so great that it was practically impossible to pump it. Moreover, it was deemed unsafe to lower the natural water level on account of endangering the foundations of adjacent buildings. To meet these conditions the following methods were devised:

Sectional caissons of reinforced concrete were constructed, circular in form, each section having an inside diameter of 7 ft., a height of 2 ft. 8 ins., and a thickness of 5 ins. The sections were provided with marginal recesses and with cored holes, through which passed the vertical rods used to fasten the sections together. The lower section, which was 6 ft. high, was provided with a steel cutting edge and with a steel lining, to protect it while the rock surface was being leveled by blasting. In excavating the subsoil within a caisson the material was loosened with a water jet and was removed through a suction hose, both of which were operated from the bottom by a diver. The excavated material was delivered through the suction hose and through a centrifugal pump into a settling basin, from which the water was drained off over a weir and conducted back, through a flume, to the caisson. Where large stones and boulders were encountered they were hoisted, but stones as large as 4 ins. in diameter were brought up in large quantities through the suction hose and pump. To facilitate the sinking of the caissons the motor-driven air compressor, used to furnish air for the drilling machines, was set up on top of a caisson as the latter was being sunk. This compressor vibrated considerably and the results obtained by its use in this manner were very satisfactory. After the caisson reached bedrock, the surface was leveled, by drilling and blasting, and the caisson was filled with concrete, deposited under water.

The contractor in charge of this work reported that the methods adopted proved both rapid and economical. We believe that equally satisfactory results can be obtained in many parts of this country. The use of similar methods in constructing the foundations of bridges and buildings, especially in water-bearing soils where there is likelihood of a settlement of adjacent structures, should prove both effective and economical.

A Sliding Salary Scale for City Engineers.

Convenience seems the only justification of the general practice of fixing the salary of city engineers by law and of basing such salaries on the size of the town served rather than upon the amount of work done. A much more logical procedure would be the payment of a minimum salary to the city engineer, based on the size of the town, and an additional sum proportional to the excess of the city's expenditure for public works construction over an amount defined by law as the normal average for the city according to its size. The first sum mentioned is in the nature of a "readiness to serve" charge. Manifestly the whole-time city engineer is entitled to a fair compensation for being on the job ready to handle routine and other work as it arises. The bonus mentioned would be an extra payment for extra performance. It is well known that municipal improvements are made spasmodically. It is inequitable to pay the city engineer the same salary year in and year out regardless of the amount of work done, particularly as the office changes hands frequently. Moreover there is ample justification for the statement that the salaries of city engineers are predicated more nearly upon the expenditures made in lean years in public improvements than in the fat years.

A step toward correcting the unfortunate and unjust condition now existing in this particular was taken at the latest annual meeting of the Indiana Engineering Society. The committee on legislation suggested a law whereunder the city engineer would be paid, in part, in proportion to his responsibilities in the expenditure of public funds. The chief provisions of the suggested law are as follows:

The mayor shall appoint a city civil engineer, who shall be subject to the board of public works, except in cities of the fifth class, where he shall be subject to the orders of the common council. Such city civil engineer shall receive a salary in cities of the first class of $2,500 a year, which may be increased by ordinance to not more than $3,500 a year; in cities of the second class a salary of $2,000, which may be increased by ordinance to not more than $3,500 a year; in cities of the third class a salary of $1,200, which may be increased by ordinance to a sum not exceeding $1,800 a year; in cities of the fourth class a salary of $1,000 a year, which may be increased by ordinance to a sum not exceeding $1,500 a year; and in cities of the fifth class a salary to be fixed by ordinance; provided, that in cities of the fourth class, where the cost of construction of public improvements authorized by said city and constructed under the designs of and under the supervision of the city civil engineer shall exceed $100,000 for any one year, and in cities of the third class where such cost shall exceed $150,000 for any one year, and in cities of the second class where such cost shall exceed $300,000 for any one year, and in cities of the first class where such cost shall exceed $300,000 for any one year, the city civil engineer shall, in addition to his regular compensation fixed by ordinance, receive an additional compensation equal to 1 per cent of the excess cost of construction over and above the amount designated for the city in which class such excess occurs, such additional compensation to be due and payable out of the general fund of such city upon final approval of the

assessment roll of each improvement after the total cost of improvements for the year have equaled the amount set forth for such city. It is further provided that in no case shall the total compensation of the engineer in any city exceed the sum of $5,000 for any one year.

This suggested law was discussed by the members of the society at the 1915 convention and will be taken up at the 1916 meeting for final discussion. If it is approved by a majority of those present and voting at the 1916 meeting an effort will be made to have it enacted into law in the state.

We quote this law because of its form rather than because of its specific provisions. We are not prepared to state in positive terms that the sums named are adequate or inadequate. Clearly there is room for difference of opinion in these particulars, but such differences can doubtless be composed after consideration and full discussion.

That the suggested law is basically sound we do not hesitate to affirm. Laws of this type in the several states will make for better salaries and better public works design and construction.

A Solution of the Construction Camp Club House Problem.

A noteworthy development of human welfare doctrine in construction camps is the recent co-operation with contractors of the Industrial Department of the Young Men's Christian Association. At perhaps a dozen large construction jobs of the U. S. Reclamation Service and of such corporations as Stone & Webster and J. G. White & Co., the Association has established and operated club houses and other welfare services with apparently universal success. It is interesting to note the functions on which this success has been based. They are recreation and entertainment. Abstract religious teaching is carefully subordinated. These facts are best brought out perhaps by a program of activities recorded by the Association Clubhouse of one construction camp:

1. EDUCATIONAL—
   (a) Reading room with daily papers and periodicals.
   (b) Library, a few books and State Traveling Library.
   (c) Distribution of old magazines.
   (d) Night classes in English for foreigners, and such other evening classes as might be called for.
   (e) Practical talks by experts on such subjects as: Handling Explosives, First Aid to the Injured, Concrete Construction, Irrigation, etc.
2. SOCIAL—
   (a) Games: Chess, Checkers, Shuffle-board, Pool, Billiards.
   (b) Phonograph.
   (c) Stereopticon, Reflectoscope or Moving Pictures.
   (d) Entertainments: Musical, Dramatic, etc.
   (e) Orchestra, Glee Club or Band.
   (f) Organ or Piano.
3. PHYSICAL—
   (a) Baseball.
   (b) Tennis.
   (c) Field Athletics.
   (d) Horse-shoe.
   (e) Volley Ball.
4. RELIGIOUS.
   (a) Sunday evening service with addresses by special speakers.
   (b) Song services.
   (c) Bible classes.
   (d) Council of Secretary with men regarding their personal problems.
   (e) Conducting burial or memorial services.
5. GENERAL—
   (a) Envelopes and writing paper furnished free.
   (b) Postage stamps and postcards on sale.
   (c) Mail for men handled by Secretary.
   (d) Purchases made in town for the men.
   (e) Checks cashed and deposits taken for savings.
   (f) Men in hospital visited.

Does this sort of service succeed? Letters from engineers and contractors connected with the works where these houses exist report that it does, and generally these men at the beginning felt if they did not express skepticism. As one contractor writes: "When I first heard of a Y. M. C. A. in a construction camp, I thought it was a joke, but it has more than made good in our camp." It has made good, it is also noted by several of the letters, not merely as a sociological experiment, but as a working investment. The men have been more easily retained, have worked more steadily, have caroused less, and have been more thrifty. In one camp, for example, that at the Arrowrock Dam in Idaho, the Association secretary encouraged and received deposits in bank during the year amounting to $112,865, besides issuing foreign drafts aggregating $2,240.

The plan of recreation rooms and means for athletic exercises and other entertainment is not novel in construction work. Many managers of such work have introduced it. The interest of the Y. M. C. A. plan to the contractor and engineer is nowise in its novelty but lies in the fact that it provides an organization fully equipped and trained to take a troublesome task off unfamiliar hands.

GENERAL

A Discussion of Depreciation.

Contributed by Philip J. Kealy, Kansas City Railway & Light Co., Kansas City.

Preface.

The regulation of rates charged by public utility companies is probably the most important economic subject before the American public, and an equitable solution of the many principles involved vitally affects the future prosperity of this country.

When the present status of rate regulation has been thoroughly analyzed and after both parties to the question have been heard, the arguments pro and contra invariably evolve on the question of proper operating expenses and the capitalization or amount of fixed charges under which the company is laboring. Indeed, the occasion of most of the rate regulatory investigations and applications has been furnished by the belief that the capitalization is and has been excessive, and the profits of the business exorbitant.

In the majority of instances where these charges have been substantiated, the excess capitalization has been due to the former policy of not setting aside a fund to provide for the renewals and continuance of the property; the cost of renewals having been capitalized instead of being charged against operating expenses, both an apparently favorable, but in reality fictitious, earning capacity and an inflated capital account were created. This practice resulted in a two-fold evil, for not only was the integrity of the original investment destroyed, but the fixed charges were necessarily increased by the additional interest. And as this policy was continued, there came a time when the fixed charges became so high that the payment of dividends was impossible, the bond interest was defaulted, the credit of the company was attacked, no additional bonds could be floated to finance needed extensions or betterments, and either of two courses had to be taken, increase the rates or become insolvent. An increase of rates is frequently impossible on the part of certain public utility companies, especially urban traction lines, and so it is that many traction companies have become bankrupt when dividends of 15 per cent were not exceptional in their early history; and when the reorganization takes place, it is not uncommon for an appraisal of the properties to show a physical value considerably less than the bonded indebtedness, leaving nothing whatever for the stockholders except the memory of their once high dividends.

If a company chooses to become bankrupt rather than to increase the rates, or because of the impossibility of so doing, the public pay more dearly for the early mismanagement than they would have had the rates been changed, in that poor service and worn out equipment will be accorded them during the several years in which the reorganization is being perfected.

On the other hand, the inability of the company to maintain its property at a high standard on the present rates may be due to the fact that the initial rates always have been too low, that it was never possible to set aside a fund sufficient to take care of depreciation, and pay even moderate dividends out of the returns from operation; in short, the public in the past years have received too much for their money. Indeed, such is actually the case in many cities at this time, in that either the company is forced, through the conditions of its franchise, to contribute too large a portion of its earnings to the municipality, or else the public is not being charged enough, considering the character of service rendered, to allow the setting aside of a renewal fund sufficiently large to conserve the investment, and also permit payment of a dividend equal to a fair return on the capital actually invested. Thus, it will be seen that the reason of the financial difficulties in which many public utility companies find themselves is due: first, to the inability or lack of foresight, mismanagement if you will, in not providing in the early life of the property, for a fund to offset the constant deterioration of their properties; and, second, to capitalizing renewal charges. Regardless of the reasons why the fund was not accumulated, the main concern at this time is that it generally was not provided for, although the necessity is now so evident.

It is then, when the revision of rates is under discussion, a matter of the utmost importance to the company and the public in determining the cost of service that the deterioration of the property be considered, and that means of renewing it be provided for; of importance to the company because it means the preservation of its credit, the assurance of a fair return on its capital, and the conservation of its property; of importance to the investor in that the bonds will always be safeguarded; and of importance to the public in that it will neither pay for what the previous generation should have borne, nor what the generation to come should bear, that a constant standard of service may be maintained, and that the cost of this service be the least possible commensurable with good business policy.

Discussion of Theories.

The purpose of this discussion is to outline a general method of providing for depreciation; that, given a specific property in which the life and value of its various parts are known, or approximately known, the amount of money necessary to replace them as they are worn out may be set aside; that the rate of depreciation for the entire property and the amount of renewal fund necessary to offset it may be determined by means of the tables and curves hereinafter given; and that this fund should be maintained out of the gross earnings, and be properly a part of the operating charges, in order that it may be possible to determine rates which will be sufficient to provide for the continuous operation of the property.

It is deemed advisable to define at this point just what is meant by the word "depreciation" in order that the subject matter following may not be misunderstood, and in an effort to correct the erroneous ideas of this subject which still exist. By depreciation is meant the constant deterioration or wearing away of physical property, the erosion, as it were, which destruction is independent of the maintenance of the property; it is a function of the age, as well as the service to which any physical article is put. Perhaps the following homely example will assist in comprehending the different terms associated and oftentimes confused with the word depreciation. Suppose a man purchase a suit of clothes which under normal conditions would wear two years. In order to obtain two years' service from these garments, certain amounts of money must be spent for cleaning, pressing, and, if the owner be an unhandy bachelor, for sewing buttons. These outlays would be maintenance expenditures, and regardless of the number of times the suit was cleaned and pressed, it would last but two years because of the constant wearing away of the fabric, or, in other words, no amount of maintenance can prevent depreciation, which in this case would be 50 per cent per annum. However, if the owner was an economical gentleman, it may be that the purchase of a pair of trousers when the suit was 18 months old would give an additional life of 10 or 12 months to the outfit. This purchase would represent a renewal charge. But, on the other hand, if instead of regularly cleaning the suit, it was neglected for some time and required more expensive tailoring than mere cleaning and pressing, this accumulated expense would therefore be deferred maintenance. There are so few things in actual practice that permit of perfect maintenance, which condition would, of course, wipe out depreciation, it may be considered a theoretical condition. It is to all intents and purposes a fact and generally so admitted, that no amount of maintenance can offset depreciation.

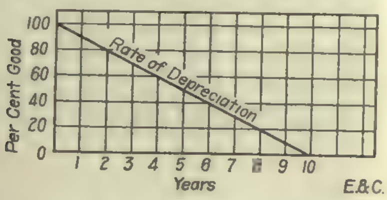


Fig. 1. Curve Showing Average Per Cent Condition of a Single Tie at Any Year. Scrap Value Neglected.

(Life of tie assumed to be 10 years.)

Another point about which considerable difference of opinion exists is in regard to the form that the depreciation curve should take; especially as to whether it should be considered as a straight line, or as a sinking fund curve. In this discussion all tables and curves have been based on a straight line depreciation curve, for in treating of an operating company, no other method is possible. As a matter of fact, there is no such thing as a sinking fund curve as applied to depreciation. Stripped of the high sounding verbiage which is all too frequently associated with this topic, for what purpose is a street car purchased? For nothing else than service. And if this car is expected to operate 20 years, when it is one year old, there are 19 years of service remaining, and when it has run 10 years, there are 10 years' service remaining. In other words, when one year old, it has depreciated 5 per cent; when 10 years' old 50 per cent. From an operating company's standpoint, there can be no other than a straight line depreciation curve, but it is not intended that such a curve would be applicable in determining the second-hand value of property, nor does it bear any relation to the renewal fund curve, which may take the form of any of several curves, the sinking fund curve among others.

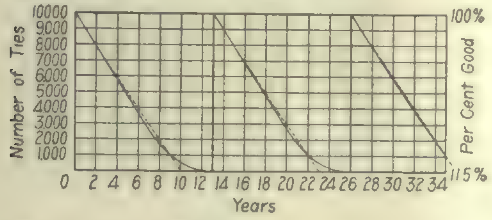


Fig. 4. Curve Showing Per Cent Condition of a Group of Ties During a Term of Years Assuming No Annual Renewals.

It is striking how most engineers are prone to confuse depreciation and the renewal fund, two entirely separate and distinct subjects, for in the past year, in at least five important contributions to the discussion of depreciation, the authors speak of the "sinking fund" curve of depreciation, and then proceed to discuss a renewal fund.

This discussion of the theory of depreciation, while applicable to any public service corporation, for the sake of brevity only treats of parts of the track of an urban street railway company.

The track is assumed to be of tee rail on untreated wood ties, bonded joints, the whole track to be on stone ballast, and the continuity of the roadbed broken by several tunnels or trestles, in short, of construction comparable with that of the average electric railroad.

These individual elements entering into the construction of what is termed track, although acting together to withstand traffic, from their very nature deteriorate at widely varying rates, as, for example, the timber trestles and ties wear out more rapidly than the metallic elements of track, such as the rails or joint plates, although they all combine to perform the same work. The rate of deterioration, or rate of depreciation, as it will hereinafter be termed, may also vary somewhat for each element under different conditions of service, as, for example, the ballast will have to be replaced at a rate dependent on the nature of the sub-soil, or on the density of traffic supported. In this discussion various elements of the track will be analyzed, and rates of depreciation will be assumed, which rates, however, do not apply to any particular property, location, or traffic condition, but are average, conservative estimates of the ultimate life of the element to which applied.

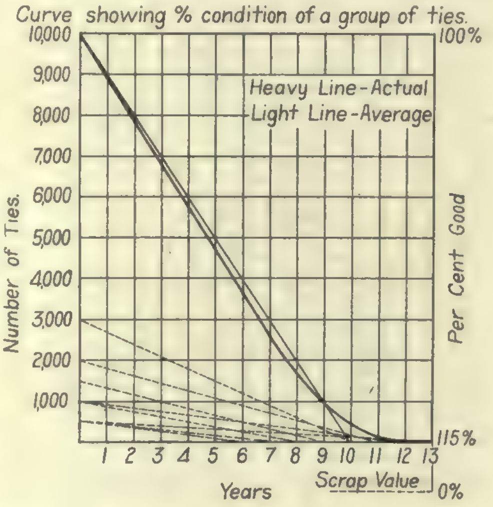


Fig. 3. Curve Showing Per Cent Condition of a Group of Ties.

THE TIE.

The first element considered will be the tie, since that is the least complicated of the many involved, and possesses a life which is more readily determined, and which is less a function of the work performed than any of the others. The ties have been assumed to have an average life of ten years, or to depreciate 10 per cent per annum, that is, a straight line depreciation has been taken. This is shown graphically in Fig. 1. In this case the assumption has also been made that the total cost of the tie is eventually worn out. As a matter of fact, even when the tie is worn out from the trackman's point of view, and discarded, it has a scrap value as cord wood, or for some other local use, resulting in a small return to the railroad company, even after the tie is removed, which means that the tie is never 100 per cent depreciated in the track. Assuming that the ties cost 70 cts. in place, and that they can be disposed of at 8 cts. apiece when removed from the track, the curve in Fig. 1 becomes the curve in Fig. 2. It will be observed from this curve, that when the tie is worn out, it has depreciated 88.5 per cent, or on the straight line depreciation, at a rate of 8.85 per cent per annum against 10 per cent where the scrap value has not been considered.

The foregoing assumptions have been made for individual ties, which have been given an average life of ten years. As a matter of fact, in actual practice, all the ties will not last ten years, although that may be the average life; but the period of renewals will start some years earlier than the tenth year and continue several years longer. For the purpose of this analysis it has been assumed that the first renewals would take place in the sixth year, and that thirteen years will be the longest life of any of the ties. Assuming a line having 10,000 ties in the track, we have estimated that 500 would be replaced in the sixth year, 500 in the seventh year, 1,000 in the eighth year, 1,500 in the ninth year, 3,000 in the tenth year, 2,000 in the eleventh year, 1,000 in the twelfth, and 500 in the thirteenth year. This rate of depreciation, provided the worn ties are removed, but not replaced by new ones, is as Fig. 3. The close relation of this curve to that of Fig. 2 should be noted. If no renewals were made, the history of the ties during any term of years, would be a series of curves, as of Fig. 3, extending over that time. This is shown in Fig. 4.

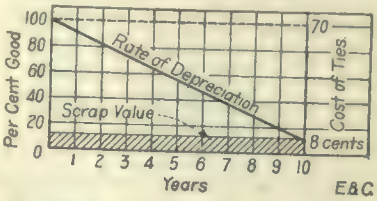


Fig. 2. Same as Fig. 1. Excepting That Scrap Value Has Been Considered.

This is, of course, an impossible condition when a road is in operation, for the ties in that case must be renewed in order to permit the continuance of traffic. What does occur is this; when in the sixth year the replacement of 500 ties becomes necessary, the life of the ties as a whole is extended by this renewal. These new ties will, in turn, vary in length of life in just the same proportion as the initial 10,000 or, in other words, the life of the ties will be raised by this renewal, but immediately after installation the new ties depreciate at the same rate as the entire lot were depreciating before their addition. Assuming that the ties are replaced as soon as they are worn out (as they must be to permit operation) on the schedule outlined above, the curve of Fig. 4 becomes that of Fig. 5-a for the life of the original number. However, when the property is maintained for a long term of years, at some future time the renewals will become almost constant. On that basis the curve in Fig. 4 becomes that of Fig. 5 when the property is maintained for a term of years beyond the life of the initial number of ties installed.

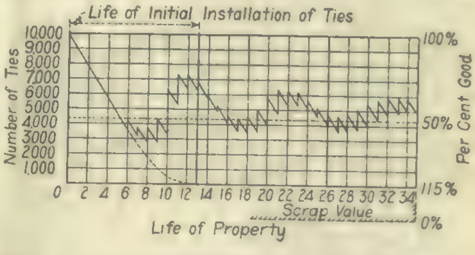


Fig. 5. Curve Showing Per Cent Condition of a Group of Ties During a Term of Years Assuming Renewals Are Made on Basis of Table 1.

From this curve it will be observed that, not only is the number of ties renewed each year becoming almost constant, although the number replaced in the early history of the track varied widely, but also, as the number of tie renewals is approaching an average number, the present value or condition of the ties is approaching a value more than 50 per cent of the cost new. On further consideration it will be found that no matter what assumption is made as to the order or amount of the tie renewals, provided they are not all renewed the same year, there will come a period in which the number of ties replaced each year will be almost the same, and at such a time the value of the ties will be more than 50 per cent of their cost. If the average life of the ties is longer than ten years, and this life does not vary more than two or three years, the average period of renewals will be late in the history of the track, but should the ties wear only a few years, it will come about very soon. The curve of tie renewals will, however, always take on the general form of the curve in Fig. 5, the exact form being determined by the history of the initial ties installed.

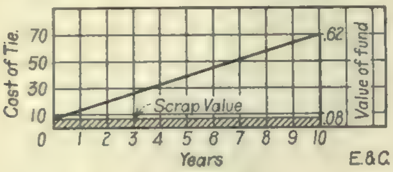


Fig. 6. Curve Showing Annual Amount Necessary to Set Aside in Order to Provide Fund to Replace Tie When Worn Out. No Interest on Fund Considered.

RENEWAL FUND.

Since at some time the tie wears out, and must be replaced, provision should be made for this replacement. The tie assists in carrying the traffic, is as necessary in the daily operation as the cars, and therefore is responsible for the money earned by operation in its own small way. This being true, a part of the money earned by the constant wearing out of the tie should be used to renew it. If the tie wore out in ten years, as in Fig. 1, then 100 per cent of its cost would be necessary to buy another one to put in its place, provided it is the intention to continue operation beyond the life of the tie, and this cost of renewal should properly be distributed over a term of years equal to the life of the element to which applied.

TABLE I.—ANNUAL NUMBER OF TIES REPLACED (10,000 ORIGINAL NUMBER).

On the assumption that of 10,000 ties
500 will be replaced in the 6th year
500 will be replaced in the 7th year
1,000 will be replaced in the 8th year
1,500 will be replaced in the 9th year
3,000 will be replaced in the 10th year
2,000 will be replaced in the 11th year
1,000 will be replaced in the 12th year
500 will be replaced in the 13th year, etc.

No. of ties renewed.	Year.																																		
....	1	....																																	
....	2	....																																	
....	3	....																																	
....	4	....																																	
....	5	....																																	
500	6	500																																	
500	7	500																																	
1,000	8	1.000																																	
1,500	9	1,500																																	
3,000	10	3,000																																	
2,000	11	2,000																																	
1,025	12	1,000...	25																																
550	13	500...	25	25																															
125	14	....	50	25	50																														
250	15	....	75	50	50	75																													
550	16	....	150	75	100	75	150																												
800	17	....	100	150	150	150	150	100																											
1,126	18	....	50	100	300	225	300	100	50	1																									
1,453	19	....	25	50	200	450	450	200	50	1	25	1	1																						
1,760	20	....	——	25	100	300	900	300	100	2	25	1	1	6																					
1,626	21	....	500	——	50	150	600	600	150	4	50	2	2	6	12																				
1,219	22	....		500	——	75	300	400	300	8	75	4	4	13	13	27																			
833	23	....			1000	——	150	200	200	5	150	8	8	19	25	28	40																		
528	24	....				1500	——	100	100	3	100	5	5	37	37	55	40	56																	
497	25	....					3000	——	50	1	50	3	3	25	75	82	80	56	72																
648	26	....						2000	——	——	25	1	1	12	50	165	120	113	73	88															
815	27	....							1000	25	——	——	——	7	25	110	240	169	145	88	81														
1,104	28	....									500	25	25	——	13	55	160	339	218	176	82	61													
1,298	29	....												125	——	28	80	225	436	264	162	61	42												
1,404	30	....													250	——	40	112	290	528	244	122	42	26											
1,360	31	....														550	——	56	146	352	488	183	83	27	25										
1,176	32	....															800	——	73	176	325	365	125	53	25	32									
1,047	33	....																1126	——	88	163	244	250	79	49	32	41								
764	34	....																	1453	——	81	122	166	158	75	64	41	55							
697	35	....																		1760	——	61	83	106	149	96	71	55	65						
865	36	....																			1626	——	42	53	99	192	122	110	65	70					
883	37	....																				1219	——	26	50	128	244	166	130	70	68				
1,046	38	....																					833	——	25	65	163	331	195	140	68	59			
1,182	39	....																						528	——	32	82	221	389	211	136	59	52		
1,243	40	....																							497	——	41	110	259	421	204	118	52	38	
1,229	41	....																								648	——	56	130	281	408	176	205	38	35
....	..	....																									815	——	65	141	272	353	157	76	35
....	..	....																										1104	——	70	136	235	314	115	70
....	..	....																											1298	——	68	117	209	229	104
....	..	....																												1404	——	59	105	153	209
....	..	....																													1360	——	52	77	140
....	..	....																														1176	——	38	69
....	..	....																															1047	——	35
....	..	....																																764	——
....	..	....																																	697

In the case of Fig. 1, this would mean that one-tenth of the cost of the tie should be set aside each year. However, since, when the tie is discarded, a part of its original cost will be returned in the scrap value, it will be necessary to set aside one-tenth of original cost minus the scrap value as shown by Fig. 6. This basis does not, however, take into account the interest accumulating on the money in the several years before it is spent, that is, if the annual amount necessary to be set aside in order to replace a 70 ct. tie in ten years is 6.2 cts. (from Fig. 8) should this money be invested each year, the fund would become an annuity, and the annual charge would be considerably less. Assuming that the fund can be so placed as to return 4 per cent interest per annum, the annual charge on the annuity basis becomes 5.146 cts. as shown in Fig. 7.

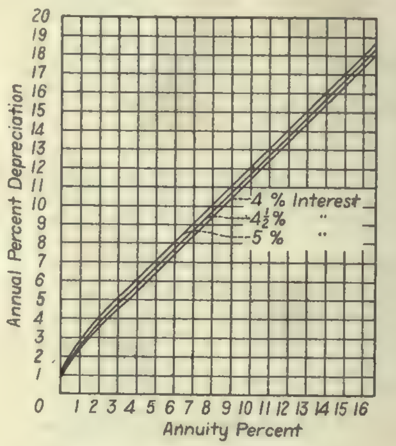


Fig. 8. These Curves Are Based on Tables III., IV. and V.

Tables III, IV and V have been prepared to show the annuity necessary to redeem a $1,000 property, depreciating at a rate varying from 1 per cent to 20 per cent per annum. In the first column is the life assumed, in the second the annual depreciation for that life. The third column shows the annual amount necessary to redeem $1,000 in the number of years shown in column 1, while the fourth column shows the amount necessary to redeem $1,000 in the same number of years, but on an annuity basis. The fifth column sets up the percentage of the amount actually put aside to the total amount of the fund when accumulated in the number of years in column 1. For example, if the life of a certain element of track is 15 years, and $66.66 were reserved as a fund to renew that element, at 4 per cent interest $1,000 would be in renewal fund in 15 years, and of this $1,000 from column 5 we find that 75 per cent is the amount actually

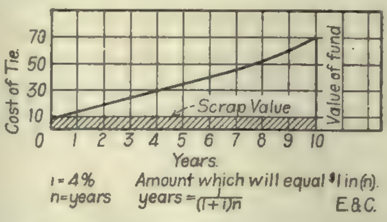


Fig. 7. Same as Fig. 6, Excepting Fund Has Been Figured on an Annuity Basis With Interest at 4 Per Cent.

TABLE III.

Annuity, rate of int., 4%.

Life in years.	Yearly per cent depreciation.	Annual depreciation on $1,000.	To redeem $1,000 in No. of years, Col. 1.	Ratio annuity to depreciation, per cent.	Per cent.
5.0	20.0	$200.00	$184.63	92.5	18.46
6.666	15.0	150.00	133.86	89.1	13.39
8.0	12.5	125.00	108.53	87.0	10.85
10.0	10.0	100.00	83.29	83.0	8.33
11.111	9.0	90.00	73.24	81.5	7.32
12.5	8.0	80.00	63.22	79.2	6.32
14.286	7.0	70.00	53.25	76.0	5.33
15.0	6.666	66.66	49.94	75.0	4.99
16.666	6.0	60.00	43.36	72.3	4.34
18.5	5.405	54.05	37.53	69.5	3.75
20.0	5.0	50.00	33.58	66.3	3.36
22.222	4.5	45.00	28.76	63.9	2.88
25.0	4.0	40.00	24.01	60.0	2.40
30.0	3.333	33.33	17.83	53.2	1.78
33.333	3.0	30.00	14.84	49.5	1.48
35.088	2.85	28.50	13.52	47.5	1.35
40.0	2.5	25.00	10.52	42.2	1.05
45.045	2.22	22.20	8.25	37.2	.83
50.0	2.0	20.00	6.55	32.7	.66
66.666	1.5	15.00	3.16	21.0	.32
100.0	1.0	10.00	.80	8.0	.08

TABLE IV.

Annuity rate of int., 4½%.

Life in years.	Yearly per cent depreciation.	Annual depreciation on $1,000.	To redeem $1,000 in No. of years, Col. 1.	Ratio annuity to depreciation, per cent.	Per cent.
5.0	20.0	$200.00	$182.79	91.5	18.28
6.666	15.0	150.00	131.97	88.0	13.20
8.0	12.5	125.00	106.60	85.3	10.66
10.0	10.0	100.00	81.38	81.4	8.14
11.111	8.0	90.00	71.34	79.2	7.13
12.5	8.0	80.00	61.34	77.7	6.13
14.286	7.0	70.00	51.41	73.5	5.14
15.0	6.666	66.006	48.11	72.2	4.81
16.666	6.0	60.00	41.57	71.0	4.16
18.5	5.405	54.05	35.78	66.3	3.58
20.0	5.0	50.00	31.87	64.6	3.19
22.222	4.5	45.00	27.12	60.3	2.71
25.0	4.0	40.00	22.44	55.5	2.24
30.0	3.333	33.333	16.39	49.2	1.64
33.333	3.0	30.00	13.49	45.0	1.35
35.088	2.85	28.50	12.21	43.0	1.22
40.0	2.5	25.00	9.34	37.3	.93
45.045	2.22	22.20	7.19	32.3	.72
50.0	2.0	20.00	5.60	28.0	.56
66.666	1.5	15.00	2.53	16.8	.25
100.0	1.0	10.00	.56	5.6	.06

TABLE V.

Annuity, rate of int., 5%.

Life in years.	Yearly per cent depreciation.	Annual depreciation on $1,000.	To redeem $1,000 in No. of years, Col. 1.	Ratio annuity depreciation, per cent.	Per cent.
5.0	20.0	$200.00	$180.98	90.5	18.10
6.666	15.0	150.00	130.08	87.7	13.01
8.0	12.5	125.00	104.72	83.6	10.47
10.0	10.0	100.00	79.50	79.5	7.95
11.111	.9.0	90.00	69.48	77.3	6.95
12.5	8.0	80.00	59.51	74.5	5.95
14.286	7.0	70.00	49.62	71.0	4.96
15.0	6.666	66.66	46.34	68.5	4.63
16.666	6.0	60.00	39.85	67.5	3.99
18.5	5.405	54.05	34.11	63.0	3.41
20.0	5.0	50.00	30.24	60.5	3.02
22.222	4.5	45.00	25.55	56.7	2.56
25.0	4.0	40.00	20.95	52.4	2.10
30.0	3.333	33.33	15.05	45.2	1.51
33.333	3.0	30.00	12.24	40.8	1.22
35.088	2.85	28.50	11.01	39.3	1.10
40.0	2.5	25.00	8.28	33.0	.83
45.045	2.22	22.20	6.25	28.1	.63
50.0	2.0	20.00	4.78	23.9	.48
66.666	1.5	15.00	2.01	13.4	.20
100.00	1.0	10.00	.38	3.8	.04

put aside and 25 per cent the compounded interest. In column 6 is given the annual percentage necessary to renew a property depreciating at a rate shown in the second column when the fund is handled as an annuity. Figure 8 has been prepared to show the amount of the annuity fund graphically. From the curves given on this table, the annuity per cent necessary to redeem a property depreciating from 1 per cent to 20 per cent per annum, bearing interest at 4 per cent, 4½ per cent or 5 per cent can be readily determined.

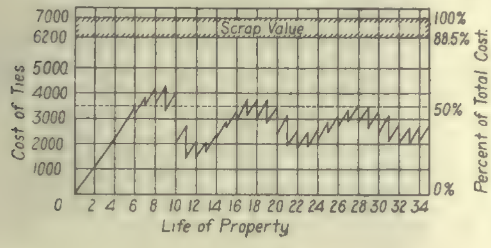


Fig. 9. Value of Renewal Fund, Showing Yearly Fluctuation.

TABLE II.

On the assumption that of 10,000 ties
1,000 will be replaced in the 9th year
8,000 will be replaced in the 10th year
1,000 will be replaced in the 11th year

No. of ties renewed.	Year.																												
....	1																												
....	2																												
....	3																												
....	4																												
....	5																												
....	6																												
....	7																												
....	8																												
1,000	9	....	1000																										
8,000	10	....	8000																										
1,000	11	....	1.000																										
....	12																												
....	13																												
....	14																												
....	15																												
....	16																												
....	17																												
100	18	....	100																										
1,600	19	....	800	800																									
6,600	20	....	100	6400	100																								
1,600	21	....	——	800	800																								
100	22	....	1000	——	100																								
....	23	....		8000	——																								
....	24	....			1000																								
....	25																												
....	26																												
10	27	....	10																										
240	28	....	80	80	80																								
1,950	29	....	10	640	640	10	640	10																					
5,600	30	....	——	80	80	80	5120	80	80	80																			
1,950	31	....	100	——	——	10	640	10	640	640	10																		
240	32	....		800	800	——	——	——	80	80	80																		
10	33	....				100	640	100	——	——	10																		
....	34	....							800	800	——																		
....	35	....									100																		
1	36	....	1																										
32	37	....	8	8	8	8																							
387	38	....	1	64	64	64	1	64	64	1	64	1																	
2,144	39	....	——	8	8	8	8	512	512	8	512	8	8	8	8	512	8	8	8										
4,870	40	....	10	——	——	——	1	64	64	1	64	1	64	64	64	4096	64	64	64	1	64	1	64	64	1				
2,144	41	....		80	80	80	——	——	——	——	——	——	8	8	8	512	8	8	[illegible]	8	512	8	512	512	8	8	8	[illegible]	
388	42	....					10	640	640	10	640	10	——	——	——	——	——	——	——	1	64	1	64	64	1	64	64	64	1
32	43	....											80	80	80	5120	80	80	80	——	——	——	——	——	——	8	8	8	8
1	44	....																		10	640	10	640	640	10	——	——	——	1
....	..	....																								80	80	80	——
....	..	....																											10

For a long term of years the curve for a renewal fund for any one tie having an average life of ten years would be a series of curves as of Fig. 7. Referring back to the first assumption as to the annual number of ties of the initial 10,000 which would have to be renewed, the renewal fund curve becomes that of Fig. 9, since a portion of the fund must be expended to pay for ties replaced.

There is given in Table VI, on which Fig. 9 is based, the amount of the renewal fund at any one year for the term of years covered in Fig. V. It will be noticed that the annuity charge is somewhat more than that required to redeem $6,200 in ten years (9.85 years), resulting in an average depreciation of 10.15 per cent. Had this table been figured on a 10 per cent annual depreciation, $520 annuity charge, the renewal fund would have been $655 less in the fortieth year, or a difference of 10.5 per cent of the total cost of the ties. From this statement the importance of determining the proper annuity charge or life of the element which the annuity is to replace, may be realized.

TABLE VI.—AMOUNT OF RENEWAL FUND.

To pay for replacement of ties on basis of Table 1, interest at 4%.

Annuity required, $526.40—say, $526.

Year.	Fund and interest for 1 yr.	Annuity.	Fund and interest plus annuity.	Renewal expense.	Balance in fund.
1	....	....	....	....	$ 526
[illegible]	$ 546	$526	$1,072	....	$1,072
3	1,115	526	1,641	....	1,641
4	1,707	526	2,233	....	2,233
5	2,322	526	2,848	....	2,848
6	2,962	526	3,488	$ 310	3,178
7	3,305	526	3,831	310	3,521
[illegible]	3,662	526	4,188	620	3,568
[illegible]	3,711	526	4,237	930	3,307
10	3,439	526	3,965	1,860	2,105
11	2,187	526	2,713	1,240	1,473
12	1,532	526	2,058	620	1,438
13	1,495	526	2,021	310	1,711
14	1,779	526	2,305	77	2,228
15	2,317	526	2,843	155	2,688
16	2,796	526	3,322	341	2,981
17	3,100	526	3,626	496	3,130
18	3,255	526	3,781	698	3,083
19	3,206	526	3,732	901	2,831
20	2,944	526	3,470	1,091	2,379
21	2,474	526	3,000	1,008	1,992
22	2,072	526	2,598	756	1,842
23	1,916	526	2,442	516	1,926
24	2,003	526	2,529	327	2,202
25	2,290	526	2,816	308	2,508
26	2,608	526	3,134	402	2,732
27	2,841	526	3,367	505	2,862
28	2,976	526	3,502	684	2,818
29	2,931	526	3,457	805	2,652
30	2,758	526	3,284	870	2,414
31	2,511	526	3,037	843	2,194
32	2,282	526	2,808	729	2,079
33	2,162	526	2,688	649	2,037
34	2,118	526	2,644	474	2,170
35	2,257	526	2,783	432	2,351
36	2,445	526	2,971	526	2,445
37	2,543	526	3,069	547	2,522
38	2,623	526	3,149	649	2,500
39	2,600	526	3,126	733	2,393
40	2,489	526	3,015	771	2,244
41	2,334	526	2,860	762	2,098

Table II has been developed to support the previous statement that no matter what the life of the ties, the curve representing the present condition of the property will take on the general form of that of Fig. 5, and that sooner or later in the history of the ties, depending on the length of the first renewal period, there will be a time when the number of ties renewed per annum will be almost constant, and at that time the present value of the ties will be more than 50 per cent of the original cost.

Figure 10 illustrates the combined value of the renewal fund and the present value of ties for any year during the term of years considered.

In conclusion it may be stated that, while the actual curve of depreciation may or may not be a straight line, for all purposes it may be so considered, that the average wearing value plus the scrap value of the ties, will be slightly more than 50 per cent of the cost new of the property when the renewal expenditures are almost constant, and also that, if the renewal fund is on the proper basis, the combined value of the renewal fund plus the present value of the property, will be more than 95 per cent of the original cost.

Particular attention is directed to the second conclusion, that when the renewals closely approach an average annual amount, the present worth of the wearing value of the physical property will be approximately 50 per cent of the cost new. This applies only to a property which is not expanding. Most public utilities, however, are located in growing communities where constant extensions and additions to plant are being made, with the result that this average, or 50 per cent condition, is materially raised by these added increments. The per cent by which the average condition of the property will be increased, owing to the fact that extensions are constantly being added, depends altogether upon the proportion that these extensions bear to the remainder or older portions of the property. It is frequently required that public utilities be maintained in from 70 per cent to 90 per cent condition. This condition is an *impossible requirement, unless the property be one which is growing rapidly* and from experience with a large number of public utilities (street railway, electric light and telephone companies), it would be the writer's opinion that it is impossible to maintain the average public utility in a better condition than from 80 per cent to 84 per cent of its cost new value, for to attempt to maintain the property to a higher per cent condition would mean discarding various elements before their full wearing value had been obtained. Realizing this condition, the American T. & T. Co., as well as the better managed independent telephone companies, seek to maintain a depreciation or renewal fund varying from 16 per cent to 18 per cent of the cost new value, so that the difference between the original investment and the depreciated value of their property is at all times available in a renewal fund. The significance of this condition and its resulting seriousness to the operating company lies in the fact that the present day tendency is to regulate, and determine rates of, service upon the depreciated value of the physical property, in other words, on an amount which represents 80 per cent and 85 per cent of the sum originally invested. Because of this fact alone, it behooves every public utility, unless it can effect a change in the present attitude of public service commissions, or desires what virtually amounts to a

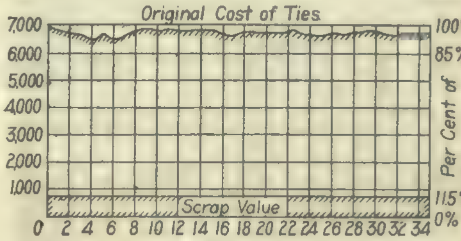


Fig. 10. Curve Showing Combined Value of the Ties and Renewal Fund at Any Year.

confiscation of approximately 17 per cent of its investment, to consider the accumulation of a renewal fund one of the most vital considerations in the operation of its business.

One point which has not been previously emphasized is that the renewal fund bears little or no relation to the gross income, although it is often provided that a certain per cent of the gross shall be set aside for renewals, and any attempt to provide a satisfactory renewal fund on that basis is not advisable, for depreciation is almost constant, while income fluctuates. The renewal fund should be worked out on the reproduction cost of the depreciable property independent entirely of the gross earnings.

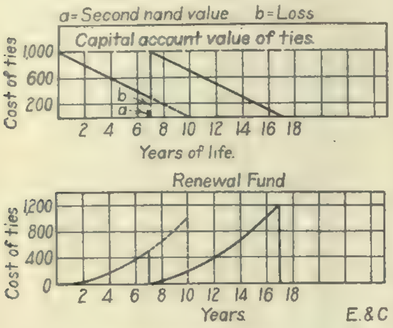


Fig. 11. Obsolesence Caused by Changes Resulting in Increased Earnings.

OBSOLESCENCE.

In the foregoing paragraphs the assumptions have been made on the basis that the full wearing value of the tie would be realized. This is not always the case, however, because for any one of several reasons, the tie becomes obsolete, and is discarded several years before the wearing value under the initial conditions is returned.

Obsolescence is of two varieties, differing widely in manner and method of handling. The first variety or kind of obsolescence is that in which the removal or replacement of the property will result primarily in increased earnings, and which may or may not improve the service. The other kind of obsolescence is that in which the replacement is occasioned by legislation or public improvements. For example, on a line over which hourly service with light cars has been furnished, because of the rapid growth of the territory served, it is proposed to operate with heavier cars on five minute headway. This change in weight and frequency of traffic will necessitate the renewal of a considerable number of ties immediately, whereas under the previous traffic condition, the ties would have performed satisfactorily for some time to come, but, since the change is accompanied by increased earnings, the company is justified in assuming the excess cost of the new ties over the amount accumulated in the renewal fund for their replacement plus whatever second-hand value exists.

TABLE VII.—AVERAGE SCRAP VALUE, PER CENT OF COST NEW.

	Per cent.
Track	5
Paving (contingent on per cent of granite used).	
Electrical distribution system	31
Rolling stock	5
Power plant and substation equipment	6
Fixed tools	5
Stores, supplies, floating tools	No depreciation
Furniture	0
Buildings	0
Real estate	No depreciation

As an example of the second kind of obsolescence, that caused by legislation, or public improvement, suppose on this same section of track an act of the municipality provided for the paving of the street in which the tracks existed, and as a preliminary step in such improvement, as is frequently the case, grooved rails were ordered to replace the girder or tee rails now furnishing satisfactory traction. The Company would, no doubt, have to replace the ties, as well as the rail, and yet no increased earnings would accrue from these changes, at least not for some time to come. In this case the entire excess cost of the new ties over the amount accumulated in the renewal fund, and the secondhand value, if any, could not be capitalized, because, as was stated, no increase in earnings is effected by the improvement, rather it is an additional tax placed upon the operating company by the municipality. How then will it be possible for the company to pay for these ties if the renewal fund is not large enough to take care of the expenditure, and no addition to capital is permitted? At the time of renewal a new fund will be started, which will redeem the ties last installed at such a time as when the full wearing value is absorbed, but the company has lost the wearing value of the ties existing when they become obsolete, and should be recompensed for this loss. And just as certain as the company's loss should be returned to it, so certain is it that the public should bear the amount of the loss either by increased rates or in decreased taxes (which may be levied in several ways), since the benefits brought about by the changes resulting in the loss were in the public's favor, and not the operator's. This means a double charge during a term of years, and results in a higher operating cost, but since the supposition is that the rates or taxes are based on cost of service, the public's return or the rates paid by them, would be changed so as to allow for the additional expense, thus throwing the cost of the improvement on the shoulders of the side profiting by it, but extending the payment of the cost over the terms of years, in which better service was given than would have been the case had no changes been made.

In passing it may be remarked that, no matter whether the cost of the renewal is less than, equal to, or greater than the amount in the fund at the time it is made, a loss equal to the amount of wearing value remaining in the ties, less the second-hand value, is placed upon the company by forcing the improvement.

The remarks on depreciation up to this point have been limited to a discussion of but one element of a property, the ties, and although it was stated in the first part of the paper that each portion of the track would be considered separately, the discussion has proven so much more lengthy than was initially intended, and since the theories outlined will apply to any other group of elements just as much as to the ties, no further remarks concerning the various other units of track will be made at this time.

RATES OF DEPRECIATION.

It is necessary, however, before applying the theories already outlined to any specific property, that definite information be available as to the performance of the different elements comprising the property, either in the track under consideration, or in some other track operated under analogous conditions. From this information approximately correct rates of depreciation may be assumed, and consequently the amount of the annuity determined upon.

It would perhaps be well to state at this time that all of the property does not depreciate, and that the first step will be to class the different items under the two general divisions, depreciable and non-depreciable property.

Among the items which may be classed as non-depreciable, and which represent a considerable part of the cost of the property are the following:

(1) Legal and franchise expenses,
(2) Carrying charges,
(3) Bond discount,
(4) Organization expense,
(5) Development expense,
(6) Real estate, including private right-of-way,
(7) Right-of-way damages,
(8) Excavation for track trench,
(9) Fills,
(10) Stores, supplies, etc. (on operating account),
(11) Concrete-lined tunnels,
(12) Concrete bridges and culverts,
(13) Filled trestles.

TABLE VIII.—AVERAGE ANNUAL RATES OF DEPRECIATION.

	Per cent.
Track	4
Paving (preferably by inspection)	8
Electrical distribution system	4½
Rolling stock	4
Power plant and substation equipment	3⅓
Fixed tools	2
Stores, supplies, floating tools—None	(Operating charge)
Furniture	10
Buildings (brick or concrete)	1½
Real estate	None

On the other hand, in segregating the plant account into the two divisions previously referred to, there should be included with the depreciable items the same proportion of the overhead charges for incidentals, organization or business management and engineering as the cost of the depreciable items is of the total value of the plant, likewise the labor charge covering the installation of the depreciable items, since these intangible costs or

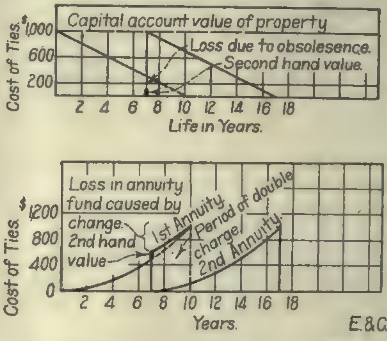


Fig. 12. Obsolesence Due to Legislation or Public Improvements.

TABLE IX.—PER CENT OF TOTAL CAPITALIZATION.

Appraised by	Traction Valuation Com., Chicago.					B. J. Arnold.	
Company	Chicago City, Capital.	Chicago Ry. Co., value.	South Chi. St. Ry. Co.	Southern St. Ry. Co.	Chicago & Sou.	*International Trac. Co., Buffalo, N. Y.	
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Track	21.72	24.18	29.61	33.66	43.40	30.40	30.78
Paving	4.52	5.42	10.14	22.32	10.72	11.35	7.15
Elec. dist. system	8.58	7.61	4.26	4.65	6.04	8.06	3.22
Rolling stock	21.91	16.81	14.42	10.64	15.01	18.22	18.89
Power plant equip	6.18	4.15	7.15	7.18	2.49	7.21	7.50
Fixed tools	.69	.95	.65	.38	1.02	.55	.71
Supplies, stores, floating tools	2.66	2.21	4.54	3.11	1.70	1.35	2.55
Furniture, buildings	9.27	9.15	.15	.11	.42	.16	.08
			6.51	7.08	8.88	7.03	5.45
Real estate	4.10	4.63	5.26	3.81	1.23	6.58	9.55
Miscellaneous	10.03	12.68	....	....	....	....	....
Overhead charges ?	10.34	9.65	7.26	7.06	9.09	9.09	13.04
	100.00	‡97.44	¹89.95	²100.00	100.00	100.00	³98.92

? Covers carrying charges, legal expenses and contingencies.

*From figures reported in Electric Ry. Journal, November, 1911.

‡Tunnels, 2.56 per cent.

[1] Fills, 10.05 per cent.

[2] Fills.

[3] Bridges and tunnels, 1.08 per cent.

values will be renewed when the element to which they are inseparably related is renewed and therefore will also depreciate at the same rates.

It is almost impossible to set up rates of depreciation whose application might be general, for these rates are dependent on so many local factors, on climatic conditions, and are so inter-related, each property must be considered separately. For example the life of the tie is determined first, by the kind of wood; second, by the section of the country in which it is located; third, whether treated or untreated; and fourth, by the type of the track itself, that is, whether or not ballast, tie plates or concrete have been used. The life of the rail likewise depends on the type of rail, tee or girder, on the type of joint, and on the amount of traffic carried, etc. And so on down the list, each item varying in length of life according to any one of several factors. For example, the life of treated ties imbedded in concrete has been estimated by Chicago traction engineers to be twenty-five years, whereas untreated ties in open track construction and under much less severe traffic conditions last but seven or eight years in the Pacific Northwest. The Consolidated Traction Company of Chicago had installed under service last year several built up cross-overs which were still in fair condition although seventeen years old, yet on the larger Chicago companies, layouts of solid manganese installed only a few years ago are in urgent need of renewal. There are several miles of track laid with 57-lb. tee rail in 1893 along the Canadian side of the Niagara River gorge, the rail of which is in excellent shape, yet on certain streets in Chicago the rail (7-in. tram rail) was worn out and discarded in comparatively a few years, although the car traffic was light, because the vehicular traffic had worn out and broken off the tram.

In other cases where interurban cars are using the urban lines the track plainly evidences the fact that it was never designed for the heavier cars and is very rapidly depreciating, by the low battered joints, uneven surface and poor alignment.

Therefore it is reiterated that general rates of depreciation can not be applied to a specific property with the idea of attaining any other than an approximate result, unless careful consideration is given to local conditions.

APPLICABLE TO A HYPOTHETICAL PROPERTY.

Having segregated the non-depreciable portion of the capitalization or "Cost to Reproduce New" value of the plant from the total value, the next step is to estimate the scrap and wearing values, since the depreciation will only be estimated on the latter. The writer has prepared Table VII representing the estimated average scrap value of the various portions of a traction system, which estimate is based upon ten or more appraisals covering some of the largest traction companies of the country:

TABLE X.

Item.	Cost new.	Scrap value.[1]	Wearing value.	Per cent annual deprec. rate.[2]	Annual depreciation.
Track	$20,000,000	$1,000,000	$19,000,000	4	$ 760,000
Paving	4,000,000	....	4,000,000	8	320,000
Electrical dist.	8,500,000	2,500,000	6,000,000	4½	270,000
Rolling stock	21,000,000	1,050,000	19,950,000	4	798,000
Power plant equip.	6,000,000	360,000	5,650,000	3⅓	188,333
Fixed tools	600,000	30,000	570,000	2	11,400
Supplies, stores, etc.	2,600,000	Not depreciated.		..	....
Buildings and fixtures	9,200,000	....	9,200,000	1½	138,000
Real estate	4,100,000	Not depreciated.		..	....
	$76,000,000	....	$64,370,000	..	$2,485,733
Carrying charges, etc., 15 per cent	$11,400,000				
Bond discount	8,000,000				
Cost new of property	$95,400,000				
Annual depreciation	$ 2,485,733				
Life of property (is 25.9 years)	64,370,000				
	$2,485,733				

[1]From Table VII. [2]From Table VIII.

No scrap value has been allowed on buildings since the cost of tearing down the structure will offset any return for salvage. High salvage value of Electrical Distribution System is due to the comparatively large scrap value of copper wire.

From this table, knowing the "Cost New" of a property, the wearing value of the depreciable part of the property may be calculated and an average annual depreciation then determined by applying to the various elements comprising these items the depreciation rate which experience has proven should apply on the particular property under consideration. For reference there is given in Table VIII average rates of depreciation based upon the rates which were applied in the appraisals referred to above:

In Table IX there is given the per cent of the total "Cost New" value which the individual exhibits represent, in order to illustrate the fact that the annual depreciation will differ widely on each property because of the varying proportion of the non-depreciable items.

When the amount of the estimated annual depreciation has been found the per cent that this sum is of the total wearing value should next be determined and from this the average life of the property may be ascertained.

Table X illustrates all the steps so far outlined on a hypothetical property.

Since for many reasons it is convenient to express the annual depreciation as a percentage of the total Cost New of the property the rates of the annual depreciation to the sum of both depreciable and non-depreciable portions of the property should then be obtained, which percentage will be the per cent of the total capitalization which should be annually set aside in order to provide a fund which will offset the estimated depreciation of the property in the number of years previously determined. In the example worked out above, this annual per cent would be $\frac{2,485,733}{95,400,000}$ or 2.61 per cent on a straight line basis.

Since this renewal fund should be on an annuity basis, the net amount to be annually set aside would be the annuity, which at 4 per cent or 5 per cent interest would equal $2,485,733 in 25.9 years, or approximately 60 per cent of 2.61 per cent—the straight line percentage of the total capitalization or plant value. As this percentage is based upon the ratio of an amount which is the sum of different percentages of varying other amounts to an amount which in turn also comprises widely differing items, the annual rate of depreciation will quite likely be different in every property. In other words, since the relative values of the major divisions of the plant, the rates of depreciation and the per cent of the total capitalization which is represented by non-depreciable property will vary in each property, no hard-and-fast-rule can be given, but rather each property is a problem by itself. Yet several state commissions prescribe that a certain flat percentage of the gross earnings shall be set aside by every public utility company under their jurisdiction to cover depreciation. There is no fixed general relation between annual depreciation and gross earnings.

As an illustration of the error of attempting to estimate depreciation as a per cent of gross earnings and the result of overlooking the importance of only calculating it on the depreciable portion of the plant, in a recent case the officials figured, correctly enough, that the life of the depreciable property would be about 20 years but that the depreciation would be 5 per cent per annum, which in turn meant that 25 per cent of the gross should be annually set aside. Since their operating ratio was about 73 per cent, leaving but 2 per cent to meet fixed charges, taxes and pay dividends, the early finish of the property appeared to be imminent, until the error of their assumption was pointed out.

BRIDGES

A Simple Method for Determining Two-Hinged Arch Reactions.

Contributed by C. S. Whitney, New York City.

The writer recently made use of a very simple method for obtaining the horizontal reactions of two-hinged solid web arch ribs which renders the analysis of such arches practically as easy as that of three-hinged arches. The method is based on Maxwell's theorem of the reciprocal relations existing between the displacements of the points of elastic structures, and is an application of Culmann's graphic method of determining elastic curves. The solution is so easy and accurate that the writer was surprised to find that there appeared to be no description of it in English. Only the most common case of the symmetrical rib with a varying moment of inertia and vertical loading will be considered here.

THEORY.

Consider the arch rib *A B C* (Fig. 1), supported on rollers at *A* and hinged at *C*, acted upon only by the equal horizontal reactions *H* at each end. According to Maxwell's theorem the vertical displacement of any point *a* produced by a horizontal force acting at *A* is equal to the horizontal displacement of the point *A* produced by a vertical force acting at *a*. From the common theory of elasticity, we have $\triangle'_{aA}$, the vertical displacement of any point *a* relative to the tangent at *B*, caused by a horizontal force of unity acting at *A*, equal to

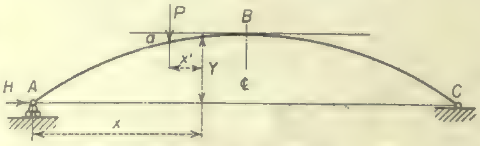


Fig. 1.

$$\int \frac{Mx'ds}{EI};$$

or since *y* is the moment at any point

$$\triangle'_{aA} = \int_a^B \frac{yx'ds}{EI}.$$

The vertical displacement of the point *A* due to this load is

$$\int_A^B \frac{yxds}{EI},$$

and hence the vertical displacement of any point *a* relative to the chord of the arch *A C* is

$$\triangle_{aA} = \int_A^B \frac{yxds}{EI} - \int_a^B \frac{yx'ds}{EI}.$$

From Maxwell's theorem $\triangle_{aA}$ is also equal to the horizontal displacement of *A* due to the vertical load of unity at the point *a* on the rib.

The horizontal displacement of *A* under unit horizontal load applied at *A* is

$$\triangle_{AA} = \int \frac{Myds}{EI} = \int_A^C \frac{y^2ds}{EI}$$

The final horizontal displacement of the point *A* when the rib is acted upon by a vertical load *P* and a horizontal reaction *H* will then be (still considering *A* on rollers),

$$\triangle = P\triangle_{aA} - H\triangle_{AA}.$$

For constant temperature and fixed hinges $\Delta = 0$, or

$$H = P\frac{\triangle_{aA}}{\triangle_{AA}}.$$

GRAPHICAL SOLUTION.

For graphical treatment, the arch rib should be divided into parts so that $\frac{\Delta s}{I}$ is constant. The number of divisions depends on the accuracy desired, but 18 or 20 are ordinarily sufficient. Then assuming a constant value of *E*, the modulus of elasticity, the formula becomes

$$H = \frac{P\left[\Sigma_A^B yx - \Sigma_a^B yx'\right]}{\Sigma_A^C y^2}$$

The graphical solution of this equation is very simple, and is shown in Fig. 2. The summations of the products of *xy* and *x'y* and y^2 are obtained by laying off the values of *y* vertically and horizontally for the force diagram with its pole at *O*, and then constructing the two funicular polygons *CD* and *GH* with their sides parallel to the corresponding rays. From the polygon *CD*, $\Sigma yx'$ equals the ordinate between *CD* and *DE* multiplied by the pole length *p*, and $\Sigma\, xy = p\,.\,CE$.

Hence

$$\Sigma_A^B yx - \Sigma_a^B yx' = y'p$$

From the other polygon, *GH*,

$$\Sigma_A^C y^2 = c\,.\,p'$$

Then the horizontal reaction produced by a load *P* at any point is equal to $H = P\frac{y'p}{cp'}$ or, since *p* was made equal to *p'*,

$$H = P\frac{y'}{c} = P y''.$$

The ordinate of the influence line is $y'' = \frac{y'}{c}$.

In measuring the ordinates of the funicular polygon, the ordinates under the points of division of the arch ring should be taken and not those of the mid-points of the different values of Δs.

Temperature stresses may be found in the following manner: The horizontal displacement of the end due to a change in temperature Δt would be Δtle (where l = span in feet and e = coefficient of expansion), if the end was on rollers, and the horizontal force required to bring it back is found by equating Δtle to $H\triangle_{AA}$, or

$$H = \frac{\triangle tle}{\triangle_{AA}} = \frac{\triangle tle}{\int_A^C y^2 \frac{ds}{EI}}$$

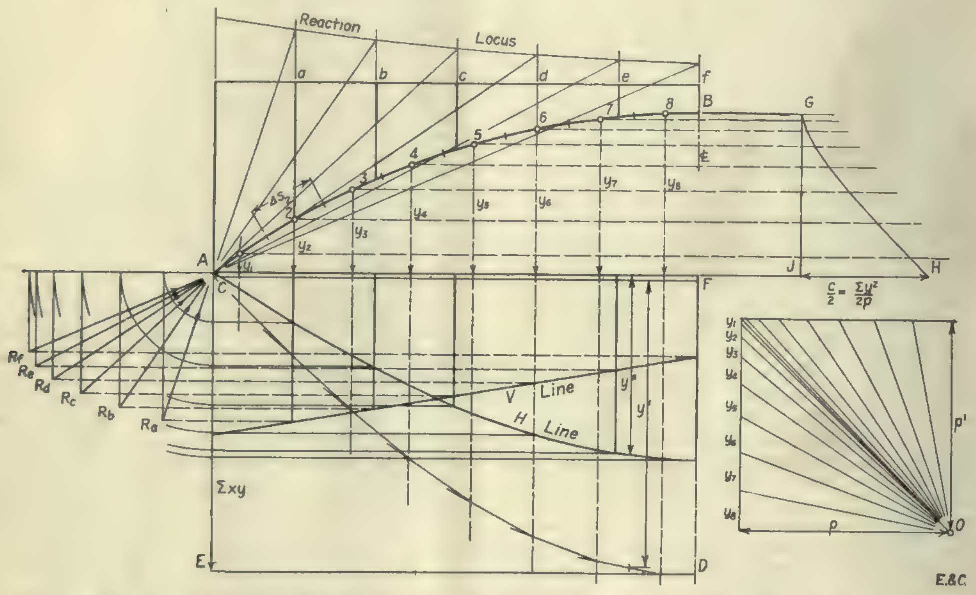


Fig. 2. Graphic Determination of Reactions of Two-Hinged Arch.

This is found from the graphical work by the formula,

$$H = \frac{\Delta tle}{cp'\frac{\Delta s}{EI}}$$

In the preceding manner, the horizontal reactions at the end hinge for a load at any point is found, and the problem is reduced to one of simple statics by merely drawing two polygons. The number of panels of the bridge makes no difference in the solution nor does the shape of the arch rib or the manner of variation of the moment of inertia so long as they are symmetrical. The arch shown in Fig. 2 was assumed to be divided into 12 panels by verticals at *a*, *b*, *c*, *d*, etc. The corresponding ordinates of the *H* and *V* influence lines were projected over to the end hinge, and the reactions were drawn in and the reaction locus located for half the span. For this simple case of the symmetrical arch only one half of the arch rib need be considerd in finding the reactions.

This method is an application of a general method which may be used for the solution of any form of continuous beam or arch rib whether free or hinged. It is in common use in Europe and deserves wider recognition in this country. There is no doubt that the graphical solution is sufficiently accurate for the purpose of practical design. The writer has found that the error can easily be kept within 1 per cent or smaller if desired.

Reconstruction of Piers of Little Rock Junction Bridge Across the Arkansas River at Little Rock, Ark.

(Staff Abstract.)

PART II.

In our issue of Aug. 4, 1915, we published Part I of this article, the published portion treating of the conditions existing at the site of the Little Rock Junction bridge over the Arkansas River at Little Rock, Ark., of the early difficulties due to the displacement of some of the piers, and of reconstruction work done on pier No. 4. This article treats of work done in connection with the reconstruction of piers Nos. 3, 4 and 5.

PLAN ADOPTED AND WORK OF RECONSTRUCTING PIER 3.

The method of reinforcement finally adopted for pier No. 3 consisted of securing additional supporting power by the use of a pneumatic caisson on each side of the old pier. This was extended later by adding caissons for the ends, forming an annular caisson surmounted by a cofferdam, the space above the annular caisson to be filled with concrete, doing the same to the crib, and encasing the old pier in a new reinforced concrete shell.

The delay in arriving at a decision as to what should be done at pier No. 3 consumed the best working months of 1912. The change to pneumatic construction, necessitating the assembling and erection of the pressure plant and the construction of the caisson, further delayed the work up to the time of flood period. The compressor plant was finally ready, and the steel caisson was shipped early in November, 1912. Figure 4 shows the general features and details of the annular caisson and cofferdam. The old records showed the old caisson under pier No. 3 to be 14 x 31 ft.; therefore the dimensions of the inner cutting edges of the new caisson were made 16 x 33 ft. The caisson was made of steel primarily to reduce its necessary width and consequently the displacement; the presence in the old bridge-material yard of a large number of duplicate second-hand floorbeams, which could readily be converted into a caisson, also encouraged the use of steel.

It was decided to build up a cofferdam on the outer wall of the caisson, and to connect the cofferdam to steel lattice work or towers bolted to the roof of the caisson. These towers were provided in order to form the backbone of the rigid framework it was known would be required to brace the new cofferdam against the old crib during excavation.

The greatest care was taken in the design of the joint between the caisson and the cofferdam. The timbers in the bottom row, 8 ins. thick, were cut to fit the steel as closely as possible, and were set in a bed of hot tar and oakum. Surfaced timbers were used, and each layer was set on the next below in hot tar and caulked. Tar-paper was then placed over the timbers, and 2-in. matched sheeting placed outside. The lower ends of the sheeting were driven into a groove, filled with hot tar and oakum, over the roof of the caisson, formed between the bottom timber and the upstanding leg of the angle at the top corner of the caisson. A space about ½ in. wide between the sheeting and the angle was then caulked. To bind all parts together effectually, and to provide additional weight for sinking, a 2-ft. 6-in. layer of concrete was then placed over the roof of the caisson enclosing the bottoms of the towers. This concrete was banded to the steel roof by a large number of ¾-in. bolts, 21 ins. long, fastened to the steel plate and extending vertically into the concrete.

The construction of the remainder of the cofferdam was similar to that just described.

For the support of the annular caisson during the assembling and sinking, until the entire load rested on the river bed, the temporary support from the pier and trusses shown in Fig. 4 was provided. Two 8x16-in. x28-ft. timbers were placed across each end of the pier, as close as possible to the truss shoes. The coping stones at each end had to be removed in order to place the timbers low enough to permit the draw-span to swing over them. The ends of the timbers were held up by inclined struts gained into their under sides and set in grouted notches cut into the masonry of the pier. For additional stability and stiffness, the north end was connected by rods and struts to the end posts of the north span which, in turn, were stiffened by timber struts (similar to collision struts) running down to the first panel points. On account of the necessity of having the draw-span free to swing, it was not possible to provide corresponding connection with the end post on the south side of the pier.

Four 3-in. steel rods, threaded for their entire length, were passed through between the ends of the timbers, the nuts on them resting on heavy plates over the timbers, and the lower ends of the rods reaching down to chairs made of rails supporting other smaller rods in pairs, on which the long sides of the caissons were supported near the water level after being floated out to the pier. The short sides or ends were then floated on barges and connected to the long sides by machine bolts. After the caisson was assembled and caulked, and all shaft, pipe, and wire connections were made, it was lowered into the water and the construction of the cofferdam was started.

During and after the placing of the 30-in. layer of reinforced concrete over the roof of the caisson, the sinking progressed as fast as the work permitted. At the commencement of sinking the river bed at the downstream end of the caisson was several feet higher than at the upstream end. As the caisson was lowered, the sand scoured deeper and deeper at the upstream end, and the workmen shoveled the sand from the downstream end of the caisson into the water at the upstream end until the cutting edge landed all around, following which the sand and other material, much of which consisted of heavy riprap and logs (almost petrified), were removed in buckets through the locks. The removal of the sand formerly against the downstream end of the pier relieved it of pressure to such an extent that it partly righted itself. Trouble was continually experienced by the caisson catching on the protruding upper ends of the sheeting planks of the old crib, which had been torn loose by the settlement of the timbers and bulged by the pressure of the material escaping from the crib. These were particularly annoying before the cutting edge rested on the river bed, as the workmen had to pick their footing in the caisson. On all the old records available the caisson of the old pier was shown to be plumb, and a clearance of 2 ft. was supposed to have been allowed between it and the new caisson, but it was found that the old caisson had a sharp batter, which necessitated ripping off the old vertical sheeting before the new caisson could be landed. The cutting edge of the old pier was founded on rock everywhere except at short dips which had been filled with concrete.

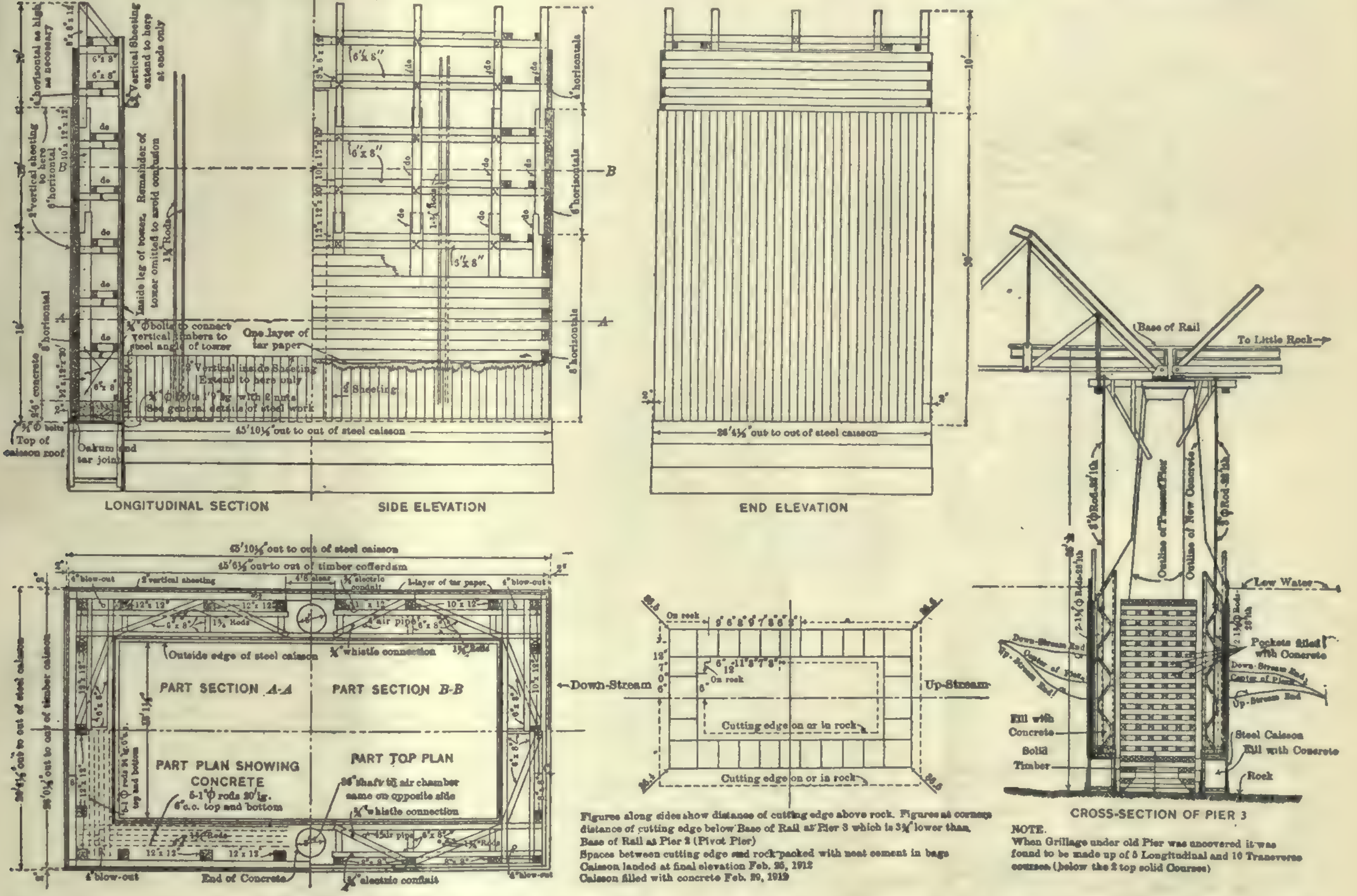
All the material within the new caisson had to be removed through the locks, because sufficient pressure could not be maintained to force the sand through the blow pipes. This was caused by all the material between the old and new work running into the caisson and leaving the inner cutting edges usually exposed; and, when an attempt was made to increase the pressure to blow out the material, the air would blow out under the inner cutting edge instead. As it was desired to avoid the resulting washing out of sand from the old crib caused by the commotion in the water during these blow-outs, the efforts to use the discharge pipes were abandoned. "Mattson" locks were used, and they permitted the rapid removal of the material. No other particular difficulties were encountered.

The cutting edges were everywhere landed on rock, except over short dips, which were cleaned out and filled with concrete. The working chamber was filled with concrete carefully rammed to the roof, and before it had set, the lower sections of the shafting were also filled with grout.

While the caisson was supported from the pier the inspector was required to compute daily and report weekly the weight supported. To guide him in the control of the work, and to avoid overloading the temporary supports, he was told the maximum weight that could be allowed, and was given a copy of a typical programme of work and a tabular summary of weights, together with the following instructions, the whole idea being to control the construction and sinking in such a manner as to keep the smallest load on the rods and take advantage of the immersion.

The weight of the steel caisson, the cofferdam surmounting it, and the layer of concrete over the roof was not sufficient to sink the caisson after the river bed took the load off the rods. Inner forms for concrete in the ends of the cofferdam were built up as the caisson was lowered, and concrete was deposited in them with bottom-dump buckets as the weight became necessary. Rods were placed in this concrete projecting from the inner face so as to form a bond with the remainder of the concrete to be placed later.

While waiting for the concrete in the working chamber to set, preparatory to pumping out the cofferdam, a rapid rise came down the river and overtopped the dam on Feb. 29, 1912. The water subsided in about six weeks, and when pumps were started it was found that the cofferdam had acted as a settling basin and was full nearly to the top with fine packed sand. The removal of this sand proved very burdensome, slow, and expensive, especially on account of the presence of the numerous braces. In the face of another rise, the dam



Figures along sides show distance of cutting edge above rock. Figures at corners distance of cutting edge below Base of Rail at Pier 3 which is 3¼" lower than Base of Rail at Pier 2 (Pivot Pier)
Spaces between cutting edge and rock packed with neat cement in bags
Caisson landed at final elevation Feb. 26, 1912
Caisson filled with concrete Feb. 29, 1912

NOTE.
When Grillage under old Pier was uncovered it was found to be made up of 5 Longitudinal and 10 Transverse courses (below the 2 top solid Courses)

Fig. 4. Details of Timber Cofferdam Used in Making Repairs at Pier 3 of Little Rock Junction Bridge—Cofferdam Rests on a Steel Caisson.

was extended up to 52 ft. above the caisson, but the water went over that again several times and stayed up for a considerable period, depositing more sand within the dam. The removal of this material, however, presented no difficulty other than the cost and delay. One pump easily controlled the leakage up to a 50-ft. head, giving a dry dam within which to work on the old pier. The filling of the old pier was found to consist of some riprap and more sand. In order to remove the sand, much rock had to be taken out. In fact, all the loose rock was removed with the sand, and only the tight rock was permitted to remain. The latter and the entire inside of the crib were washed out with a strong jet and then filled carefully with concrete. On account of the rather rapid settlement of the pier upsteam, that end of the crib was first concreted, and, following the placing of that stiffener, the squeezing of the timbers at the downstream end caused the pier to settle in the other direction, righting itself several inches. The entire space inside the cofferdam was filled with concrete, being brought up as the concreting of the crib progressed.

After filling the crib and the surrounding space with concrete, the pier was safe, but, as it was canted so much that it presented a poor appearance, and as the draw-span had only a very small bearing on the pier and was causing the upper courses of masonry to break away, the pier was encased in a reinforced concrete shell. As the new caisson had made the footing large enough, the reinforcement was built for double-track. Figure 5 shows the details of the reinforced pier.

The tie bars at the bottom were placed through bolts cut in the pier, and grouted in. The bridge seats under the spans were entirely renewed in concrete finished at the proper level for double-track spans. The difference in level was made up by concrete pedestals placed in sections.

No falsework was used for the suport of eithr span, and the bridge was never out of service during the conduct of the work.

The outer surfaces of the timbers in the crib under pier, No. 3 were squeezed down at the ends an almost imperceptible amount. The upper timbers were burst open on account of the crushing load.

RECONSTRUCTION OF PIER 4 IN 1912.

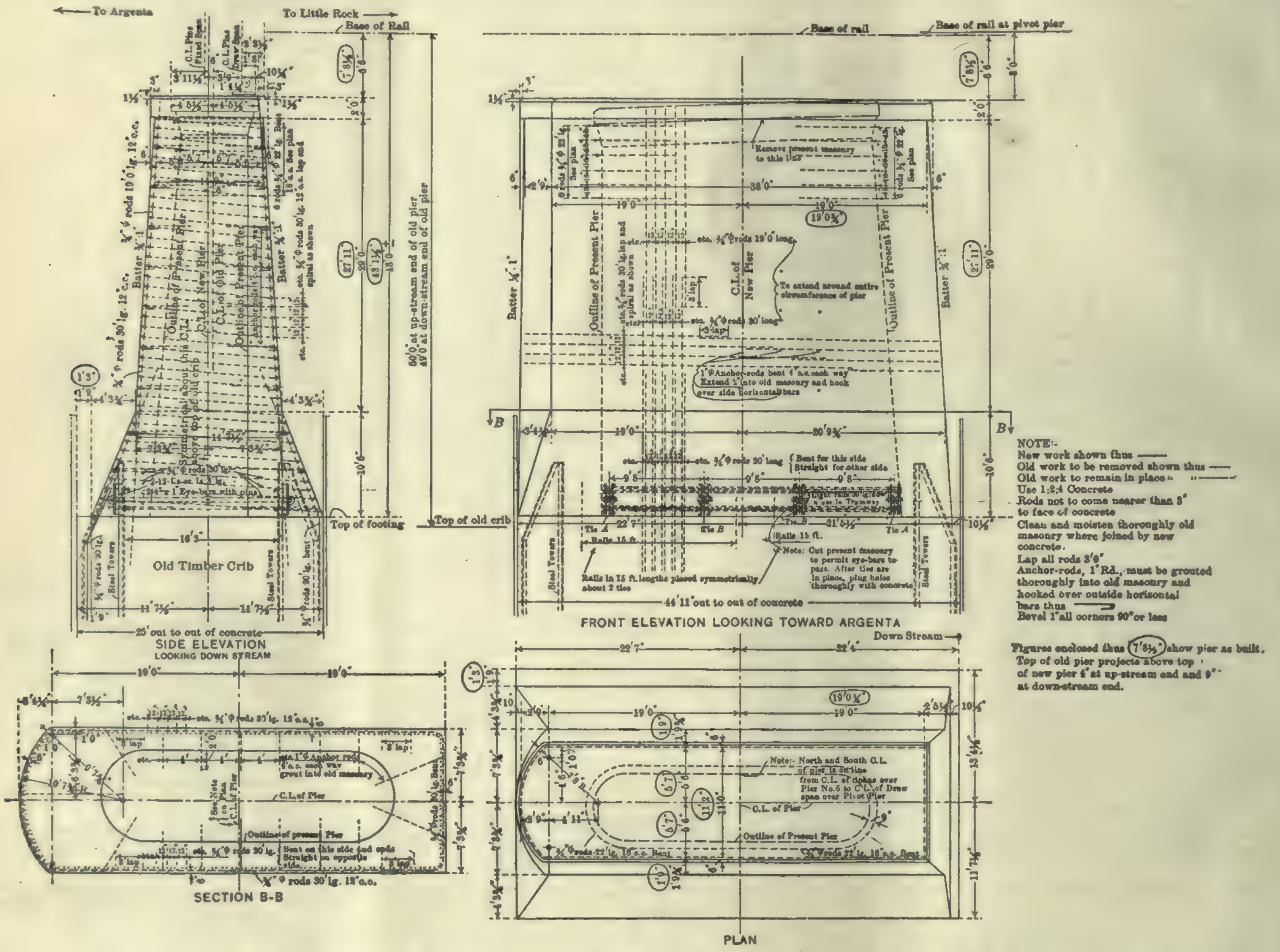
In anticipation of the reconstruction of pier No. 4 it was decided to replace the rods and yokes holding piers Nos. 3 and 4 to the intermediate span with a pair of cables attached in such a manner as to relieve the spans of the pull. As an anchor for each cable two 4x1-in. eye bars, with I-beam anchors, were embedded in the new concrete of pier No. 3 near the top and just beyond the ends of the old pier.

Before proceeding with the work on pier No. 4 two 1¾-in. steel cables were attached to the anchor rods at pier No. 3 and suspended from the span. At pier No. 4 two 24-in. I-beams were laid flatwise north of the pier; tension was then placed in the cables by means of two 60-ton jacks and the yokes removed, the jacks being placed horizontally with their bases braced against the face of the pier. By this arrangement it was possible to right the pier about 6 ins., although this was done more to get a good grip on the pier than in any effort to right it.

On account of the success at pier No. 3 it was decided to employ the same methods for pier No. 4, use being made of the caisson and cofferdam sunk in 1898. Soundings showed that the top of that cofferdam had been damaged when the upper courses were removed, and it was necessary to smooth it by cutting off drift bolts under water and removing loose timbers. It was decided to make an effort to extend the outer wall upward and make it sufficiently tight to permit the pump to expose the inner wall, and, after extending the latter, to rely on it for the rest of the work. The work was explained to the men, and a sufficient number were willing to work in the water for slightly increased pay. The depth of water was from 3 to 5 ft., and as it was summer time the men made extensive use of their "bare-skin" diving suits. The extension was made in a very short time, and a canvas having been stretched around the work, the dam was pumped out at the first trial. The inner wall was then very carefully dressed down in the dry and extended upward thoroughly water-tight, making it possible to pump out the water between that and the pier and start excavation. The concrete between the 1898 cofferdam and the old crib was first removed on the south side, but was not disturbed on the north side until some time later, after the yokes and cables were in place to anchor the pier to pier No. 3.

The removal of the material down to rock was slow and tedious. The old cofferdam had been badly racked during sinking, and large leaks were found all the way down. They were overcome, and the rock was laid bare and covered with concrete up to the top of the caisson of the old pier, after which the crib was cleaned out, filled with concrete, and surrounded as at pier No. 3.

There was always a great flow of water from the south side and in excavating it was



To Argenta
To Little Rock
Base of Rail
Old Timber Crib
Top of footing
Top of old crib
Steel Towers
SIDE ELEVATION
LOOKING DOWN STREAM
Base of rail
Base of rail at pivot pier
Remove present masonry to this line
Outline of Present Pier
C.L. of New Pier
To extend around entire circumference of pier
Batter ¾"-1'
44' 11" out to out of concrete
25' out to out of concrete
FRONT ELEVATION LOOKING TOWARD ARGENTA
NOTE:-
New work shown thus
Old work to be removed shown thus
Old work to remain in place
Use 1:2:4 Concrete
Rods not to come nearer than 3" to face of concrete
Clean and moisten thoroughly old masonry where joined by new concrete.
Lap all rods 3'0"
Anchor-rods, 1" Rd., must be grouted thoroughly into old masonry and hooked over outside horizontal bars thus
Bevel 1" all corners 90° or less
Figures enclosed thus (7'8½") show pier as built.
Top of old pier projects above top of new pier 4" at up-stream end and 9" at down-stream end.
Down Stream
C.L. of Pier
Outline of present Pier
Note:- North and South C.L. of pier is on line from C.L. of spans over Pier No. 6 to C.L. of Draw span over Pivot Pier
Outline of Present Pier
SECTION B-B
PLAN

Fig. 5. Details of Reinforced Concrete Shell Used to Enlarge and Incase Pier 3 of Little Rock Junction Bridge.

found that it came through under the cutting edges of the 1898 cofferdam where a dip in the rock had been bridged over and was supposed to have been filled with concrete. Several bad "blows" occurred under the 1898 caisson, and it was not possible to pump down to the bottom until after the material had been removed and the leak stopped by placing a sealing course of concrete under water.

Some of the timbers were crushed to 6 ins. in height, and on account of the inclination of the pier new cracks developed in the timbers while the excavation progressed. The weakest portions of this crib were concreted as they were reached. Attention was given to the upstream end, and excavation was first made there. The movement of the pier increased while that work was in progress, but was immediately arrested when the excavated pockets were filled with concrete.

In fact, by concreting at the upstream end and cleaning out the spaces at the downstream end, the pier was made to right itself, the top moving back about 9 ins. The first concreting was done in the two upstream pockets of the crib, for its full width for a height of 5 ft. below the top, after which 5 ft. more below that were placed. The situation was always well under control, and the top of the pier could have been sent in any direction by guiding the work. The underpinning was hurried as much as possible, however. In placing forms within the crib and concreting individual pockets the men worked inside the crib.

As a rule, the inspector was compelled to be present during work on the old crib, as it was desired to guard against any panic among the workmen that might be caused by the sudden bursting of one or more timbers, several of which burst open during the work.

In order to be prepared for emergency, if pier No. 4 should move upstream too rapidly, plans were made and instructions issued to be in readiness to sink cribs for anchors downstream from the pier, to which cables could be attached for pulling on the pier at right angles to the bridge. These cribs would have been composed of 12x12-in. timbers, forming a crib 15 ft. square and 6 ft. high, sheeted inside with 3-in boards 6 ins. apart. When such a crib is weighted down with rock and dropped on the bed of the Arkansas River it becomes buried immediately and forms an almost immovable anchor. It was not found necessary to sink such cribs, however.

No falsework was used while pier No. 4 was under reconstruction, and the pier carried traffic at all times.

The reinforced concrete shell placed around pier No. 4 is practically a duplicate of the construction used at pier No. 3. The tie rods at the bottom were passed through the pockets in the crib and concreted in, instead of being passed through the pier. At this pier the ends of the spans were shifted sidewise to permit the construction of each concrete pedestal in one piece.

As pier No. 5 had moved north somewhat, as a result of its own weakness and the thrust of pier No. 4, anchors were buried in the latter and the cables shifted ahead, pier No. 4 now acting as an anchor for pier No. 5.

REINFORCEMENT OF TOP OF PIER 5 IN 1913.

The small tops of these piers, their reported movement, and the frequent shifting of the spans, all contributed to a very poor condition of the bridge seat on pier No. 5, on which the stones were breaking out under the end of the south span which rested close to the edge of the pier. (This pier was originally a duplicate of pier No. 4.)

To strengthen the bridge seat the top 10 ft. of the pier were encased in a reinforced concrete jacket about 9 ins. thick. The sides were connected by passing the reinforcing rods around the curved ends of the pier and also by three sets of rails set vertically in the reinforced concrete at the middle and quarter points of the length of the pier. The lower ends of these rails were attached to the pier by 2-in. anchor bolts set in grouted holes. Their upper ends were connected by 2-in rods extending across the pier tops in channels cut in the bridge seat and filled with concrete. All cracks in the pier top were carefully grouted. The bridge seat appears to have taken on a new lease of life.

It is expected that, as pier No. 5 is quite a distance from the ordinary channel, there is little likelihood of the material surrounding it washing away, and no trouble is apprehended unless this should occur.

Following the reconstruction of pier Nos. 3 and 4 and the reinforcement of pier No. 5 the entire bridge, which was badly out of line and level, was lined and leveled. It was found that the draw-span was somewhat twisted, and one end hung lower than the other. As far as could be done without injury to the span, the inequalities were corrected.

The work on the three piers and spans cost about $100,000, which is much more than it would have cost had the work on pier No. 3 been started earlier and the floods avoided.

The reinforcement of piers Nos. 3 and 4 was executed on a force-account basis by Bates & Rogers Construction Co. The adjustment of the spans and the reinforcement of pier No. 5 were executed by the railway company forces.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by C. E. Smith, in Transactions, American Society of Civil Engineers, Vol. XL, p. 2678. In our abstract we have centered attention on the conditions which required reconstruction and on the design and construction methods used, but have omitted detailed reports and communications dealing with the various problems encountered from time to time.

WATER WORKS

Data on the Life of Wooden Pipe Pertaining to 79 Pipe Lines.

(Staff Abstract.)

The tables given herewith contain data tending to show the serviceable life of wooden pipe. These data pertain to 79 different pipe lines and were compiled by Mr. D. C. Henny, consulting engineer, United States Reclamation Service. Mr. Henny has had long and extensive experience in the use of wooden pipe as a practicing irrigation engineer, and his intimate knowledge of the details of its manufacture, acquired as manager for ten years of one of the largest wooden stave pipe companies in the country, give him high rank as an authority on wooden pipe and its uses. His report on the durability of wooden pipes, as made to the director and chief engineer of the Reclamation Service, is here given practically in full as published in the Reclamation Record for August, 1915.

TABLE I.—LIFE OF FIR AND REDWOOD PIPE UNDER CONTINUOUS WATER PRESSURE.

Wood.	Condition.	Years.	Serial No.
Fir	Uncoated, buried in tight soil	20	13
Do	Uncoated, buried in loose soil	4-7	4, 10, 12
Do	Uncoated, in air	12-20	9, 16, 21
Redwood	Uncoated, buried in tight soil, loam or sand, and gravel	Over 25	27, 29, 38, 41, 48
Fir	Well coated, buried in tight soil	25	63, 64, 75
Do	Well coated, buried in loose soil	15-20	51, 52, 69, 70

The inquiry covered wooden stave pipe of both the continuous stave and machine banded types, and bored wooden pipe.

The information obtained is tabulated in accordance with the following classification:

(a) Fir, continuous stave type, uncoated; Table II, serial Nos. 1-26. (b) Redwood, continuous stave type, uncoated; Table III, serial

TABLE II.—DATA ON LIFE OF CONTINUOUS STAVE FIR PIPE, UNCOATED.

Location.	Length. Miles.	Diameter. Inches.	Pressure. Feet.	Soil.	Built in—	Remarks.	Life.	Serial No.
Astoria, Oreg.	7.5	18	0-150	Loam and sand with decaying vegetable matter.	1895	Gradually increasing leakage due to decay of wood. Replaced by redwood pipe in 1911.	16	1
Basin, Wyo.	...	40-96	......	Not stated	1906-1908	In good condition except where not constantly full.	8+	2
Belle Fourche, S. Dak.	.3 .4	36 42	......	Clay and gumbo	1912	In good condition	3+	3
Clarkston, Wash.	7.0 4.0 1.5	48 40 32	......	Volcanic soil, also loose rock.	1907	Where in loose soil or rock, decayed near top; 400 feet replaced in 1911; 1,000 feet replaced since.	4	4
						Balance O. K.	8+	
Everett, Wash.	...	20	50-125	Clay and loose soil	Before 1909	Decayed except where buried in clay	6	5
						Replaced 2,600 feet	6+	
Gothenburg, Nebr.	.2	72	0-46	Loose, sandy, partly uncovered by wind.	1890-1891	Decayed, especially where uncovered, causing increasing leakage; new wood pipe built in 1913, covered 2 feet and uncoated.	22	6
Logan, Utah	1.2	60	15-80	Not buried	1904	Decayed at pitch seams, otherwise O. K.	11+	7
Loveland, Cal.	8.0	12	0-200	⅓-foot cover	1902	Some decay on top of pipe	13+	8
Ogden, Utah	5.0	72	......	......	1897	Small amount at upper end decayed where pressure light and soil very porous; no decay where exposed.	18+	9
Post Falls, Idaho	5.0	42	0-40	Loamy gravel, loose	1910	1 mile with maximum pressure badly decayed.	5	10
						Remainder partly decayed	5+	
Preston, Utah	.6	60	0-300	Not covered	1905	In good condition except leaking in places due to settlement.	10+	11
Pueblo, Colo.	...	48	......	Adobe	1906	Commenced leaking, due to decay, in 1909. Serious decay in 1913 had gone one-half though wood. Then encased in concrete.	7	12
Seattle, Wash.	.5	54	......	Clay, sand and gravel	1899-	Part has decayed and has been reconstructed.		

TABLE II.—(CONTINUED.)

Location.	Length. Miles.	Diam. Inches.	Pressure. Ft.	Soil.	Built in—	Remarks.	Life.	No. Serial
	13.5	44			1900	Superintendent's estimate:		
	8.5	32				In sand and gravel	7-12	13
						In clay	12-20	
						Pipe buried in clay is reported as good as new.	16+	
Sugar City, Colo.	4.0	..	......	Soil not stated, cover 2-4 feet.	1904	Wood not decayed; ½-inch bands corroded; replaced in 1910 with ⅝-in. iron.	11+	14
Sunnyside, Wash.	2.1	55	25-130	Volcanic ash, gravel, and sand, about ⅝ laid on ground not covered.	1908	Uncovered portion badly decayed in 1913.		
	.3	48	130		1908	Uncovered and coated 1913-14.		
						Relaid 1914-15:-		
						In open soil	6	15
						In air or water	7+	
Utah power pipes	1.6	36	......	On saddles	1903-04	Decayed	12	16
	2.1	36	6-226	In open trench	1907	In good condition	8+	17
	3.1	58	8-180	Laid on earth	1910	Do	5+	18
	1.5	30	4-91	In open trench	1908	Do	7+	19
	4.7	30	12-13	On earth	1910	No decay	5+	20
	1.8	24	10-37	Do	1907	Wood from old circular flume, built in 1901, in fair condition.	14+	21
	2.7	78	24-44	Do	1913	Wood in good condition	2+	22
	4.3	132	......	On concrete saddles	1914	Do	1+	23
	.8	102	15-125	On wooden saddles.	1908	Some decay at butt joints	7+	24
	1.3	74	......	Buried	1909	Some decay where back fill porous	6+	25
	1.2	24	......	On earth	1908	In good condition	7+	26
Wenatchee, Wash.	1.7	44	0 to 100	Buried in clayey soil except where crossing bridge.	1903	The upper end for 750 feet, pipe did not run full at all times, and was replaced in 1908, and was again replaced later.		
						Balance of pipe, where buried, O. K. so far as known.	12(?)	
						Pipe where exposed in good condition	12+	26a
	2.3	42	Same	Same	1907	Buried pipe decayed where no pressure, renewed in 1914.		
						Balance O. K.	8—	26b

Nos. 27-48. (c) Fir, continuous stave and wire-wound types, coated; Table IV, serial Nos. 49-75. (d) Various woods, continuous stave type, uncoated; Table V, serial Nos. 76-79.

The term "fir" is applied to the most common wood of the Pacific Northwest. Scientifically it is a bastard spruce, first named by Douglas. Locally it is known as fir or Douglas fir, and distinction is sometimes made between yellow and red fir. These come from the same kind of tree, the yellow fir being most common. The large trees yield yellow fir, while the wood from smaller trees is apt to show a reddish tint. Sun exposure also appears to affect the color to some extent. In California the wood is termed Oregon pine. This wood is strong and can be obtained in long lengths. Mill run of commercial sizes probably averages 20 ft. in length. It contains pitch, which forms in seams and pockets, normally occurring even in commercially clear wood within certain limits. The trees usually yield less than 25 per cent of wood free from sap and knots. The expense of eliminating these defects has led to the practice, as regards pipe construction, of permitting some small and sound knots and sap.

Redwood grows on the Pacific coast from Santa Cruz north into southern Oregon. By reason of the average large diameter of the trees the logs are cut shorter than in the case of fir, and the commercial mill run averages about 16 ft. in length. The wood is not as strong as fir. About 50 per cent of the wood cuts up clear and free of sap, which has led to the custom of demanding freedom from knots and sap in ordinary pipe specifications.

The "various woods" referred to in Table V cover individual examples of the use of Texas pine, yellow pine and Colorado pine.

Continuous stave pipe consists of staves

TABLE III.—DATA ON LIFE OF CONTINUOUS STAVE REDWOOD PIPE, UNCOATED.

Location.	Length. Miles.	Diameter. Inches.	Pressure. Feet.	Soil.	Built in.	Condition.	Life.	Serial No.
Butte, Mont.	9.1	24	0.150	Loam, mixed with gravel and loose rock	1892	Redwood sound except some deterioration where covered with loose rock only	23+	27
	6.2	26	0-150	Same	1899 }	Wood sound except in few places where pressure light	15+	[illegible]
	8.5	24	0-150	Same	1900 }			
Denver, Colo.	16.4	..	......	Covered	1890	Still in use	25+	29
	[1]...	..	......	Soil not stated	....	......	....	..
Greensboro, N. C.	1.3	18	20-200	Covered	1907	Sound, both wood and bands; superintendent would use nothing else	8+	30.
	3.0	20	20-200	Soil not stated	....	......	....	..
	2.5	24	20-200					
Hollywood, Cal.	0.3	12	50	Loam	1898	Much of wood decayed in 1910, probably due to light pressure and dry soil. Possibly not full at all times. (Finkle.)	12	31
	6.9	14	50			Company gives far better report.		
Ithaca, N. Y.	[2]...	[2]..	[2]......	Not stated	1905	No maintenance cost; so far as known in good condition	10+	32
Logan, Utah	1.5	18	0- 70	Gravelly soil	1893	In excellent condition; wood sound; metal slightly rusted	22+	33
Los Alamitos, Cal.	3.5	18	30- 50	Not stated	1906	Used 4 months each year for disposing of waste from sugar factory; wood slightly deteriorated. Most bands have had to be replaced	....	..
Mount, Nebo, Utah	0.3	48	0- 70	Not stated	1895	Wood sound; no corrosion in bands reported	20+	34
	1.1	[3]72	0	On wooden saddles	1895	Wood slightly decayed. Bands rusted; some had to be replaced.	20+	35
North Yakima, Wash.	0.2	32	0- 90	Heavy soil partly exposed on rocky side hill	1894	Wood had decayed some at upper ends of siphon; bands somewhat rusted	21+	36
	0.2	32	0- 90	Same	1903	Wood sound; bands slightly rusted; replaced in 1914 by larger pipe in connection with concreting of canal	12+	37
Ogden, Utah	5.5	24	......	Not stated	1890	4,674 feet light pressure replaced in 1911, but still used as overflow pipe. Balance still in use in good preservation. Where exposed and protected from sun by board wood perfectly sound	25+	38
Palo Alto, Cal.	1.4	12	0	Salt marsh	1900	Used as outfall sewer; runs one-half to one-third full; bands badly corroded. Replaced in 1908 on 3,000 feet; replaced in 1911 on 1,025 feet	15+	39
Poso, Cal.	.03	72	10	Sand	1893	Used for irrigation; full part of each year; reported in fair condition	22+	40
Provo, Utah	5	14	0-125	Clay, gravel, light loam	1891	In light loam, nearly gone; in gravel, fair; in clay, sound	24+	41
	.5	60	......	Clayey soil except 500 feet on bridge	1910	Staves show decay at ends where many joints leaking and where not covered. No water for 4 months in year	5+	42
Redlands, Cal.	.4	48	Light.	Partly in earth; partly on trestle	1892	Decayed considerably where in contact with earth; was replaced with ditch as a matter of precaution in 1912	20+	43
Temple, Tex.	1.7	18	5- 35	Not stated	1899	In good condition as to both wood and bands; only trouble where wood damaged by sharp rocks thrown in for back fill	16+	44
Utah Power & Light.	2.1	26	6-144	Exposed; on earth	1910	In good condition	5+	45
	1.1	28	5-176	Same	1907	In good condition; staves show tendency to buckle up at joints	8+	46
	1.7	22	3-137	Buried	1907	In good condition so far as known; no maintenance expenses	8+	47
Yuma, Ariz.	2.1	26	90-120	Adobe and sand and gravel	1892	In good condition; has replaced a few staves; superintendent says as good as 20 years ago	23+	48

[1] Partly Texas pine. [2] Not stated. [3] One-half circumference of flume.

TABLE IV.—DATA ON LIFE OF FIR PIPE, CONTINUOUS STAVE AND WIRE-BOUND TYPES, COATED.

Location.	Kind of pipe.	Length. Miles.	Diam. Inches.	Pressure. Feet.	Soil.	Built in.	Character of coat.	Condition.	Life.	Serial No.
Belle Fourche, S. Dak.	Cont. stave	0.3	60	0- 20	Clay and gumbo	1914	2 coats asphalt compound	Wood, sound	1+	49
Butte, Mont.	W. W.	4.4	14	0-300	All kinds soil	1911	Manufacturers' standard	Good condition	4+	50
	W. W.	[1]...	[1]..	....	....	[2]1895	Manufacturers' standard	Good condition	20+	51
Clarkston, Wash.	W. W.	[1]...	[1]..	60-300	Volcanic soil	[2]1903	Manufacturers' standard	Good condition, except wood in some collars is soft and spongy, losing strength and causing leakage. Some decay in 4-inch size attributed to sap	12+	52
Colfax, Wash.	W. W.	14.0	8-10	0-200	....	1904	Manufacturers' standard	Good condition, except decay and leakage in upper section, also 1,500-foot section over Gerber Hill, where pressure is light; upper section not now used	11+	53
								Gerber Hill section replaced by same kind pipe laid on lower grade in 1910	6	54
Greeley, Colo.	W. W.	38.0	20	0-205	Not stated	1907	Manufacturers' standard	Good condition; 6 staves decayed presumably account sap. Some collars decayed where pressure light	8—	55
Hood River, Ore.	W. W.	5.6	2-20	10-150	Loam	[2]1905	Manufacturers' standard	Wood sound; few leaks in joints	10+	56
Lewiston, Idaho	W. W.	[1]...	[1]..	100-300	Not stated	1906	Manufacturers' standard	Good condition, except collars, which in some instances have decayed	9+	57
Montrose, Colo.	W. W.	[1]...	[1]..	....	Strongly alkaline	1905	Manufacturers' standard	Wood in fair condition; some staves in pipe decayed where pressure light after 5 years; decay in collars first noted after 5 years; chief difficulty, erosion of wire, being replaced by endless number of clamps	10+	58
North Platte, Nebr.	C. S.	.4	24	....	Light, sandy loam	1914	Tar, 2 coats, 1/16-inch	Good condition	1+	59
	W. W.	.3	18	....	Light, sandy loam	1913	Manufacturers' standard	Good condition	2+	60
	W. W.	.1	16	....	....	1913	Manufacturers' standard	Good condition	2+	61
North Yakima, Wash.	W. W.	...	4-20	10-200	Loam and gravel	[2]1905	Manufacturers' standard	Wood in pipe sound; wood in some collars spongy and decaying; some leakage in joints	10+	62
Olympia, Wash.	W. W.	10.0	2-12	100-220	Clay soil with some gravel in places	1896-1912	Manufacturers' standard	In excellent condition, including wire	19+	63
	Bored log	4.5	2- 8	100-200	Same	1890-1900	Manufacturers' standard	In good condition, including flat iron hoops	25+	64
Post Falls, Idaho	W. W.	5.0	12-24	0- 50	Gravelly clay open	1910	Manufacturers' standard	In good condition except decaying collars	5+	65
Provo, Utah	W. W.	2.5	21	[3].......	Gravelly	1907	Manufacturers' standard	Decayed; sleeves replaced with concrete; requires rebuilding	8	66
	W. W.	2.6	18-24	[4].......	Gravelly	1911	Manufacturers' standard	Some decay in pipe; heavy maintenance account decay in collars	2	67
Pueblo, Colo.	C. S.	3.0	24	[5].......	Adobe, loam and shale	1904	Probably manuf'rs' standard	Wood so far as known all right; wire began to fail in 1911; 4,000 feet replaced in 1912; remainder in 1913	8+	68
South Bellingham, Wash.	C. S.	...	20	0-200	Clay and loose soil same as in Bellingham	1900	Asphalt	In excellent condition	15+	69
Spokane, Wash.	W. W.	[1]...	[1]..	[6].......	Gravelly soil	....	....	After 5 years begins to trouble in seams and joints, not from decay, but water ram	....	..
Sunnyside, Wash.	Bored log	[1]...	[1]..	0	Volcanic ash, gravel, etc., buried 4 to 8 feet	1893	Manufacturers' standard	Main canal turnouts taken up in 1905-6 because too small, pipe found in excellent condition	13+	70
	Bored log	.4	13	3- 15	Volcanic ash, 1.5 to 2 ft. cover	1903	Manufacturers' standard	Sound, tight, metal little corroded	12+	71
	W. W.	.4	4	10- 60	Volcanic ash	1898	Thinly painted with creosote.	Decayed in 4 years	4	72
	W. W.	...	24	....	....	1906	....	Sound, but extensive repairs on wooden collars	9+	73
	W. W.	...	14	0- 25	Sandy loam	1908	Manufacturers' standard	Sound, except 1,000 feet at upper end, had not run full; lasted 3 years, renewed in 1912; balance gives trouble with leaky joints; otherwise will probably last 10 to 20 years	7+	74
Tooele, Utah	Bored log	...	..	....	Buried	1890	Probably manuf'rs' standard.	Wood in good condition where kept wet; pipe has flat iron hoops	25+	75

[1]Various sizes. [2]And later. [3]Light pressure. [4]Heavy pressure. [5]Not stated. [6]Water works pressure.

breaking joint and clamped together with bands, which since 1888 have universally been made up of steel bolts and lugs, the latter being made of cast iron, malleable iron or pressed steel. The butt joints are made tight by a metal or wooden plate.

Wire-wound or machine-banded pipe is pipe made up in sections from 10 to 24 ft. in length. It consists of staves held together by galvanized wire, spirally wound around the pipe under heavy tension. The wood is usually kiln dried, which is not the case with continuous stave pipe. The ends of each section are machine turned to an exact diameter, sometimes slightly tapered. Sections are united by some form of sleeve, a sleeve made up of staves and wound around with wire or individual bands being most common. Light-pressure pipes are often provided with mortise and tenon ends, dispensing with the necessity of sleeves. Under the head of wire-wound pipe in the tables a few cases have been grouped of bored log pipe, which is wound not with wire, but with flat iron or steel. Such pipe is often jointed by metal sleeves, generally riveted iron or steel.

The wood surface in continuous stave pipe is, with a few exceptions, uncoated, while sectional pipe is heavily coated, the coat consisting of asphaltum and tar, with sawdust on the outer skin.

The investigation has had in view especially the life of pipe as affected by the durability of the wood. The life, as given in the last column of the tables, refers to the wood alone, and is further confined as to sectional pipe to wood in the pipe sections and not to wood in the sleeves. Figures followed by the plus sign show age rather than life. The information collected is based mostly on reports received from managers or owners, and in small part on personal observation. It is not as complete as is desirable, which, however, is not due to failure to elicit further information.

Reviewing the information as grouped under its headings, it may be estimated that under conditions of continuous water pressure the life of various kinds of pipe may be as shown in Table I.

Under conditions interfering with complete saturation of the wood the life is cut down materially. These conditions are in the case of uncoated pipe brought about by open soil and low water pressure. The effect of coating appears to be equivalent to tight soil cover, with possibly the additional advantage of tar in the coating acting as a disinfectant. The effect of unfavorable conditions as to lack of complete saturation is serious in redwood, resulting in a life which may be shorter than 15 years (No. 31), but is much more marked in fir, where it may be as low, in spite of coating, as six years (No. 54).

It is quite possible that the life of individual pipe is not merely affected by surrounding conditions, but may have been shortened by the quality of the individual pieces or the treatment of the wood. The wood from the bottom of a tree is close grained and likely to last longer than from the top of the tree, even though free from sap. Bastard staves, especially in fir, resist penetration of the water in the pipe to a greater extent than diagonal grained or vertical grained wood, and may show a shorter life. Again, too rapid kiln drying, which may at times have been practiced on lumber from which staves for wire-wound pipe were run, may have partially destroyed the vitality of the wood. It has not been practicable to differentiate between the causes which in this manner may have shortened the life of the wood in pipe, nor to ascertain what has been the effect of permitting some sap in the wood from which decay may have spread to the adjoining sound wood. Unquestionably much wire-wound pipe has been manufactured without being subjected to strict supervision and inspection.

RELATIVE LIFE OF FIR AND REDWOOD PIPE.

On the whole the following conclusions seem justified as regards the relative life of fir and redwood in pipe:

(a) Under favorable conditions of com-

TABLE V.—DATA ON LIFE OF VARIOUS WOODS, CONTINUOUS STAVE PIPE, UNCOATED.

Location.	Wood.	Length. Miles.	Diameter. Inches.	Pressure. Feet.	Soil.	Built in.	Condition.	Life.	Serial No.
Denver, Colo.	Colorado pine..	...	..	......	Not stated.	1884	Top staves above water line decayed rapidly; part near river in wet soil still in use in 1912..	18+	76
	Yellow pine....	7.7	24-30-37	......	Not stated.	1886-1887	Some lasted till 1907, when replaced with fir.....	....	..
	Texas pine.....	16.4	[1]30	......	Not stated.	1890	Still in use..................................	25+	77
Pueblo, Colo.	Texas pine.....	...	[illegible]	......	Adobe	1900	Condition in 1913: Decayed irregularly one-half to three-fourths of stave; some new staves account decay; bands near leaks or in moist soil corroded rapidly..................	23	78
Pueblo, Colo.	Texas pine.....	...	[2]54	......	Not stated.	1890	Coated part with tar, part with asphalt; 1,500 feet running partly full, replaced in 1895 with redwood	5	..
							Portion painted with asphalt replaced in 1910....	20	79
							Portion painted with tar sound in 1910..........	20+	..

[1]Partly redwood. [2]Coated.

plete saturation fir well coated may have the same life as redwood uncoated.

(b) Either kind of pipe will have a longer life if well buried in tight soil than if exposed to the atmosphere. Such life may be very long—30 years and over—if a high, steady pressure is maintained.

(c) Either kind of pipe will have a longer life if exposed to the atmosphere than if buried in open soil, such as sand and gravel and volcanic ash, provided in hot and dry climate it be shaded from the sun.

(d) Under questionable conditions, such as light pressure or partially filled pipe, fir, even if well coated, may have only from one-third to one-half the life of redwood.

(e) Under light pressure the use of bastard staves in fir pipe should be avoided.

(f) The use of wooden sleeves in connection with wire-wound pipe is objectionable and has caused endless trouble and expense. It is possible that the objection may be partially overcome by dipping ends of sleeves in creosote and by applying a heavy coating of tar to the ends of the sleeves. Saturation of sleeve wood will never be as perfect, however, as of the straight pipe, and full creosote treatment of the wood or else some form of metal sleeve, either riveted iron or steel heavily coated, or cast iron, will probably be well worth its extra cost.

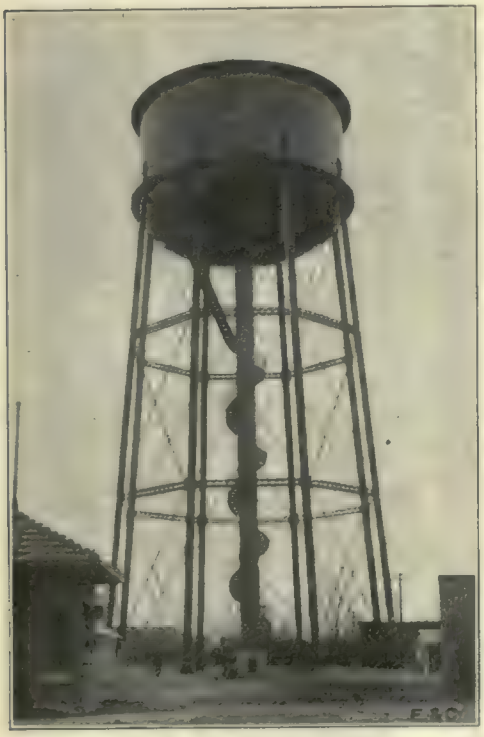


Fig. 1. View of 500,000-gal. Elevated Water Tank at Appleton, Wis.

(g) If wooden sleeves are employed they should be provided at least for sizes from 10 ins. up with individual bands to permit taking up leaks.

Pitch seams do not occur in redwood. In fir they should be distinctly limited as to size, frequency and depth. In respect to knots, there appears to be no reason for making any distinction between the two classes of wood. Small, sound knots, if not passing through the full thickness and not occurring close to edges or ends, might be permitted in either wood. Sap is objectionable, and the higher cost in prohibiting it entirely or putting narrow limitations on it is probably justified in both fir and redwood.

Wooden pipe is not suitable in cases where it cannot be kept full and under pressure during periods of use. Coating cannot under such conditions be expected to afford protection against decay. Coating should be continuous and heavy, not less than 1/16 in. to be fully effective, and should preferably consist of more than one individual coat of a mixture of asphaltum and tar, or of an application of gas tar followed by one or more applications of refined coal tar. Little experience, however, can be quoted in support of all-tar coating.

All tentative conclusions herein presented are necessarily based on the limited data which could be collected and will undoubtedly require amendment as further experience accumulates.

Design and Construction of the New 500,000-gal. Elevated Water Tank at Appleton, Wis.

Contributed by D. D. Williams, Chicago, Ill.

The city of Appleton, Wisconsin, has lately completed the installation of a 500,000-gal steel tower and tank. This tank was erected to procure a reserve supply of domestic water, and at the same time to secure a constant pressure with as slight a variation in head as possible. These requirements were fulfilled by building an elliptical bottom tank with a large diameter and a small height of shell.

The tank is supported upon an eight-post three-panel tower, with an elevation of 102 ft. 8 ins. to the bottom and 140 ft. to the high water line, giving a water pressure of 60 lbs. per square inch at the base. This tank has an elliptical bottom, made of plates, consisting of two courses, besides a circular bottom plate, to which is riveted a steel riser pipe 5 ft. in diameter. The tank is 51 ft. in diameter by 24 ft. 3 ins. high, consisting of three courses of plates. The roof is constructed of 3-16 in. metal, having a bevel of 4⅝ ins. to the foot, and is supported by a roof framing of channel rafters and angle purlins. The posts are built-up members of two channels with cover plate on their back and double laced on their front side. The riser pipe is built of 7 ft. 6 in. sections of rolled steel plates. A spiral stairway winds around the riser pipe to the top of the second panel of the tower whence it runs across to and around a post, and again spirally connects to the balcony, which encircles the tank at the spring line.

The usual method of erecting smaller tanks was used, and under the leadership of Foreman R. M. Parmley, the work was carried on without a hitch of any kind, the most remarkable thing being that this great tank did not leak a drop when first filled with its 2,125 tons of water.

Besides building this large tank, the city has rehabilitated the entire water works system. It has laid many miles of new pipe, added a great many new hydrants and valves, and in addition to this an entirely new pumping plant has been built. Diesel oil engines and triplex pumps, so arranged as to interchange pumps and engines, have been installed. This plant is perhaps the most economical fuel using pumping plant of any city in the United States, except where natural gas is used.

In the inlet pipe line, there is a 16 in. gate valve, located in the valve pit of the center foundation pier under the riser pipe; this valve is operated by water pressure from the mains by an electrical device, which is made to operate by throwing a switch at the pumping station. In case of fire this valve is closed so that the pressure in the mains can be raised considerably above that which would overflow the tank if the valve was left open.

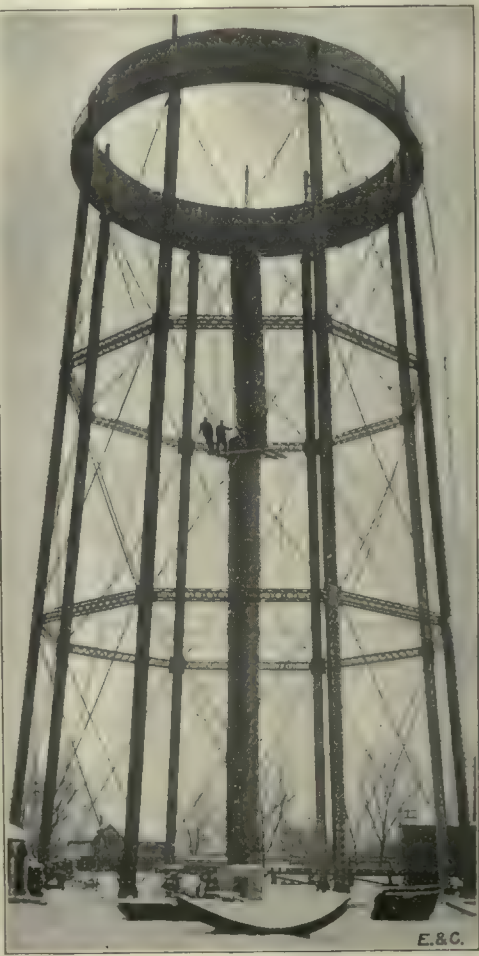


Fig. 2. Construction View of Appleton Water Tank—Placing Top Section of Riser Pipe.

The 16 in. pipe projects 4 ft. into the steel riser. This is done to permit sediment to collect around the pipe. This sediment is occasionally blown out by hydraulic pressure through a 6-in. blow-off valve, which is flush with the bottom, and which is operated by turning a shaft by means of a lever on the outside of the riser pipe.

The tower and balcony sections were raised by using a guyed gin pole, which was made of an 8x8 in. timber 40 ft. long. After the first section of tower posts and struts were raised, the gin pole was raised and set on a strut near a post. The next section of that post was then pulled up and fastened; the gin pole was then skidded along the strut to the next post, which was likewise raised. The strut above it was then erected and the pole was jumped to the next strut, and so on until the entire tower and balcony sections were in place.

The roundabout plates of the tank were erected by a stiff-leg gin pole connected to the ring of plates below the one being erected.

The three field sections of the 5 ft. riser pipe and the bottom plates were raised by a set of triple blocks with 1 in. line hung from two wire cables, the ends of which were fastened to four timbers bolted to the outside of the first ring.

The erection plant consisted of an upright boiler 36 in. by 8 ft., a dinky hoisting engine and an air compressor with a 36x6 in, receiving tank. All rivets were driven with pneumatic hammers. The fullering and calking was also done with pneumatic calkers.

This structure was fabricated and erected by the Chicago Bridge & Iron Works of Chicago, Illinois, it being the seventh of this capacity, but of varying heights, which that Company has recently built.

This design of a steel elevated tower and tank with its neat outlines and general stately appearance is worthy of careful consideration by engineers.

ROADS AND STREETS

Methods and Cost of Laying Asphaltic Wearing Surface on Concrete Pavement, Santa Barbara County, California.

(Staff Article.)

The work described comprises 5.81 miles of 4½-in. concrete pavement surfaced with a 1¼-in. wearing surface of asphaltic (Topeka) mixture, and is located between Orcutt and the Santa Maria river in Santa Barbara county, California. In Table I a summary is given of the total cost of the road but here there will be described only the work of asphaltic surfacing.

TABLE I.—COST SUMMARY.

Item.	Unit Bid.	Totals.	Unit Cost.	Totals.	Loss.	Profit.
29,298 cu. yds. excavation	$0.49	$14,608.02*	$ .515*	$15,108.29*	$500.27	....
428 lineal ft.—12" cor. iron pipe	0.44	188.32	.195	83.27	....	$ 105.05
86 lineal ft.—18" cor. iron pipe	0.65	55.90	.262	22.54	....	33.36
60 lineal ft.—24" cor. iron pipe	0.83	49.80	.234	14.06	....	35.74
195 lineal ft.—30" cor. iron pipe	1.12	218.40	.720	140.34	....	78.06
90 lineal ft.—36" cor iron pipe	1.25	112.50	.144	12.98	....	99.52
Concrete, Class "B," in Culv's and Mon'ts, 144.2 cu. yds.	15.00	2,163.00	11.232	1,619.65	....	543.35
Concrete, Class "B," in Pave't, 5,678.2 cu. yds.	3.58	20,327.96	3.394	19,251.37	....	1,076.59
Asphalt surfacing, 51,149 sq. yds.	0.5175	26,469.61	.381	19,483.32	....	6,986.29
53 monuments setting each	0.93	49.29	.661	35.01	....	14.28
Gravel surfacing, 827 cu. yds.	2.43	2,009.61	2.278	1,883.58	....	126.03
Extra work	.....	67.56	.....	58.75	....	8.81
Totals		$66,319.97	.....	$57,713.16	$500.27	$9,107.08

†Total estimate contract items = ...$66,222.19
Total cost to contractor = ... 57,713.16
Total net Profit = ... 8,509.03

Final progress estimate = ...$66,319.97
Materials furnished by state = ... 31,896.33
Total cost of section $98,216.30

†Less cost of materials wasted, $97.78.
*Plus overhaul, $252.
Note—Contractor's costs include all incidental expense and overhead.

The concrete pavement, or base, was unusual only in one particular: instead of a smooth surface a rough corrugated surface was obtained by float tamping. The purpose of this modification was to reduce to a minimum the tendency of a thin bituminous wearing surface to crop. Such longitudinal displacement is not uncommon when perfectly smooth concrete is used without paint binder. A total of 51,100 sq. yds. of pavement was surfaced.

CLEANING AND PAINTING.

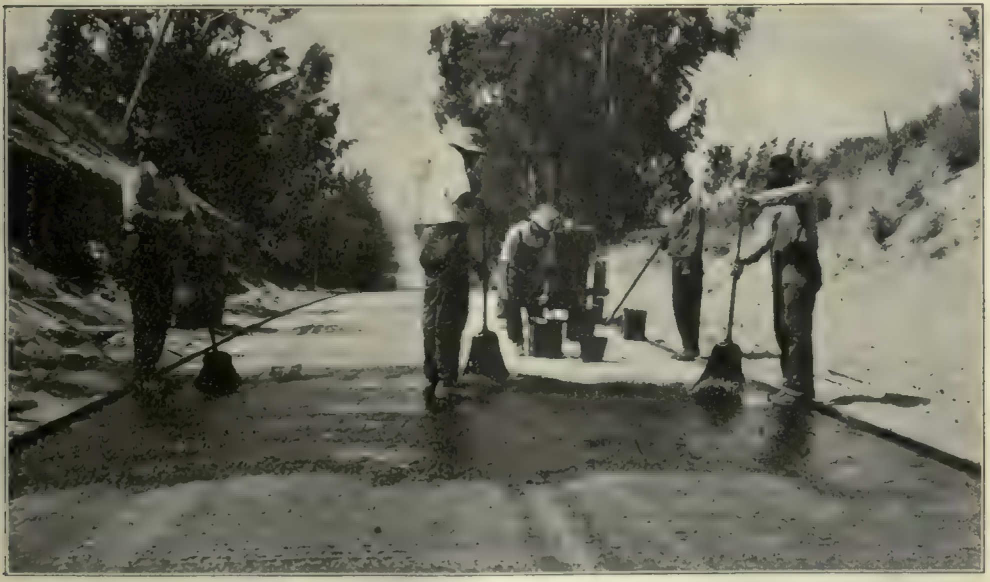


Fig. 1. Applying Bituminous Paint Coat with Brooms.

The concrete surface was first cleaned of all dirt and dust film and then painted. The paint was composed of 1 part of 80-90 penetration asphalt dissolved in 1½ parts of 50° Baume distillate. The asphalt was heated in portable kettles and measured quantities in buckets were taken a safe distance from the fire and mixed with the distillate. The mixture was then poured on the cleaned surface and swept to an even thickness with house brooms, taking care to sweep excess out of depressions. Figure 1 shows the method of applying the paint coat. An illustration of the positive binding property of the paint coat is given by Fig. 2, which shows a stub of surfacing pried loose and bringing with it in places fragments from the concrete base. The cost of cleaning the concrete base and applying the paint coat was:

Item.	Total.
8 tons asphalt at $8.75	$ 70.00
3,745 gals. distillate at 5 cts.	187.25
2 cords wood at $6	12.00
Tools, etc.	6.50
Total materials	$275.75
Total labor, inc. 2-horse broom	$650.55
Pro-rated, supt., timekeeper, etc.	52.50
Bonds and insurance	54.90
4% contractor's overhead	28.12
Total	$786.07

The grand total for 51,149 sq. yds. of pavement was $1,061.82 or 2.07 cts. per square yard.

TOPEKA SURFACING.

The composition of the Topeka surfacing used is shown by Table II. The hot mixture was turned out by the celebrated Cummer plant shown by Fig. 3. This plant had a capacity of approximately 300 half-ton batches per 8-hour day, but the actual output was somewhat less, as noted further on. The procedure at the plant was as follows: The asphaltic cement and the stone dust were weighed separately into each batch. The sand and the screenings were hauled to place in wagons and from the piles were taken by Fresno scrapers to positions adjacent to the bucket elevator as illustrated by Fig. 4. In scraping the sand and screenings they were taken alternately and deposited near the elevator in layers of proportionate thickness. The shovelers feeding the elevator, by cutting vertically through the layers, got the required proportions of each material. The plant inspector checked the mixture by taking samples from time to time during the day from the mixer box, such samples containing

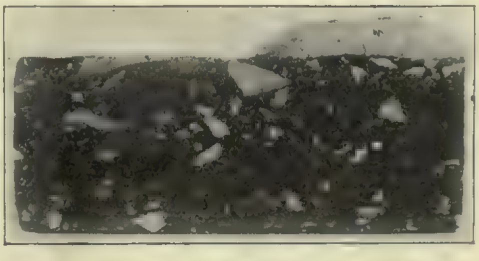


Fig. 2. Slab of Bituminous Surfacing Removed with Clinging Concrete.

TABLE II.—CERTAIN ANALYSES OF "TOPEKA" MIX ASPHALTIC SURFACING SHOWING SACRAMENTO LABORATORY TEST AND FIELD TEST OF THE SAME DAY.

		Date, 1915													
		April 26.		May 3.		May 6.		May 7.		May 15.		May 19.		May 20.	
Item.	Specification.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.
Passing	Between														
200	8% and 13%	9.1	9.0	13.2	13.4	10.4	11.8	10.2	13.7	9.4	10.8	8.4	8.4	9.9	10.1
80-200	14% and 25%	19.6	19.0	23.8	19.7	20.1	19.0	21.5	20.0	16.9	19.5	23.0	21.8	18.0	21.9
40-80	17% and 29%	24.1	21.0	27.4	27.0	26.6	25.0	28.3	27.0	27.3	26.7	25.8	26.5	27.4	24.2
10-40	5% and 11%	11.5	10.5	10.1	10.3	10.8	11.8	11.2	11.5	13.3	11.8	10.8	11.3	12.3	11.7
4-10	15% and 25%	18.0	22.0	10.6	14.0	15.3	16.0	12.0	11.9	14.9	14.4	17.0	16.2	18.5	16.2
2-4	3% and 10%	9.2	9.0	5.3	6.0	7.0	6.7	6.8	6.4	8.8	7.2	6.4	6.2	4.2	6.3
Bitumen	7½% and 10%	8.5	*9.5	9.6	*9.6	9.8	*9.7	10.0	*9.5	9.4	*9.6	8.6	*9.6	9.7	*9.6

Note: A—Sacramento Laboratory test. B—Field test.
*=Percent bitumen calculated.

everything except the asphaltic cement and being thoroughly mixed. A 2-lb. sample was run through the sieves and owing to the size of sample operative errors were reduced to a minimum. The materials hauled to the plant cost as follows:

Sand, per ton	$0.75
Screenings, per ton	1.60
Limestone (dust), per ton	6.10
Asphaltic cement, per ton	8.75

The mixing process at the plant was carried through so that the complete cycle of each batch averaged 1¾ minutes, which limited the capacity of the plant to 280 batches, weighing approximately 1,000 lbs. each, or 140 tons of "hot stuff" per eight-hour day. A complete cost of plant operation, batch and ton costs of mixture, etc., is given in Table III.

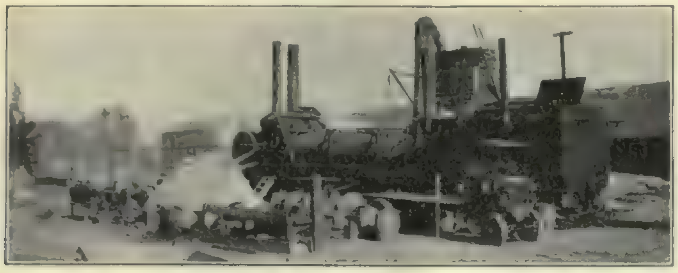


Fig. 3. Front View of Mixing Plant.

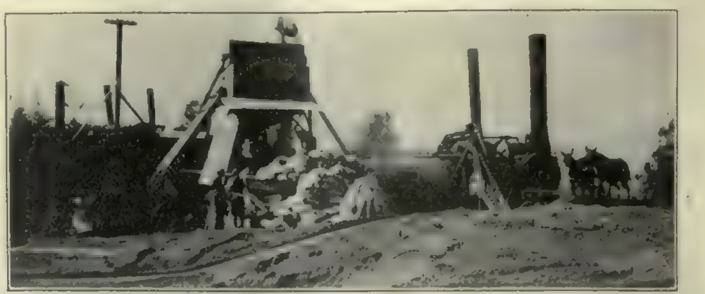


Fig. 4. Rear View of Mixing Plant.

TABLE III.—COST DATA.

PLANT OPERATION.

Setting up plant	$ 241.70
Wrecking plant	68.25
Labor at plant (mixing)	914.00
Labor at plant (watchman)	119.75
Blacksmith work	14.50
Superintendent-timekeeper-horse and buggy (one-half total cost)	210.00
Water	40.00
Oils and fire brick, etc.	29.82
Hardware, etc., belting	50.00
Wood for fuel	100.00
Gas for fuel	290.50
Rental at $50 per day	1,500.00
Freight on plant (and return)	870.00
Incidentals—R. R. fare, etc.	35.00
Bonds and liability insurance	219.60
Phone, etc.	37.50
Freight on wagons, and tools, and depreciation on same	300.00
	$5,040.62
Plus 4%	102.73
	$5,143.35

LAYING SURFACING.

Labor	$1,247.15
Rolling	205.00
Transporting men, etc.	250.00
Headers (labor)	103.70
Superintendent-timekeeper, etc.	157.50
Insurance and bonds	164.70
Railroad fare (incidentals)	35.00
Phone, etc.	37.50
Freight on equipment and tools, and interest and depreciation on same	200.00
Supplies for roller	13.00
5.86 tons coal for roller	88.00
Hardware, etc.	43.50
Lumber for headers	504.70
	$3,049.75
Plus 4%	78.53
	$3,128.28

PAINT COAT.

Total, see page 10	$1,061.82
Incidental work—Shoulders, etc.	522.15

MATERIALS.

Hauling sand and other materials	$1,656.50
Unloading stone dust	28.45
Screening rock (dirty)	89.65
1,083.13 tons rock (screenings)	1,158.97
286 tons extra sand	128.70
344.05 tons asphaltic cement at $8.75	3,010.45
210 tons limestone dust at $6.10	1,281.00
	$7,353.72
Hauling "hot stuff" by contract—30c per batch—7,580 batches (40 batches rejected on job.) (7,540 batches net in pavement.)	$2,274.00

SUMMARY.

	Total.	Per Sq. Yd.	Per Ton.	Materials & Mixing. Per Ton.
Clean concrete and paint coat	$ 1,061.82	$0.0207	$0.282	.....
Laying surfacing	3,128.28	0.0612	0.830	.....
Plant operation	5,143.35	0.1005	1.364	$1.364
Incidental work on shoulders	522.15	0.0102	0.138	.....
Materials for mixture	7,353.72	0.1440	1.951	1.951
Hauling mixture	2,274.00	0.0445	0.604	.....
Total	$19,483.32	$0.3811	$5.169	$3.315

Note—40 batches, or 20 tons, of mixture were thrown out on the work, leaving 7,540 batches to go into the pavement.

Some little difficulty was experienced in deciding upon the proper amount of asphaltic cement to add to the mixture during the first period of the work. In order to obtain proper "pat stains" and to keep a firm pavement under the rolling the amount of asphaltic cement per 1,000-lb. batch was increased from 92 lbs. to 98 lbs. and subsequently decreased to 96 lbs., at which point the greater portion of mixture was turned out. Based on "pat stains," 97 to 98 lbs. of asphaltic cement per 1,000-lb. batch seemed to be the proper amount, but excessive "balling up" occurred in the raking and the surfacing "jellied" under the roller; so this amount was cut back to 96 lbs. The plant operation was carried on with the following labor:

General superintendent, ½ day @ $7.50	$ 3.75
Foreman, 1 day @ $5.00	5.00
Engineer, 1 day @ $5.00	5.00
Watchman, 1 day @ $3.00	3.00
Mixerman, 1 day @ $3.00	3.00
Asphalt man, 1 day @ $2.75	2.75
Laborer, 1 day @ $2.75	2.75
Laborer, 2 days @ $2.50	5.00
2-H. Fresno, team and driver, 1 day @ $5.00	5.00
Total	$35.25

The mixture was hauled to place on the pavement in three five-ton motor trucks with end dump bodies, each truck load consisting of 13 batches or approximately 6½ tons. The contractor paid for this hauling at the rate of 30 cts. per batch. The average haul was three miles. The haul therefore cost 20 cts. per ton mile. The hauling contractor paid his drivers full time on this work, and kept four trucks on hand (one for emergency), and owing to the delays due to wet weather (12 days out of 36) his profit was a very meagre one.

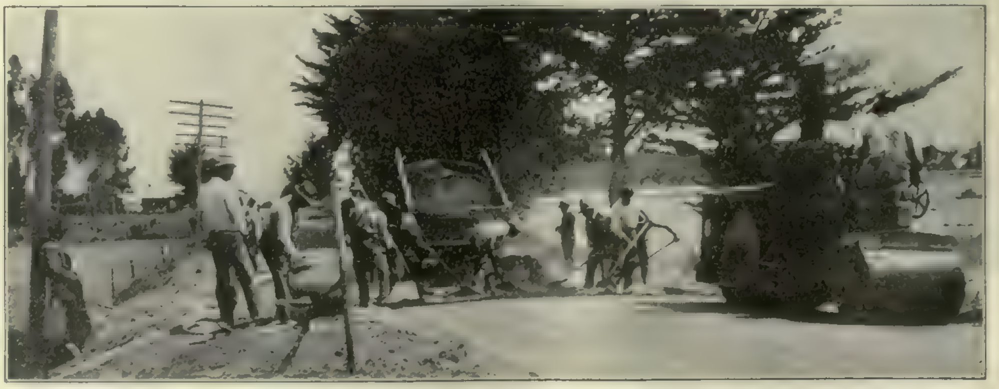


Fig. 5. Motor Truck Dumping Hot Mixture and Laying Gang at Work.

Figure 5 shows a motor truck just beginning to dump the "hot stuff" in piles, and the shovellers starting to turn the mixture over into place for the rakers, two of whom (three to this gang) are just starting to work. A typical paving gang on this work consisted of thirteen men as follows:

General superintendent, ½ day @ $7.50	$ 3.75
Foreman, 1 day @ $6.00	6.00
Rollerman, 1 day @ $5.00	5.00
Raker, 1 day @ $3.50	3.50
Raker, 2 days @ $3.00	6.00
Tamper, 1 day @ $2.75	2.75
Shovelers, 5 days @ $2.50	12.50
Hand Rollerman, 2 days @ $2.50	5.00
Total	$44.50

An average day's work for this gang is 2,000 sq. yds. of 1½ in. surfacing. The above amount of $44.50 does not represent the total cost of laying, as certain lost time charges, general superintendents and contractor's overhead and some incidental supplies and plant charges must be added. Complete laying costs appear in Table III.

ACKNOWLEDGMENT.

Prepared from report by Walter C. Howe, Division Engineer, furnished by A. B. Fletcher, Highway Engineer, California Highway Commission.

Cost of Brick Pavements.

(Staff Abstract.)

The following statements regarding cost must be considered as representing average conditions, and care must be exercised in applying them to special cases. They are intended as a guide in preparing estimates of probable cost.

The grading is usually paid for by the cubic yard, and the cost, of course, varies with the character of the soil and the necessary amount of excavation. In light, easily loosened soils, grading may usually be done at from 25 to 40 cts. per cubic yard. In hard earth containing more or less loose rock the cost per cubic yard generally runs from 40 to 75 cts., while grading in solid rock may sometimes cost as much as $1.50 per cubic yard. The cost of the rough grading should be considered entirely apart from the cost of the pavement.

The cost of shaping and rolling the subgrade after the rough grading is completed will ordinarily vary from 3 to 5 cts. per square yard. This cost should be included with the other items which make up the cost of the pavement.

The cost of the curbs varies with the character of the material used. Stone curbs ordinarily cost from 25 to 75 cts. per linear foot, while curbs made of Portland cement concrete cost, as a rule, from 20 to 50 cts. per linear foot. The higher prices for the concrete curbs apply principally to special cases requiring extra form work or considerable extra material.

The cost of the foundation depends largely on the cost of the materials with which it is constructed. Gravel or broken stone can usually be spread and rolled at from 5 to 7 cts. per square yard, while the cost of these materials, delivered, varies from $0.60 to $2 per cubic yard. Mixing and placing concrete usually costs from 35 to 75 cts. per cubic yard, according to the amount of work to be done and the methods employed, and the cost of the materials, delivered, ordinarily varies from $2.50 to $4.50 per cubic yard of concrete.

The cost of paving brick at the kiln varies from about $13 to $16 per thousand. Estimating 40 brick to the square yard, each 1,000 brick over approximately 25 sq. yds., which makes the cost at the kiln per square yard of pavement vary from 55 cts. to about 65 cts. These figures mean very little, unless the kiln is located conveniently near where the brick are to be used, for freight charges not infrequently amount to more than the cost of the brick.

A force consisting of one paver and five laborers should place on an average about 220 sq. yds. of brick per 10-hour day; while supervision, rolling, and incidental expenses are ordinarily equivalent to the cost of hiring about three and one-half additional laborers.

If C = cost of cement per barrel, S = cost of sand per cubic yard, A = cost of coarse aggregate per cubic yard, B = cost of paving bricks per 1,000, and L = cost of labor per hour, with all materials considered delivered on the work and all costs expressed in cents, then the probable cost of constructing a brick pavement, including the subgrade, a 6-in. concrete foundation, and suitable curbs, may be estimated by substituting in the formula:

$$\text{Cost per square yard} = 1.90\ L + .213\,C + .138\,S + .157\,A + .040\,B.$$

The cost as estimated from this formula should usually be increased by about 10 per cent to allow for wear on tools and machinery and to guard against unforseen contingencies. If it is desired to use a different thickness of foundation, it is safe to assume that each inch subtracted or added to the thickness of the foundation will make a corresponding difference of from 8 to 12 cts. in the cost per square yard.

ACKNOWLEDGMENT.

Extract from Bulletin 246, Department of Agriculture, by V. M. Pierce and C. H. Moorefield.

Expansion Joint Protectors for Pavements with Varying Crown.

To the Editors: In your issue of July 28, 1915 is an interesting article by Mr. C. H. Campbell on the methods pursued in adapting expansion joint protectors to a pavement having a varying crown. He suggests the makeshift method of having the plates in two parts connected at the center with two bolts and a strap and cut curved to the "average" crown. Assuming the section of the pavement to be a parabola with the quarter point one-quarter the crown below grade, and the crown to vary from 3 to 9 ins. with an average crown of 6 ins., we find no drainage is secured at the summit from the center line to the quarter point (see Fig. 1). There is a new joint bar on the market which is being extensively used on concrete pavements and alleys in and about Chicago. To protect a joint only one bar is required and it is so made as to bend automatically to fit any crown or "dish," while maintaining the joint in a straight line and in a vertical plane.

No installing devices are used with this bar and it seems to meet the expansion joint problem very satisfactorily.

The bar referred to is manufactured by the Universal Concrete Bar Co., 167 W. Washington St., Chicago.

Very truly yours,
H. J. Fixmer,
Division Engineer Bureau of Local Improvements,
Chicago, Ill., Aug. 3, 1915.

Progress of State Management of Public Roads.

(Staff Abstract.)

Of the progress of state road management it may be said that 42 states have thus far established highway departments for educational or administrative work, and of these 30 have made actual appropriations in aid of road construction or maintenance. In all $208,000,000 had been appropriated from state funds between 1891 and Jan. 1, 1915, for construction, maintenance, administration and educational road work, and a total of about 31,000 miles of improved roads is the evidence to show that this expenditure was not in vain. These roads were built for the most part as a joint state and local undertaking, so that a large local outlay not included in the state total was involved. It is most gratifying, however, that within a period of 22 years a policy begun on a small scale and cautiously extended has produced a mileage of improved roads greater in extent than the entire "Routes Nationale" of France, and that in 1913 alone a total of 5,000 miles of state-aided roads were completed.

HISTORY OF THE STATE-AID POLICY.

The rapid and widespread acceptance of the policy of state participation in road improvement may be understood by a hasty chronological narrative. Following the action of New Jersey in 1891 similar legislation was enacted by Massachusetts and Vermont in 1892, Connecticut and California in 1895, Maryland and New York in 1898, Maine in 1901, Rhode Island in 1902, New Hampshire and Pennsylvania in 1903, Ohio in 1904, Idaho, Michigan, Minnesota and Washington in 1905, Virginia in 1906, Arizona, Colorado, New Mexico, Utah and West Virginia in 1909, Louisiana in 1910, Alabama and Wisconsin in 1911, and Oregon in 1913. North Carolina in 1901 authorized the state geological survey to conduct educational and research work as a state highway department, and has continued on this basis up to the present time, except for the authorizing of a portion of its state convict force to be used on roads under the direction of the state geological survey. Delaware in 1903 provided for state aid, but only one county out of the three utilized the aid granted. Iowa established a highway department in the state agricultural and mechanical college at Ames in 1904 for educational and research work, and in 1913 the law was very much broadened by the creation of a state highway commission having control over all road work in the state.

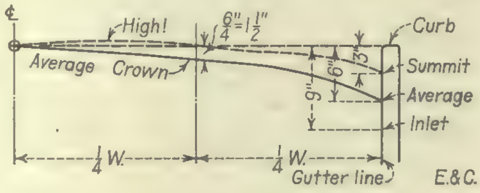


Fig. 1.

Illinois established a highway department in 1905 which was restricted to educational and investigative work and the distribution of crushed stone prepared by state convicts. In 1913 the Illinois law was greatly broadened and actual state aid in the form of a state road levy was granted. Missouri established in 1907 a highway department for educational and investigative work, but the state has distributed considerable sums of money to the various counties for road purposes from a war debt paid to the state, automobile license taxes and corporation taxes. Georgia in 1908 provided for the granting of state convict labor to road improvement, with the actual work under local supervision. North Dakota established an educational highway department in 1909, but has made no appropriation for actual aid. Kansas and Oklahoma established state highway departments for educational purposes in 1911, and Oklahoma gave authority for the use of state convicts on public roads. In the same year Nebraska provided aid for bridges and later required that bridges costing over $500 shall be designed and built from plans and specifications prepared by the state engineer. Legislation was also enacted providing for an advisory state highway commission. Nevada and Wyoming in 1911 made appropriations for the use of convicts in road construction under the direction of the respective state engineers. Kentucky estalisbhed a highway department for educational work in 1912, and the law was amended in 1913 to provide state aid by a one-half mill tax levy. Arkansas established a highway department for educational work in 1913. At the present time only the states of Florida, Indiana, Mississippi, South Carolina, Tennessee and Texas have no provision for any sort of state participation in road work.

CLASSES OF STATE-AID SYSTEMS.

The systems of road management now prevailing in the various states may be grouped in six general classes. The first class comprises those states in which the construction of all roads is more or less under state control. In the second class are comprised those states in which state control of road construction is limited to those roads in which state funds are expended. In the third class are included the states which grant aid in the form of state funds, but allow the expenditure to be made under local control. In the fourth class are those states which have established highway departments for educational and advisory work. The fifth class is composed of the states which devote the labor of state convicts to road improvement, and the sixth class comprises those states in which the control of all road construction is entirely local.

In the matter of road maintenance, the states may be conveniently classified in four groups. In the first group are comprised those in which the control of the maintenance of all roads rests with the state. In the second class are those in which the state control of road maintenance is restricted to the roads in which state funds are expended for construction. In the third class the state requires that roads on which state funds have been expended shall be maintained, but leaves the actual maintenance to be performed under local control and with local funds. In the fourth class are included the states which make no specific provision for the maintenance of roads on which state funds have been expended. The remainder of the states are those in which maintenance is an entirely local matter and under local control.

COST.

Based upon general averages, it has been ascertained that under average conditions macadam roads can be built in southern states at from $4,000 to $5,000 per mile, gravel roads at from $1,500 to $2,500 per mile, and sand-clay and topsoil roads at from $800 to $1,500 per mile. In New England and the other eastern states, macadam roads are reported at from $6,000 to $9,000 per mile, gravel roads at from $3,200 to $5,000, and bituminous macadam from $8,000 to $13,000, according to the character of construction, whether surface-treated, penetration, or mixing method. The bituminous type is quite general in the eastern states. As indicating costs in other sections of the country, the State Highway Commissioner of Michigan reported in 1913 the average cost for macadam roads $4,300 per mile, clay-gravel roads $1,500 per mile, and concrete roads about $10,000 per mile. The average cost of state highways constructed in Ohio in 1913 was $8,383. According to types, in 1912 the brick-paved highways averaged $14,650 per mile and the macadam highways $5,950. In California the first 356 miles of the state system of highways cost an average of $8,143 per mile and consisted principally of thin concrete with a thin coat of bitumen. The maximum and minimum figures given in this paragraph are not absolute, but are intended to present the usual range of costs. The rates given include grading, drainage, surfacing, and engineering costs.

ACKNOWLEDGMENT.

Extract from discussion by J. E. Pennybacker, Chief of Road Economics, Office of Public Roads, in Yearbook of Department of Agriculture for 1914.

Method of Recording Expenditures on Account of Maintenance, Pennsylvania Highway Department.

(Staff Abstract.)

For information and convenience, the maintenance division requires all expenditures to be classified under the following heads: (1) General Repairs; (2) Resurfacing; (3) Oiling; (4) Bridge Construction; (5) Removing Snow; (6) Tools and Equipment; (7) Repairs to Equipment; (8) Storage.

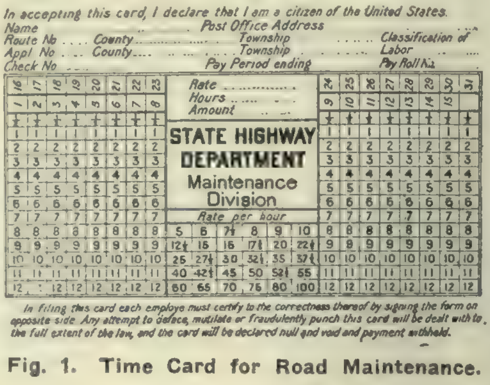
A separate accounting for labor expenditure and material purchased is demanded and no expenditures on these accounts are permitted without specific authorization from the maintenance engineer in charge of the Maintenance Division of the State Highway Department at Harrisburg.

Each laborer employed by the state highway department upon starting work is furnished with brass check bearing a number, and given a time card (Fig. 1) which is punched each day showing rate and number of hours employed, both of which must be presented to the paymaster before paycheck will be delivered, nor is an assignment of account permitted, and this department finds itself helpless in the matter of accepting liens or attachments. Every effort is made to have individual checks issued and delivered to each workman within ten days after the close of a pay period.

A requisition (Fig. 2) for material needed on any place of work, whether it be a state highway route or state-aid road, is issued, and if approved by the maintenance engineer, a purchase order (Fig. 3) is drawn. The purpose of the purchase order is to provide a written request for all material ordered and save misunderstanding and delay, likewise to prevent an unauthorized person from securing material under the guise of being an employee of the state highway department. All merchants and supply men are warned that no purchase of material is authorized unless accompanied by a formal purchase order issued by the Pennsylvania State Highway Department. On each purchase order is plainly stated when and where material is to be shipped, all shipments being made on Department shipping orders and department bills of lading.

Each purchase of material, as far as practical, is made for some definite piece of work, and on the face of the order is plainly stated the class of expenditure to which charge is to be made, the matter of accounting for material purchased being thereby simplified.

Extract from an article, in "Pennsylvania Highway News," by William R. Main, Auditor State Highway Department.

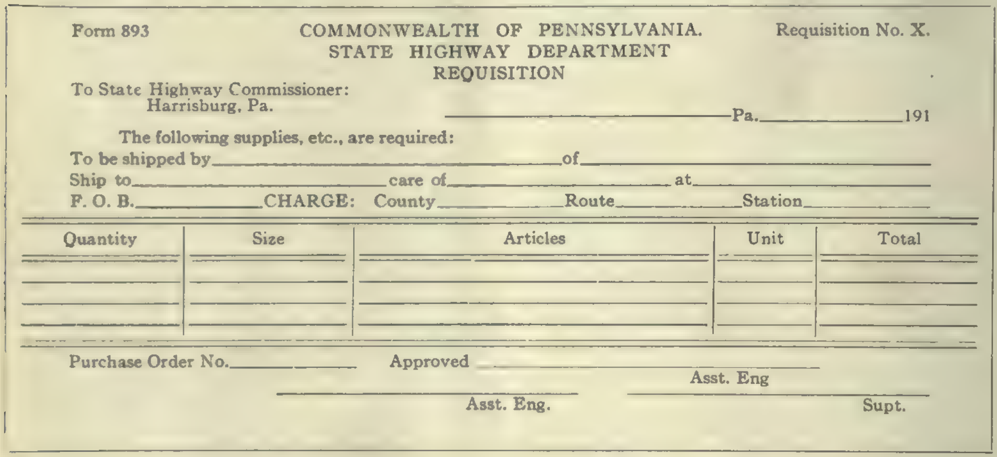


In accepting this card, I declare that I am a citizen of the United States.
Name .... Post Office Address ....
Route No .... County .... Township .... Classification of
Appl No .... County .... Township .... Labor ....
Check No .... Pay Period ending .... Pay Roll No.

16	17	18	19	20	21	22	23	*Rate*						24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	*Hours* .... *Amount*						9	10	11	12	13	14	15	
½	½	½	½	½	½	½	½							½	½	½	½	½	½	½	½
1	1	1	1	1	1	1	1	STATE HIGHWAY DEPARTMENT Maintenance Division						1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2							2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3							3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4							4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5							5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6							6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	*Rate per hour*						7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	5	6	7½	8	9	10	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	12½	15	16	17½	20	22½	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	25	27½	30	32½	35	37½	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	40	42½	45	50	52½	55	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	60	65	70	75	80	100	12	12	12	12	12	12	12	12

In filing this card each employe must certify to the correctness thereof by signing the form on opposite side. Any attempt to deface, mutilate or fraudulently punch this card will be dealt with to the full extent of the law, and the card will be declared null and void and payment withheld.

Fig. 1. Time Card for Road Maintenance.



Form 893 COMMONWEALTH OF PENNSYLVANIA. Requisition No. X.
STATE HIGHWAY DEPARTMENT
REQUISITION

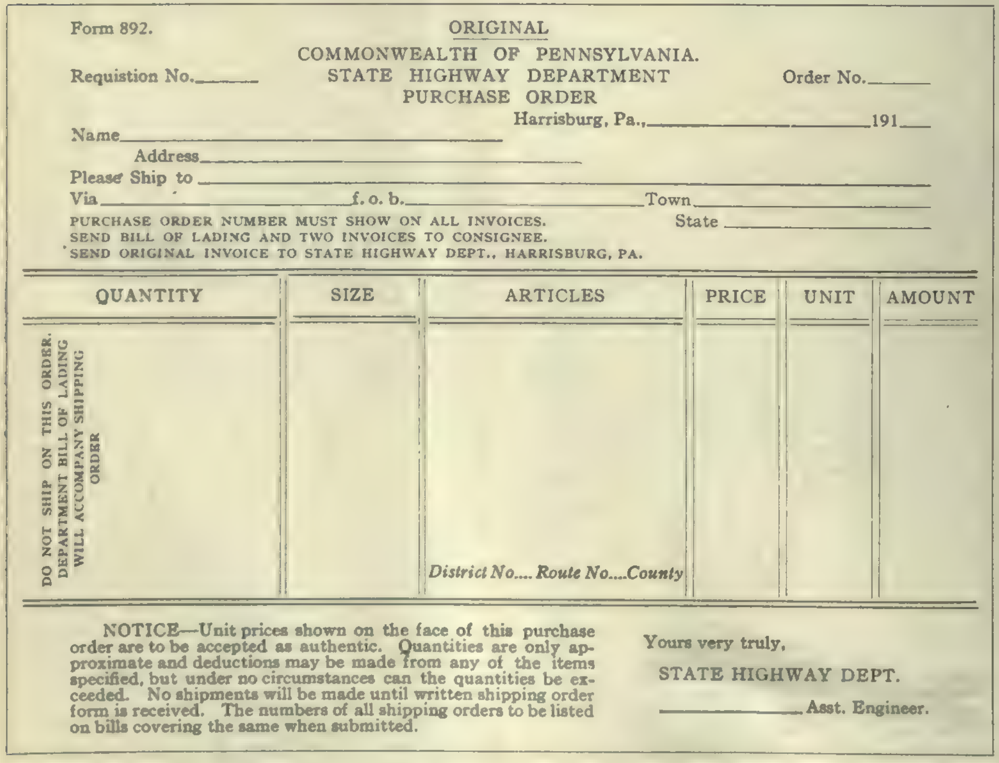
To State Highway Commissioner:
Harrisburg, Pa.
________________Pa.________191

The following supplies, etc., are required:
To be shipped by________________of________________
Ship to________________care of________________at________________
F. O. B.__________CHARGE: County__________Route__________Station__________

Quantity	Size	Articles	Unit	Total

Purchase Order No.__________ Approved ________________
Asst. Eng
________________ ________________
Asst. Eng. Supt.

Fig. 2. Requisition for Materials for Road Maintenance.



Form 892. ORIGINAL
COMMONWEALTH OF PENNSYLVANIA.
Requistion No.______ STATE HIGHWAY DEPARTMENT Order No.______
PURCHASE ORDER
Harrisburg, Pa.,________________191____
Name________________
Address________________
Please Ship to ________________
Via________________f. o. b.________________Town________________
PURCHASE ORDER NUMBER MUST SHOW ON ALL INVOICES. State ________________
SEND BILL OF LADING AND TWO INVOICES TO CONSIGNEE.
SEND ORIGINAL INVOICE TO STATE HIGHWAY DEPT., HARRISBURG, PA.

QUANTITY	SIZE	ARTICLES	PRICE	UNIT	AMOUNT
DO NOT SHIP ON THIS ORDER. DEPARTMENT BILL OF LADING WILL ACCOMPANY SHIPPING ORDER		*District No.... Route No....County*			

NOTICE—Unit prices shown on the face of this purchase order are to be accepted as authentic. Quantities are only approximate and deductions may be made from any of the items specified, but under no circumstances can the quantities be exceeded. No shipments will be made until written shipping order form is received. The numbers of all shipping orders to be listed on bills covering the same when submitted.

Yours very truly,
STATE HIGHWAY DEPT.
________________Asst. Engineer.

Fig. 3. Purchase Order for Materials for Road Maintenance.

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Wood-Block Paving in Canada.—The Dominion Department of the Interior has established in connection with the Forestry Branch a forest products laboratory. This institution is constantly at work testing woods for paper making, building, furniture, etc. An investigation of the use of wood for block paving has just been completed and the results issued in a pamphlet entitled "Treated Wood-Block Paving." This gives, according to a U. S. Consular report, the latest facts and figures in regard to wood paving in Europe and America and removes many misconceptions. It shows the points to be guarded to secure the best results. Canadian citizens interested in wood-block paving may have a copy of this pamphlet free by writing to the Director of Forestry, Ottawa, Canada.

CURRENT NEWS

The Doings of the Week.

Trade, industry and finance continued their upward swing during the past week. Developments of the week were favorable to continued business improvement. Chief of these was the government crop report for August which forecasted 5,500,000,000 bu. yield of wheat, corn and oats. The wheat crop alone is estimated at 3,000,000,000 or 75,000,000 more than the previous high record. The report of the U. S. Steel Corporation showed an unfilled tonnage greater than in any period since February. 1914. The Western rate case decision was handed down by the Interstate Commerce Commission and the increases granted were comparatively small but they nevertheless will afford some relief. There also are good prospects that the case may be reopened and the carriers allowed further advances. The passenger petition which would increase the revenues of these roads some $20,000,000 is still pending. In the construction field there has been no slowing up of activities. A great number of small undertakings are ready for bids; notably big jobs also are making their appearance. One of the largest excavation contracts so far this year for the U. S. Reclamation Service is now being advertised, a 5,000,000 yd. drainage job also is ready for bids. An encouraging feature of the situation is the number of private irrigation projects placed under contract recently. Highway construction, street paving and bridge building are offering many opportunities and the municipal lines of water works and sewerage are steadily improving as regards the amount of work ready for bids. In the building field there has been some gain as is indicated by the increased price of structural steel and other materials. In the Metropolitan District of New York alone it is reported that over $54,000,000 of held over building construction will be undertaken this fall. Current indications point to a general revival of building this fall, but not to boom conditions. In the steel trade the activities of previous week continued. Active buying of pig iron at advancing prices was a feature of the week. The Cambria Steel Co. has received an order from the Russian Government for 100,000 tons of 67-lb. rails. Orders for 20,000 tons more of 67-lb. rails and 200,000 tons of 42-lb. rails for Russia are under negotiations. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Aug. 11 were as follows:

Finished Iron and Steel.	Aug. 11.	Aug. 4.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill......	1.25	1.25
Iron bars, Philadelphia	1.40	1.35
Iron bars, Pittsburgh..........	1.30	1.25
Iron bars, Chicago	1.20	1.20
Steel bars, Pittsburgh	1.30	1.30
Steel bars, New York	1.469	1.469
Tank plates, Pittsburgh	1.25	1.25
Tank plates, New York	1.419	1.419
Beams, etc., Pittsburgh	1.30	1.30
Beams, etc., New York	1.469	1.469
Skelp, grooved steel, P'gh.....	1.25	1.25
Skelp, sheared steel, P'gh.....	1.30	1.30
Steel hoops, Pittsburgh	1.30	1.30

Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.85	1.80
Galv. sheets, No. 28, P'gh.....	3.85	4.00
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.60	1.55
Fence wire, base, P'gh........	1.40	1.40
Barb wire, galv., P'gh........	2.50	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs ¼ in. thick and over, and zees, 3 in. and over, 1.30 cts.

Railways.—The Western freight rate case decision was handed down last week. While the advances will total less than 25 per cent of the amount hoped for, the carriers got something and that is encouraging. It is possible now that some of the roads may go ahead with a few of their long deferred construction undertakings. In the east one important development was the sale of $22,000,000 of bonds by the Seaboard Air Line Ry. and the announcement that an 85-mile extension from Charleston, S. C., to Savannah, Ga., would be constructed immediately. The Southern Ry. also has a considerable amount of second track work that may be placed under contract soon. Numerous short line railway companies have been incorporated in the last few days, and the voice of the promoter is once more being heard in the land. The contracts let recently include a $217,000 job secured by the Walsh Construction Co., Davenport, Ia., for yard changes at Syracuse, N. Y., for the New York Central Line. The McNichol Paving & Construction Co., at $212,000 was low bidder for the Delaware track elevation work at Philadelphia.

Roads and Streets. — A considerable amount of street paving and county road construction reached the call for bids stage during the past week. Very little new state highway work, however, came up for advertising. California will call for bids in a few days on 20 miles of work. Ottawa, Ont., is asking bids for asphalt and stone block paving to cost about $220,000; Elizabeth, N. J., opens proposals Aug. 26 on 34,600 sq. yds. of asphaltic concrete and stone block; Greenville, Tenn., is calling for bids on 40,000 sq. yds. of pavement. The Bureau of highways of Philadelphia, Pa., opened bids on $300,000 worth of work; California awarded contracts for 47 miles of state highway. The advertised county work includes 32,000 sq. yds. concrete road between Green Bay and De Pere, Wis.; $25,000 worth of sand clay road for Siloam Township, N. C.; resurfacing with bituminous concrete national road from Leatherwood, W. Va.; 28,000 sq. yds. of brick paved road in Mt. Pleasant Township, Pa.; and two sections of the Amboy-Keyport Road, New Jersey.

Bridges.—Bridge work ready for letting includes numerous small structures. Larger undertakings involve a Strauss bascule trunnion bridge at Mattawan, N. J., a $100,000 job for repairing the Belle Isle bridge at Detroit, Mich.; three steel bridges and concrete arch for the County Supervisors at Columbus, Miss.

Drainage and Irrigation.—One of the largest dredge ditch propositions so far this year is now ready for bids. The work calls for the construction of 37 ditches for drainage district No. 2 of Crawfordsville, Ark., and involves some 5,000,000 cu. yds. of earth excavation. The U. S. Reclamation Service, also is asking bids on a large amount of excavation. This provides for the earthwork on about 10 miles of the Fort Laramie Unit of the North Platte project and requires 1,206,000 cu. yds. of excavation. R. M. Quigley, Denver, Colo., was awarded contract involving 325,000 cu. yds. earth excavation for Rio Grande Drainage District of Monte Vista, Colo.; Maney Bros., Boise, Idaho, secured a $66,000 contract from the Mountain Home Co-operative Irrigation Co.

Waterworks.—Sparta, Ill., is calling for bids for water works to include 12½ miles of mains; Maumee, O., is asking for proposals on water works to include 8 miles of pipe; Board of Water Supply, New York City opens bids Aug. 31 for water pipe equipment for operating valves in shafts of city tunnel of Catskill Aqueduct. Hiram Lloyd Building & Construction Co., St. Louis, Mo., at $280,000, was low bidder for reconstructing Compton Hill reservoir for St. Louis. C. W. Blakeslee & Son, New Haven, Conn., has been awarded contract at $357,000 for constructing reservoir for Hartford, Conn.

Sewerage.—A number of fair sized sewerage jobs are now being advertised. Ocala, Fla., is asking bids on a sanitary sewer system to include about 121,000 ft. of pipe; Sellersville, Pa., asks proposals for sanitary sewer system to include about 22,000 ft. of pipe; Crofton, Neb., also is asking bids on Sanitary sewers and Chanute, Kan., is advertising for proposals on sewage disposal plant as is Brockport, N. Y. Oswego, N. Y., is calling for bids on a fair sized job and Cleveland, O., opens proposals Aug. 20 for sewer in Dugway Branch. Contracts let include a $59,000 job for Steamboat Springs, Colo., and a $35,000 contract for Syracuse, N. Y.

Better Times in Sight.

Contractors have had their troubles this year. Construction undertakings in certain lines have not been as abundant as could be wished. Competition on many jobs has been great and work has gone at prices that will make the successful bidders hustle to break even. There have been few instances this season where proposals were rejected because they were in excess of the engineer's estimates. In fact, on many jobs the bids have been 20 to 40 per cent or even more under the figures of the engineer. Then, too, weather conditions have been exceptionally unfavorable. Highway building and all grading in particular has suffered from the heavy and frequent rains. Since the first of July, however, there has been a marked increase in the amount of construction offered to contractors. The work has been going at better figures, and the "get it at any price bidder" seems to have learned his lesson. Present indications are that most of the contractors' troubles, leaving out of consideration those caused by Jupiter Pluvius, are about over.

The Late Bidder.

A case of interest to the "last minute bidder" is now before a New York Court. At a recent letting by the Public Service Commission of New York City, after the bids had been closed at the specified time an additional bidder appeared and offered to submit a proposal. The contractor stated that he had been held up on account of a heavy rain storm and by a block in the subway. The chairman of the Commission refused to accept the bid on the ground that it was not submitted at the proper time. The other bids were then opened. Later on the late bidder served a notice upon the Commission to show cause why a writ should not be issued directing the commission to accept his bid, he stating that it was lower than that of the low bidder.

Western Rate Case.

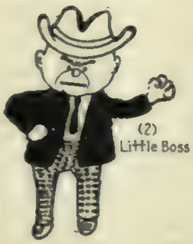
The Interstate Commerce Commission made public last week its decision in the Western Rate case. The railroads were granted increases in rates that probably will net them about $2,000,000. The next day the Commission handed down its decision in the case of the anthracite carriers, reducing the revenue of these roads close to $10,000,000 annually. The western railways had asked increases in certain commodities, which if granted, would have netted them about $7,600,000 per year. The Commission refused to grant advances on the items which would have netted the greatest revenues. The decision will be of more benefit from a sentimental standpoint than from a practical one.

The Lighter Side of Engineering and Contracting

Too Mucha da Big Eyed Chick.

A bunch of "dagos," working on a tile drain, killed a big hoot owl which they dressed, broiled and added as a delicacy to the noonday meal. About 3 p. m., the boss noticed a cessation of work on the part of the dagos. An investigation found the dagos clinging to the willows and vigorously hollering "Eu-rope! Eu-rope!" The boss proceeded to address them. "Hey, there! Wa'at ta 'ell's the matter with you — — dagos? Lookin' fur another job? Hey!" One of the Italians replied in a faint voice: "Oh, God! Sicka da bel'. Too mucha da big-eyed chick."—W. B. H., St. Joseph, Mo.

The Higher They Go the More They Kill.



TWO structural workers met one day and the following conversation took place:

Mick — Hey, Pat, how's the job?

Pat — Foine. We're up thoity floors and aint' killed a mon.

Mick — An' de yez call thot foine? Sure, we've killed three Hunks and only made tin floors.—M. D. L., Cincinnati, O.

"His Last Words Were——"

MIKE CASEY held a responsible position as section foreman for a large interurban electric line in one of our western states. Besides his duties of caring for the tracks, he was required to render several daily reports to headquarters. Frequently a car bumped some of his Mexican track laborers, requiring him to fill out a form known as "Report of Accidents to Persons or Property." One day a handcar loaded with rails got away from one of the Mexicans, taking a wild ride down a steep grade. The car failing to take a curve, hurdled the track and struck a trolley pole. When Mike reached the scene of the accident, he found a dead Mexican. Wishing to give good service to his company he immediately rendered his accident report. In column marked "Nature of Accident," Mike wrote, "Joy ride on hand car." To the next question marked, "Cause of Accident," he inserted, "Car too fast for track." However, when Casey observed the last query, "Remarks," he pondered somewhat before proceeding. Finally he inserted, "The Mex. didn't make any—He was dead."—C. A. E., Los Angeles, Cal.

How Pat Broke the News.

Tim Casey and his friend, Pat Kline,
Were blasting rock one day,
When a blast went off and blew poor Tim
Clear to the milky way.

When Tim came down he came so fast
He left his soul behind.
An arm and leg was all of him
That they could ever find.

The foreman said to Pat: "Go home
And see Tim's poor wife,
And gently break the news to her
That Tim has lost his life."

So Pat went sadly to Tim's home,
And when he saw Tim's wife
He cried: "Did Mr. Casey have
Insurance on his life?"

"You bet yer life he has!" said she.
"Hurrah for that!" yells Pat;
"We can't collect your husband, but
We'll help ye collect that."

The Private Car, the Porter and the Great Weight.

SOME 15 years ago the officials of a railway for which Pat Walsh was doing a considerable amount of construction placed at his service a private car. A Chicago friend, thinking to have some fun with the contractor, inserted an advertisement in the newspapers for a Pullman porter, with instructions for applicants to apply to Walsh by special delivery letter. The contractor is said to have received nearly 1,000 letters. He tumbled to the joke very quickly and answered each letter, inviting the applicant to apply in person at the office of his Chicago friend. The latter was beseiged by black clouds for nearly a week. After the storm was over the Chicago man determined to get even. So he sent a long collect telegram to Walsh telling him that he had nearly lost his life and ended with: "I am feeling better now, and will be quite recovered when you have paid for this telegram." There were no new developments for several days, and then an expressman brought to the office of the Chicago friend a neatly wrapped package. The charges were $4.90, and, as the man was expecting an express package, he paid them without suspicion. When he opened the box he found a lot of old paper and a rusty cast iron weight of about 50 pounds. On the weight was the following inscription: "Dear George—Your complete recovery announced by your collect telegram lifted a great weight from my heart. P. S. This is the weight. Yours, Pat."

The Demon Water.

WHILE Moses and other leaders of thought and men in ancient times were water boosters, it appears that in the Middle Ages water as a beverage, was looked upon by the supersagacious as harmful as well as punk. Some of the comments favoring water, made when it was again gaining popularity as a drink, are mildly amusing. Thus Sir Thomas Elyot, in 1541, in referring to Cornishmen said: "Many of the poorest sort, which never, or very seldom, drink any other drink, be notwithstanding, strong of body and like, and live well until they be of great age." Despite this evidence, Sir Thomas considered water as the cause of swelling in the spleen and liver. He also said: "To young men and them that be of hot complexion it does less harm, and sometimes it profiteth, but to them that are feeble, old and melancholy it is not convenient." Another writer said he knew some "honorable and worshipful ladies who drink little other drink and yet enjoy more perfect health than most of them that drink the strongest."

The First Water Rights Dispute.

THE earliest dispute regarding water rights about which there is a record, either in sacred or profane literature, was that between Abraham and a man named Abimelech (pronounced Abimelech). The record in the case will be readily turned to in Genesis, 21st chapter and 25th verse. It appears that the dispute was over the possession of a well which Abraham claimed to have dug (by proxy, as like as not). Abimelech had a chesty servant who had a way of helping himself, and this individual acquired possession of the well by force. Abraham held Abimelech responsible for this act and sued him for damages. The case was finally adjusted amicably out of court, Abraham, who could well afford to be generous, paying Abimelech seven ewe lambs to regain possession of the well.

Skinner Mulveys says: "Worked one day last week; earned enough to buy an umbrella. The rain falls alike on the Just and Unjust. Damn lie. The Just fellow is the only one that gets wet, for the Unjust man always manages to steal his umbrella."

SHIP CANAL FOR NEW ORLEANS, LA.

Proposed Routes for Waterway Connecting Lake Pontchartrain and Mississippi River.

Estimated Costs, $2,500,000 to $13,000,000.

The state of Louisiana by constitutional amendment approved Nov. 3, 1914, authorized the construction and operation within the city limits of New Orleans of a navigation canal and necessary locks, slips, laterals, basins and appurtenances connecting Lake Pontchartrain and the Mississippi River. A report on this development has been submitted recently to the commissioners of the port of New Orleans by Ford, Bacon & Davis, consulting engineers.

This report covers five distinct routes or locations within the city limits for the proposed canal. Route No. 1 begins at the Mississippi River between Carrollton avenue and the upper parish line and connects with the New Basin canal. Route No. 2 begins at the Mississippi River between Jackson avenue and Canal street and connects with the head of the New Basin canal at Rampart and Julia streets. Route No. 3 begins at the Mississippi River between Canal street and Esplanade avenue and connects with the head of the Carondelet canal between St. Claude and Rampart streets in Carondelet Wall. Route No. 4 begins at the Mississippi River between Press street and the lower parish line and extends almose due north to Lake Ponchartrain. This route is 5.3 miles in length, and gives the shortest distance between the lake and the river. Four different types or limits of development have been worked out for this route. Route No. 5 begins at the Mississippi River and Jackson Barracks and extends nearly due north to Lake Ponchartrain. The first three developments provide for barge canals equipped with locks. They are extensions of the present New Basin and Carondelet canals. The locks would be of reinforced concrete, 300 ft. long and 10 ft. deep over the sills. Details of the canal construction required for these three routes follow:

	Route No. 1.	Route No. 2.	Route No. 3.
Land to be purchased, acres....	80	18	20
New canal, width, ft.	200	80	60
New canal bottom width, ft.	80	80	60
New canal, depth, ft.	10	10	10
New canal, length, ft.	12,000	5,000	3,000
Total estimated cost, exclusive of abutting property damages	$4,120,137	$6,819,000	$4,534,880

It is stated that these three routes not only would appear to require excessive costs of construction, considering the possible earnings, but the interruptions in operation owing to the congestion of street traffic would make them impossible.

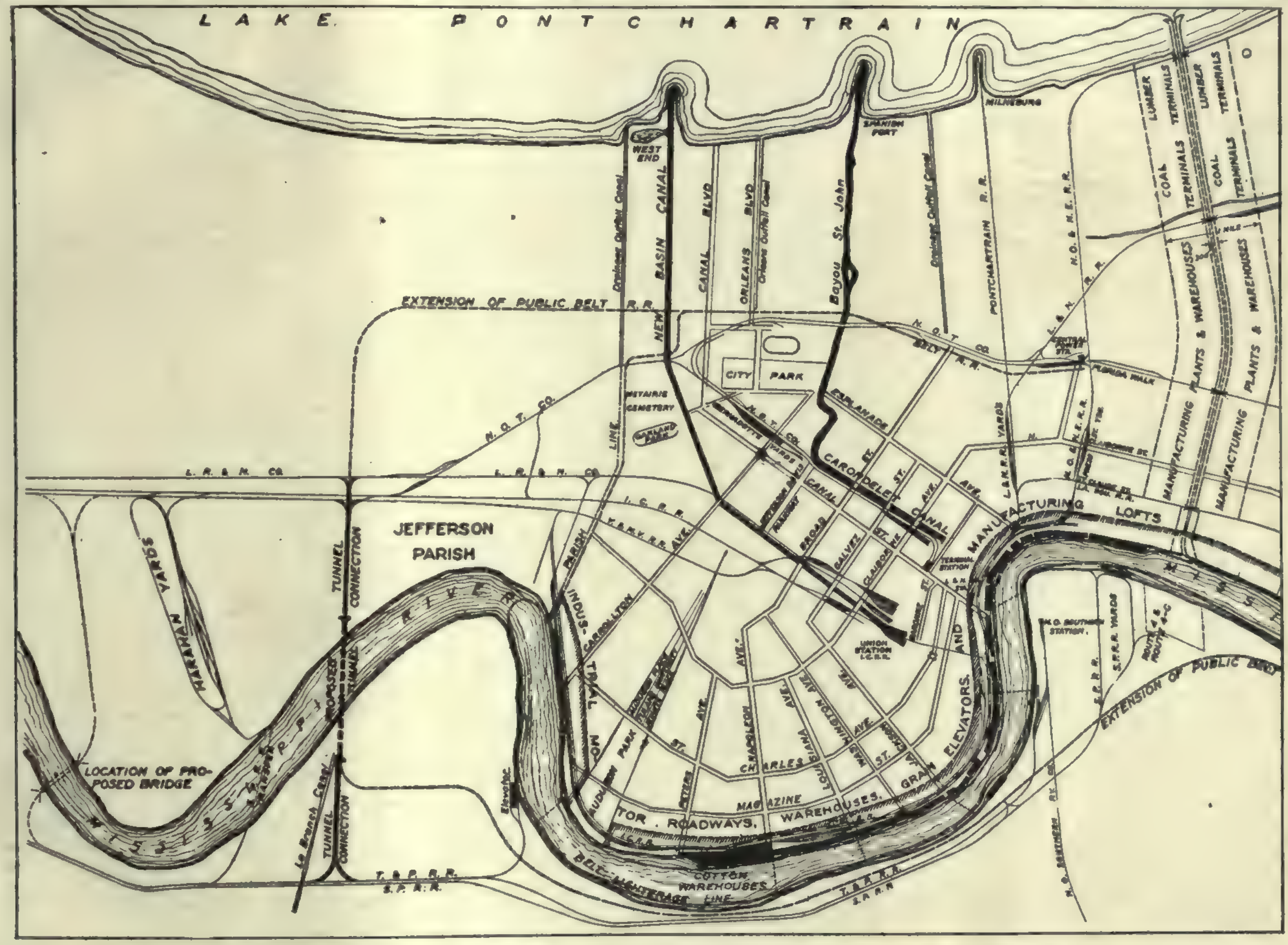
The development under route No. 4 also involves the construction of a barge canal. Under this project there would be a reinforced concrete lock 300 ft long, 50 ft. wide and 10 ft. deep at the sills. The canal would be 175 ft. wide at the top, 80 ft. wide at the bottom, 10 ft. deep and 5.3 miles long. This canal could be enlarged into a ship canal. It is located in practically vacant territory, giving ample opportunity at moderate prices for private ownership of terminals. The construction cost of the development, including necessary real estate but exclusive of abutting property damages, is estimated as follows:

Land	$ 295,277
Excavation	578,463
Lock	584,694
Railroad bridges	220,000
Breakwater	62,500
Reconstruction of public utilities.......	400,000
River protection	35,000
General, contingent and engineering expenses	261,112
Total	$2,437,046

The proposed developments Nos. 1 to 4 inclusive would receive their revenue from a system of tolls and rentals analogous to that now in effect. In addition to the four developments noted above consideration was given to four other projects. These were based upon the assumption, subject to competent legal opinion, that land on the banks of the canal or ship basin in excess of right of way requirements may be purchased en bloc by the board of port commissioners and resold at advanced prices to private individuals or corporations for the location and ownership of private terminal facilities. Under this plan the sale price of the land is assumed to amortize the entire construction and development with interest thereon during the time the bonds are outstanding.

Developments 4A, 4B and 4C are variations of route 4. They provide comprehensive plans intended to indicate the ultimate extent to which the canal basin and industrial terminal may be carried when the growth of the port warrants it. Details of the three developments are given below:

	No. 4-A.—Ship basin and barge canal.	No. 4-B—Small ship basin and barge canal.	No. 4-C—Barge canal.
Land for right of way, acres	469	206	249
Land for industrial sites, acres......	4,231	2,920	2,877
Width at locks, ft..	1,000	1,000	600
Width on ship basin, miles	1.5	1	....
Width on barge canal, miles	1.5	1	1
Ship basin, length miles	2.3	1.23	....
Ship basin, bottom width, ft.	732	300	....
Ship basin, top width, ft.	1,000	538	....
Ship basin, depth, ft.	35	30	....



Proposed Navigation Canal and Industrial Waterfront Developments for New Orleans, La.

Barge canal, length, miles	3	4.07	5.3
Barge canal, bottom width, ft.	278	40	180
Barge canal, top width, ft.	408	158	300
Barge canal, depth, ft.	12	10	10
Total length ship basin and barge canal, miles	5.3	5.3	....
Lock (ship), length, ft.	850	600	....
Lock (ship), width, ft.	90	70	....
Lock (ship), depth over sills, ft.	35	30	....
Lock (barge), length, ft.	350	....	300
Lock (barge), width, ft.	60	....	55
Lock (barge), depth over sills, ft.	18	....	15
Cost of construction	$13,929,843	$6,748,805	$5,342,233

Development No. 5 contemplates only the change of location from route No. 4, and the only modification would be one of real estate cost.

$200,000 BRIDGE AT LAWRENCE, KAN.

Bids Asked for Reinforced Concrete Structure Over Kansas River.

10,546 Cu. Yds. Concrete; 8,000 Cu. Yds. Excavation; 600,000 Lbs. Reinforcing Bars.

Bids are now being asked by the commissioners of Douglas County, Kansas, for the construction of a $200,000 reinforced concrete bridge. The new bridge will be constructed over the Kansas River at Lawrence, Kan., immediately above the present steel bridge at Massachusetts street. The present bridge consists of six steel spans on masonry piers and will be removed after the new bridge is completed. This work, however, is not included in the present contract.

The new bridge will consist of the following spans, beginning at the south end: One concrete girder span 29 ft. long; one steel girder span, concrete encased, 48 ft. 4 in. long; one concrete girder span 29 ft. long; six arch spans each 132 ft. long in the clear.

The roadway will be 30 ft. wide between curbs and there will be two sidewalks 5 ft. wide from curb to inside of railing posts. There will be one electric railway track in the center of the roadway. The six arch spans are divided into two sections of three spans each by pier No. 3, which is designed to take the unbalanced thrust due to the arch ring on the south side of the pier. Owing to this arrangement it will be practicable to strike the centers for the south three arch rings before the north three are built. In case the north three arch rings are built first the positions of the base and reinforcements for pier No. 3 must be reversed. The three girder spans at the south end will provide a crossing over the tracks of the Atchison, Topeka & Santa Fe Ry. and will be separated from the arch span portion by an abutment.

The abutment at the south end will rest on concrete piles driven to the shale bed. The foundations for the bents supporting the Santa Fe span are to be carried to this same shale stratum. The south abutment of the arch portion and piers 1 and 2 are to be carried to a limestone bed that lies 4 ft. to 8 ft. below the bed of the river. At the middle of the river the limestone bed ends abruptly, and piers 3, 4 and 5 and the abutment at the north end of the structure will be carried down to a stratum of blue sandy shale which lies 30 ft. to 40 ft. below the bed of the stream. Piers 3, 4 and 5 and the north abutment are to be sunk by the pneumatic process. The pier shafts will have angular cut-waters with steel nosings on the upstream side.

The arch spans will be of open spandrel construction. The arch ribs will be 24 ft. wide and the sidewalks and a portion of the roadway on each side will be carried on cantilever brackets.

The spaces between the cantilever brackets and sidewalk slabs are to be used for water and gas mains, telephone conduits, etc. Each arch span is divided into 12 panels of 11 ft. 1½ ins. The roadway is supported on a reinforced concrete slab, except that in the four center panels over the arch ring there is a sand fill to support the pavement.

Each pier will be surmounted by two ornamental pedestals, each carrying an ornamental combined lamp and wire pole. At the south end of the bridge there will be placed two ornamental lamp piers or monuments to which the nameplates are to be attached. The railings are to be of the spindle type. At the north end the roadway and sidewalks will be carried on a new fill. The pavement, sidewalks and railings on this fill will be of temporary construction, as it is desired to allow fill to settle thoroughly before making permanent improvements thereon. The south approach also will be filled somewhat above the present level. The bridge and south approach will be paved with brick.

The approximate quantities involved include the following:

Concrete, cu. yds.	10,546
Earth excavation, cu. yds.	7,070
Excavation, limestone rock, cu. yds.	220
Excavation in blue sandy shale, cu. yds.	700
Concrete piling, lin. ft.	680
Reinforcing bars, lbs.	600,000
Rail, splices, bolts, and spikes, lbs.	110,000
Brick pavement, sq. yds.	4,200
Approach fills, cu. yds.	17,500

Of the total amount of concrete given above 2,025 cu. yds. are to go into the bases of piers 3, 4 and 5 and 1,287 cu. yds. are to go into shafts of these piers. The concrete in the north abutment below a plane 9½ ft. below the fixed line of the arch rings will amount to 1,684 cu. yds. The concrete in arch rings, in the solid portion of piers between the arch rings and above a plane 24 ft. 3 in. below the crown of roadway, and in the solid portions of the two abutments above the plane 9½ ft. amounts to 3,231 cu. yds. Approximately 2,144 cu. yds. of concrete will be required in the arch spans above the arch rings and below the top of sidewalks and in the two abutments.

The bridge will be constructed for Douglass County, Kansas. The maximum amount which the county is authorized by law to expend from the county treasury for the construction of this structure is $200,000, to be raised by tax levies. More than half of this amount has been collected and is now in the county treasury. It is expected that the Atchison, Topeka & Santa Fe Ry. will contribute an additional sum equal to the extra cost of the bridge over and above what it would cost if it were not necessary to supply the overhead crossing of the Santa Fe tracks, and if such contribution is made the sum available for construction will be in excess of $200,000. In no event, however, will the amount expended by the county treasury exceed the sum of $200,000, and bidders must take this into account when preparing their bids.

Bids for the construction of this bridge will be received until noon Oct. 6, by Herman Broeker, county clerk, Lawrence, Kan. Hedrick & Cochran, Kansas City, Mo., are the consulting engineers.

A $250,000 Irrigation Project Near Paradise, Cal.

Steps are being taken for the formation of an irrigation district under the Wright act for lands in the vicinity of Paradise, Cal. The proposed district is about 15 miles distant from Chico, Cal., a city of 15,000 population, and is situated in the Sacramento Valley, 90 miles north of Sacramento. The Paradise Water Users' Association, an organization of fruit growers with insufficient water for rapidly developing needs, is primarily interested in the project.

As most of the water now running in the streams that would be available to irrigate lands in this locality is utilized by hydro-electric power companies, the problem is to find sufficient storage capacity from the winter run-off to supply the district with 10,000 to 15,000 acre feet of water. Several reservoir sites are under consideration, any one of which will store the desired quantity of water at an average expense of not to exceed $2 per acre per annum for a period of 40 years. This figure is based on a construction cost of $250,000 plus the discount on the bonds estimated at 10 per cent. The estimate is based on 6 per cent interest-bearing bonds running for 20 years, after which 1/20 of the bonds would be retired every year for the following 20 years.

The proposed type of construction is the multi-differentiated arch dam. The main canal and laterals are to be cemented, as the entire district lies on the mountain side at an average grade of 3.5 per cent sloping to the south. This slope is traversed by natural drainage. The main laterals are to be taken down the ridges formed by the drainage.

The length of the main canal from the nearest reservoir site to the point of distribution is about 45 miles. The floor of the reservoir at the dam site is 200 ft. above the highest point of land to be irrigated. The topography of the country will admit of the installation of a hydro-electric plant that will generate about 700 h.p. for electric lighting or other power purposes without waste of irrigation water. The new system would provide ample water for 10,000 to 15,000 acres. Steps are being taken to submit the matter of organizing an irrigation district to a vote of the people. C. S. Compton, Paradise, Cal., is the consulting engineer.

A 1,470-Ft. Reinforced Concrete Bridge at Tulsa, Okla.

The commissioners of Tulsa County, Oklahoma, are now calling for bids for the construction of a reinforced concrete bridge over the Arkansas River to connect the cities of Tulsa and West Tulsa. The structure will be erected adjacent to the old highway bridge.

The new bridge will have a total length of 1,470½ ft. end to end of abutments, and will consist of the following arch spans, commencing on the Tulsa side: One span of 74 ft. 3 in., four spans of 77 ft. 6 in., two spans of 80 ft., four spans of 77 ft. 6 in., two spans of 80 ft., four spans of 77 ft. 6 in. and one span of 74 ft. 3 in. The abutment approaches will be 36 ft. each.

The bridge will be of the open spandrel type and will have a 30-ft. roadway and two 4-ft. sidewalks. A street railway track will be built in the center of the roadway. The hand rails will be of concrete and there will be lamp posts at each pier and the abutments. The roadway will be paved with asphalt or creosoted blocks, the type to be determined after the bids are opened. The work will include about 9,800 cu. yds. of concrete and about 270 tons of reinforcing steel. Bids for the Arkansas River bridge will be received until 10 a. m., Aug. 26, by the county commissioners at Tulsa, Okla. Harrington, Howard & Ash, Kansas City, Mo., are the consulting engineers.

Pennsylvania State Highway Letting.

Bids on the first state highway letting under the new state high commissioner of Pennsylvania were opened at Harrisburg, Pa., on Aug. 10. Three contracts were under consideration. One of these called for the construction of 4,871 lin. ft. of road, varying from 22 ft. to 57 ft. in width through the Borough of Stroudsburg in Monroe County; another provided for 5,843 ft. of 16 ft. road through the Borough of Muncy in Lycoming County; and the third involved the construction of 4,940 lin. ft. 16 ft. road in Milton, Northumberland County. The improvement consists of brick block on concrete base. The number of bidders and the high and low bids on each of these roads were as follows:

	No. Bidders.	High Bid.	Low Bid.
Stroudsburg Road	15	$70,327	$45,624
Muncy Road	13	64,745	41,877
Milton Road	16	47,513	28,144

The low bidders were as follows: Stroudsburg road, Franklin Contracting Co., 52 Vanderbilt Bldg., New York, $45,624; Muncy road, Dwyer & Co., Philadelphia, $29,513; Milton road, Fogel & Co., Hollidaysburg, Pa., $28,144.

A $500,000 State Road Letting for Ohio.

Another half million dollar road letting is being advertised by the State Highway Department of Ohio. The work covers about 59 miles of roads and is divided into 30 contracts, five of which are for the Bureau of Maintenance and Repairs. The largest job calls for the construction of 5.65 miles of surface treated macadam on the Wauseon-Napoleon road in Henry County, the estimated cost of this improvement being $54,950. Another good sized contract provides for paving 5.88 miles of the Cincinnati-Chillicothe road in Clinton County with waterbound macadam; estimated cost, $48,531. Nearly all of the contracts include constructing bridges and culverts, grading roadway and paving. On Section L of the Cambridge-Caldwell road, Guernsey county, separate bids are asked for constructing an arch, over Wills Creek, estimated to cost $11,549.

Details of the contracts are given in Table I. Bids on them will be received until 2 p. m., Aug. 20, by Clinton Cowen, State Highway Commissioner, Columbus, Ohio.

TABLE I.—DETAILS OF OHIO STATE HIGHWAY CONTRACTS NOW ADVERTISED.

County.	Road Section.	Road.	Township.	Type.	Length, miles.	Width—Pavement, ft.	Width—Roadway, ft.	Estimated cost.
Adams	Sec. B	West Union-Sinking Springs	Meigs	W. B. macadam	3	14	26	$16,300
Athens	Sec. G	Athens-McArthur	Alexander	Brick	1.44	16	26	36,084
Clinton	Sec. D	Cincinnati-Chillicothe	Jefferson	W. B. macadam	5.88	14	24	48,531
Clinton	Sec. C	Cincinnati-Chillicothe	Marion	W. B. macadam	2.94	14	24	18,549
Fayette	Sec. J	Hillsboro-Washington C. H.	Union	Brick	.57	14	28	9,015
Fayette	Sec. H	Springfield-Washington	Union	Brick	.53	16	26	8,917
Fayette	Sec. I	Washington-London	Paint	Brick	1.09	16	26	18,679
Fulton	Sec. H	Toledo-Angola	Royalton	W. B. macadam	2.52	14	26	23,226
Fulton	Sec. J	Archbold-Fayette	German	Macadam[1]	1.00	14	26	7,492
Fulton	Sec. I	Toledo-Angola	Chesterfield	W. B. macadam	1.00	14	26	9,032
Guernsey	Sec. L[2]	Cambridge-Caldwell	Cambridge	Bit. macadam	2.18	16	26	30,219
Guernsey	Sec. L[3]	Cambridge-Caldwell	Cambridge	Bit. macadam	1.25	..	26	9,726
Guernsey	Sec. L[4]	Cambridge-Caldwell	Jackson	Bridge	....	..	..	1,802
Guernsey	Sec. L[5]	Cambridge-Caldwell	Cambridge	Bridge	....	..	..	11,549
Henry	Sec. D	Wauseon-Napoleon	Freedom	Macadam[1]	5.65	16	26	54,956
Highland	Sec. I	Hillsboro-Waverly	Liberty	W. B. macadam	2.35	14	26	18,400
Highland	Sec. L	Hillsboro-Washington	Penn	W. B. macadam	.83	14	26	4,935
Jackson	Sec. J	Jackson-Pomeroy	Lick	W. B. macadam	2.14	14	26	15,742
Lucas	Sec. H	Toledo-Napoleon	Providence	W. B. macadam	2.11	16	26	23,782
Mahoning	Sec. O	Akron-Canfield	Berlin	W. B. macadam	2.19	14	26	18,603
Portage	Sec. Q	Akron-Youngstown	Palmyra	Bit. macadam	1.04	14	26	13,542
Sandusky	Sec. I	Lima-Sandusky	Riley	Macadam[1]	3.21	16	26	40,502
Sandusky	Sec. H	Lima-Sandusky	Townsend	W. B. macadam	1.06	16	26	10,562
Seneca	Sec. L	Findlay-Tiffin	Hopewell	W. B. macadam	3.09	14	28	22,808
Vinton	Sec. J	Chillicothe-McArthur	Richland	Bit. macadam	1.13	14	26	11,620
Williams	Sec. K	Bryan-Pioneer	Pulaski	W. B. macadam[6]	3.18	16	26	30,581
Bureau of Maintenance and Repair:								
Lorain	Sec. M	Oberlin-Elyria	Camden	Bit. macadam	1.53	14	26	11,788
Lorain	Sec. N	Oberlin-Norwalk	Camden	Bit. macadam	.66	14	24	4,985
Seneca	Sec. K	Tiffin-Bellevue	Clinton	Macadam[7]	3.49	16	28	28,202
Delaware	Sec. G	Columbus-Sandusky	Liberty	W. B. macadam[8]	1.44	16	24	9,102
Marion	Sec. J	Waldo-Marion	Pleasant	W. B. macadam	1.08	16	26	10,449

[1] Surface treated. [2] Contract No. 1. [3] Contract No. 2. [4] Bridge superstructure. [5] Arch over Wells Creek. [6] Alternate bids will be received on bituminous macadam; estimated cost, $37,747. [7] Gravel macadam and reinforced concrete. [8] Reshaping roadway and resurfacing with waterbound macadam.

NEWS LETTERS

St. Louis, Items.

The J. W. McMurray Contracting Co. of Kansas City were low bidders for construction and repairing of dams and shore protection work on the Mississippi river between Cap Augris, Mo., and Grafton, Ill., at the Government letting in Rock Island, Ill., on July 31st. The McMurray company were also awarded a contract for constructing a reinforced concrete bridge at Independence, Mo.

Rush orders for steel bridges in Missouri, Illinois and throughout the Southwest have caused the East St. Louis Bridge Company, which ordinarily works 100 men on a day shift only, to increase the force 75 men and run night and day. The orders are for steel bridges to replace wooden structures washed out by the heavy rains of the last two months. Most of the orders are from Missouri.

A. V. Fetter & Co. of Quincy, Ill., submitted the lowest bid for the dam and shore protection work on the Mississippi river between Quincy, Ill., and Hannibal, Mo.

The J. H. Flick Const. Co. of Chicago expect to finish their contract of raising grade on the Chicago, Milwaukee & St. Paul R. R. between Elk Point and Sioux Falls, S. D., in a few days. They also will have 30 teams idle the latter part of this month that are stripping a gravel pit at Beloit, Wis. They also expect to finish loading gravel for the Milwaukee R. R. about Sept. 15th. We are very sorry to report that our friend Joe Flick has been laid up with rheumatism, but Koenig gave him a remedy when he was in the city recently that will forever cure him if he follows the prescription as directed. Flick also reports having 5 shovels and 12 yard outfits idle that he can place on work immediately.

Ralph Oliver was with us a day last week. Expected to be the first one to take advantage of Koenig's new shower bath, but he got here a few days too soon. Oliver reports the firm of Oliver & Hill of Knoxville, Tenn., being awarded $250,000 worth of road work in Humphreys County, Tenn. They were also awarded the contract for putting in $50,000 worth of concrete foundations for buildings in Kingsport, Tenn.

Mike Costello came to town the first time since his honeymoon trip. Everything lovely with Costello Bros. over on the Norfolk & Western R. R. near Danville, Va. Mike looks as though married life is agreeing.

Keating Bros. secured another county road and levee job near Taylorville, Ill.

Jas. Dunigan has moved his outfit from Franklin, Ill., on to a piece of Keating Bros.' work near Taylorville, Ill.

Roger Faubion of the J. F. McMurray Contracting Co. is resting up in Kansas City waiting for the river to fall sufficiently for them to resume work on the Government revetment job above Grafton, Ill., also on the Frisco R. R. near Cape Girardeau, Mo.

R. A. Denzer of the S. H. R. Robinson & Son Contracting Co. has gone to Chicago. Expects to return in a couple of weeks.

Mulvill Bros. sublet 18,000 yards of levee work near Wood River, Ill., to T. P. Newland last week. In addition to above they have 1800 yards of work of raising levee near East Alton, Ill., to sublet. Alton, Ill., will catch them.

J. T. McCarthy & Co. want to rent for at least three months for railroad work in Alabama fifty teams. Prefer them in outfits of from ten to twenty team with full equipment of wheelers, plows, tools, including camp equipment. They to feed and drive them. Owners to send representatives to look after stock. McCarty & Co. will pay the fare both ways. Contractors having outfits that they want to rent for this period write McCarty & Co. at Monroeville, Ala., or telegraph them at Flomaton, Ala.

J. H. McFarlin came in from Jacksonville, Ill., to get lined up on what new work is going on in the country.

The Old Trails Association of Missouri awarded Mulvill Bros. of Alton, Ill., the contract for building fourteen miles of the State Highway between St. Louis and Kansas City, beginning at the line of the Fulton Special road district and extending to the Boone County line. Mulvill Bros. will sublet this work in quantities to suit 3 to 10 team outfits.

The Hiram Lloyd Building and Construction Company was the lowest of 21 bidders on Aug. 13th for the contract of constructing a new Compton Hill Reservoir. Its bid was $280,187.70. The other bids ranged to $407,000. The Board of Public Service has estimated the cost at $410,000. The contract probably will be awarded by the Service Board Tuesday. The contractor will be required to complete the new reservoir by December 1, 1916. The water in two basins in the present reservoir will be turned off September 15, and the contractor must complete the center wall so that one basin can be put back into service by December 15, 1916. Two bids were rejected for non-compliance with the rules. The bid of Brookhurst & Potter was thrown out because its check submitted with the bid was $10,000, instead of the required $10,400. The bid of Kellerman Construction Company was rejected because it used decimal points too freely in its fractions, and could not be understood accurately. The McCormack-Coombs Construction Company was the second lowest bidder, with $287,556.05. This concern recently erected the new filtration plant at the Chain of Rocks. The Hannick Quarry and Construction Company was third, bidding $290,316.90. The Carmichael-Cryder Company, which built the Kingshighway viaduct, ranked fourth, with a bid of $292,812.97. The fifth lowest was the Heman Construction Company, with $294,771. The highest bidder was the American Contracting Company, with $407,890.

Another huge engineering task to protect the lands of Mississippi and New Madrid counties from overflow by the Mississippi River is projected. It is the levee bordering on the St. John's Drainage District and running from Dorena to above New Madrid, Mo. The St. John's levee and drainage district sold $400,000 worth of bonds and received $390,000 cash, of which $200,000 was transferred to the war department. This, with $80,000 allotted by the Mississippi River Commission, will be used by the United States Engineers to complete the levee. A specially constructed levee machine, costing $50,000, will be used to build the outside levee. Since it has been the rule for the United States River Commission to allot as much money as the levee district expends, it is believed the commission will put in an additional $120,000 to complete the levee.

The East St. Louis Sons Co. was the lowest bidder on a contract for a rush order of crushed stone to be used in the construction of the east approach of the municipal free bridge.

Mayor Kiel signed the ordinance authorizing the construction of the $200,000 Chouteau avenue viaduct. The ordinance will become effective September 13. It is planned to let the contracts on that date, and to complete the work by October, 1916. The viaduct is planned to eliminate the grade crossings of the Missouri Pacific and Frisco tracks at Chouteau avenue, between Vandeventer avenue and Tiffany street.

A. B. Koenig.

PERSONALS

Mr. J. T. Breckon has resigned as water works engineer for Vancouver, B. C., and will resume private practice as consulting and construction engineer with offices in Vancouver. Mr. Breckon has practiced civil, hydraulic and mining engineering for over twenty years in Utah, Idaho, Arizona and western Canada.

Mr. C. D. McArthur after more than a year's absence has again assumed the office of chief engineer of the Blaw Steel Construction Co., Pittsburgh, Pa. Mr. McArthur will be in personal charge of the Blaw engineering service department, and all form problems requiring special design will be under his direct supervision.

Mr. J. O. Jones has been appointed assistant professor of hydraulics at the University of Kansas. After graduating from that institution in 1911, Mr. Jones was for one year hydrographer for the Idaho Irrigation Co. at Richfield, Idaho. Subsequently he taught two years at the University of Kansas. The past year he has been doing research work in hydraulics under the McGraw Fellowship in Civil Engineering at Cornell University, and has received the degree of M. C. E.

Mr. George E. Finck has been appointed assistant engineer with the Baltimore Paving Commission, succeeding Mr. Ambrose M. White, who has accepted a position with the Pennsylvania State Highway Commission. Mr. Finck has been connected with the Paving Commission since November, 1911, as draftsman, inspector, junior engineer and assistant engineer. He is a graduate of the Baltimore Polytechnic Institute, class of 1910, and for a year and a half following graduation was draftsman with a Baltimore engineering company.

Mr. Morris Knowles, consulting engineer, and member of the American Society of Civil Engineers, has acquired the engineering business formerly conducted from offices in Pittsburgh, Pa., and Canton, Ohio, by Mr. L. E. Chapin, recently deceased. Mr. Knowles, who was previously associated with Mr. Chapin, will conduct the combined business from his office, 2541 Oliver Building, Pittsburgh, continuing to specialize in water works, water power, sewerage, sewage treatment and disposal sanitary investigation, town planning, flood prevention and valuation work.

Mr. Paul Hansen has been appointed chief engineer of the Bureau of Sanitary Engineering, Illinois State Board of Health, Urbana, Ill., having been granted one year's leave of absence by the Illinois State Water Survey of which he is engineer. This is a new department which will supplement but not overlap the work of the State Water Survey and the Rivers and Lakes Commission. The work of the department will relate to projects for water supply, sewerage, city cleaning, city waste disposal, construction camp sanitation and heating, ventilating and plumbing work. Mr. Hansen is widely experienced in such work. He served with the Massachusetts State Board of Health as engineering assistant in 1902 and 1903, and with John H. Gregory on improved water supply and sewerage for Columbus, Ohio, in 1904. During the year following he was engineer for the Pittsburgh Filter Co., and from 1906 to 1909 he was assistant engineer for the Ohio State Board of Health. For one year following Mr. Hansen was acting chief engineer for the Ohio State Board of Health and during 1910 and 1911 he was state sanitary engineer of Kentucky. Since 1911, Mr. Hansen has been engineer of the Illinois State Water Survey.

Mr. Philip J. Kealy, author of the article entitled "A Discussion of Depreciation," which appears elsewhere in this issue, is an engineer of exceptional training along the line of street railway valuation work. Though still a young man, he has held important and responsible positions and has gained a reputation as an expert in his field. Mr. Kealy was born in Bloomington, Ill., July 2, 1884. He graduated in civil engineering from the University of Illinois, and at once entered the employ of the Board of Supervising Engineers, Chicago Traction Co., as field engineer, in which capacity he made the survey for and staked out the majority of the crossings on the north and west sides of the city. In 1907 he entered the service of Bion J. Arnold and continued in that position until February, 1914. He assisted in the valuation of the Chicago Consolidated Traction Co. and subsequently was engaged on traction report work. Later he acted as assistant in charge of the valuation of the Seattle Electric Co. and also the International Traction Co. of Buffalo, N. Y.; the Chicago & Southern, Chicago Heights, the Toronto Railways, and the Metropolitan Street Railway, Kansas City, Mo. During the early part of 1912 he was engaged on the details of the reorganization of the International Traction Co. at Buffalo, his analysis of that company's capital expenditures for the previous eleven years being subsequently approved in total by the New York Public Service Commission of the Second District. In July, 1912, Mr. Kealy went to Kansas City as Mr. Bion J. Arnold's assistant in charge of valuation of the Metropolitan Street Railway. After the completion of that valuation he acted as engineering advisor to the receivers of the company in the franchise negotiations and was named in the final agreement as the company's representative on the board of control. He has held that position to date. In February, 1914, Mr. Kealy was appointed assistant to R. J. Dunham, chairman of the board of directors of the Kansas City Railway & Light Co., and has remained in that position. He was engineering advisor in franchise negotiations preliminary to the granting of a new traction franchise in Kansas City in July, 1914.

Philip J Kealy

CONTRACTORS.

The John L. Hayes Construction Co., 70 Main street, Yonkers, N. Y., has just been awarded a contract on a most interesting bit of work which is indeed one of the most difficult undertakings in road building which has come to our notice of late. This is the construction of four miles of roadway between Cornwall and West Point, N. Y. It will be a bituminous macadam road running along the side of Storm King Mountain, attaining a height in some places 800 feet above the Hudson River. The road, which is a state-aid highway, will be practically hewn out of rock and in one place, because of a railroad at the base of the cliff, rock and debris must not be allowed to fall and cannot, therefore, be removed by blasting, but must be quarried and used in fills. The contract price on the four-mile section is $395,176. The president of the John L. Hayes Co., Mr. Hayes, has been engaged in road building and canal work in the state of New York for the past ten years. He has also done considerable work for the city of Yonkers and the Westchester Street Railway Co.

CIVIL SERVICE NEWS

The state civil service commission of Ohio announces the following examinations to be held at Columbus:

Consulting chemist, geological survey, salary $50 per month, Aug. 20.

Assistant chemist, geological survey, $90 per month, Aug. 20.

Dredge engineer, $1,500 per annum, Aug. 25.

Cranesman, $90 per month, Aug. 25.

Assistant sanitary engineer, $1,600 to $1,800 per annum, Aug. 25.

Civil engineer, $900 to $1,200 per annum, Aug. 26.

The U. S. Commission announces an examination for the position of assistant supervisor of accounts, Interstate Commerce Commission, salary $3,600 to $4,800 per annum, Sept. 14.

NEW CATALOGUES

Sand Blast Equipment.—Paper pamphlets. Mott Sand Blast Manufacturing Co., 1157 East 138th street, New York City.

The Mott Sand Blast Manufacturing Co. announces that four pamphlets containing writeups of different sand blast machines are now ready for distribution and will be sent on request.

Builders' Specialties.—Paper, 6x9 ins.; 78 pp. Chicago Builders' Specialties Co., Old Colony Building, Chicago.

Illustrated catalogue of the machinery and general contractors' supplies handled by the above company. List includes reinforcing materials, concrete mixers, hoists, buckets, derricks, cranes, crushers, pumps, saw rigs, loaders, etc.

Steel Exhibit.—Paper, 7x10¼ ins.; 56 pp. United States Steel Corporation, New York City.

A description of the exhibits of the United States Steel Corporation and subsidiary companies in the palace of Mines and Metallurgy at the Panama-Pacific Exposition. Illustrated with views of the exhibit including an interesting panoramic view of the whole.

Piston Ring Sizes.—Paper, 4½x7 ins.; 134 pp. Burd High Compression Ring Co., Rockford, Ill.

A directory of piston ring sizes for automobiles, motorcycles, cycle cars, trucks, tractors and engines, intended for use by owners, repair men or dealers. Contains complete index of manufacturers and models and several useful conversion tables. Price 50c.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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For Fairness in Making Estimates of Cost of Work to Be Done by Contract.

Will there never be an end to the matching of wits between engineers and contractors? This query is suggested by the news that the City Engineer of a very important northern city recently admitted that his estimates of cost are purposely made low, on jobs to be done by contract, for the express purpose of setting a trap for the contractors' feet. We quote excerpts from this City Engineer's remarks:

> To tell the real truth about it, I always try to make my estimates low when contractors are to bid on the work. Why? Because it makes them bid lower and figure more closely than they would if they thought my estimates should be high. Lots of times I take the real estimate and knock off some, just to make sure it's low enough. . . . I just make it low enough to be safe and if they figure still lower they get the job. If they don't we readvertise for more bids. . . . The contractor knows whether he is going to lose money or not. If he doesn't, it isn't my fault. He knows the conditions underground because he makes soundings all over the site of the job. I don't do that. I figure on normal conditions, and then I make my estimate low enough to be safe. It protects the city. If the contractor loses he must foot the bill. That's not my lookout. I'm not a sewer builder. Those contractors know more than I do about their business. They ought to. I don't claim to know it as well as they do.

The policy of this City Engineer, which he discusses with such refreshing candor, is sharp practice, pure and simple. To essay the task of pointing out the dishonest character of this procedure were a labor of supererogation for which we have no liking. It is the unwisdom of the stand taken which calls for comment. Can this engineer, who admittedly makes a dishonest estimate of cost, and who has at his back the power of his great city, expect that the contractor acting single handed, with only his own slender resources upon which to lean, will long continue to render good for evil? Can the contractor be blamed for trying to cheat the city when the city, through its officers, admits that it is trying to cheat him?

The effort of a city to gouge an individual is an act of bullying which must be condemned by all with even elemental conceptions of the square deal and of fair play. The principle of the square deal dictates that cost estimates should be given out with the conviction that they are adequate to cover the cost of first-class work plus the legitimate profit to which the contractor is clearly entitled.

Can Sharp Curves on Roads Be Made Safe for Automobiles?

Since no records are kept to show the causes of automobile accidents, we are unable to say what percentage of them is attributable to sharp curvature. However, a reading of the daily paper reports of accidents makes it evident that a very large number occur at bends in the road. Skidding, for example, frequently happens when a fast moving car rounds a curve where mud, loose gravel or fresh oil exists. Then, too, collisions are frequent where approaching cars simultaneously round a sharp curve.

Danger of collision at curves is reduced by widening the road at such places, also by keeping trees and brush cut down along the inside of the curve. The placing of a large mirror at the outer side of a curve is a further precaution that is too infrequently taken.

Skidding would be less apt to occur were the road given a sharp pitch toward the inner side of the curve. It is rather remarkable that this simple expedient is so rarely seen. Engineers seem hardly yet to realize that in designing roads they are designing trackways for cars that frequently travel at express-train speed.

At the outer edge of the trackway, and between it and the ditch, it seems wise to build a heavy guard rail braced to resist the impact of a skidding car. During the repair of a road it is almost impossible to avoid periods when loose gravel or stone will not lie for a time on its surface. Skidding is then apt to occur in spite of all precautions, so a guard rail then becomes almost the sole safety device available so far as the road designer is concerned.

It seems desirable to place a sign at each end of a sharp bend, reading "Hug This Side." Thus, the travelers will become educated to clinging to the proper side of the road on curves. Other signs, such as "Danger —Sharp Curve," are no longer of much use, largely because so many of them are located where the curve is not particularly sharp. There are too many bad or useless signs along roads, which, like bad laws, serve mainly to bring people into disregard of good laws. The time has come for a general road sign cleanup. Signs advertising tires, horns, etc., should not be allowed on a road right of way. Imagine a railway company that would permit every Tom, Dick or Harry to call his printed warnings and instructions at the locomotive engineman!

Summing up our "safety first" rules for sharp curves, we have:

1. Wider trackway at curves.
2. Elevation of the outer edge of trackway.
3. Guard rail at the outer edge.
4. Removal of brush, etc., at inner side.
5. Signs reading, "Hug This Side."
6. Placing a large mirror at very sharp turns.

What Quality of Aggregate Gives the Best Wearing Concrete Road?

The interrelation of size, shape, surface texture, hardness, toughness and crushing strength of the aggregate determines the wearing quality of a concrete road. This is the lesson indicated by the series of wearing tests on concrete recently conducted at the University of Minnesota and summarized in another column. Incidentally it deserves to be noted that these tests are the first laboratory tests to have been devised which afford either much information or means for successfully obtaining information except by observation of results of road wear in the field.

Hardness and toughness have been generally assumed to be primary requisites in an aggregate for road concrete. They probably are so but only when the factor of size of aggregate is duly considered. A well balanced fine aggregate of hard and tough rock wears well. A coarse aggregate of the same rock does not wear well. The reason for inferiority in the second instance is that the softer mortar matrix wears faster than the embedded stone and the protruding stones spall down and kick out. If in addition the hard stones are seamv the breaking down is more rapid. If also the surfaces of the stones are rounded and smooth, reducing bond, they kick out of their sockets more easily. Considering then tough and hard aggregates these conclusions seem justified: (1) The aggregate to wear well must be fine and well graded; (2) broken stone is superior to gravel because its better bond with the mortar matrix reduces the chances of kicking out of the particles.

Turning now to the soft stone aggregates, that is aggregates of stone no harder than is the mortar matrix, the tests indicate that wear is even. The stone wear as fast as the mortar and the pavement remains smooth. The factor of size of aggregate or of uniform grading largely disappears. If the soft stone is less hard than the mortar matrix and particularly if this stone is friable or flaky it wears faster than the matrix which is exposed in knobs and fins which rapidly break down. The same physical condition of surface is produced as existed with the hard aggregate and softer matrix.

The more nearly that road concrete approaches to being a homogeneous material the better it wears. With aggregate much harder than the motar homogeneity is approached only by using a fine graded stone. If commercial sizes are used a sound stone no harder than the mortar is superior to a much harder and tougher stone. These conclusions follow from the tests which we describe but it is to be kept in mind that the tests are not great enough in number to have established definite conclusions on all points.

Oil Engine Pumping for Irrigation.

The oil engine is a noteworthy development of the last few years in irrigation pumping engineering. This development has been brought about by economic conditions. The gasoline engine is superior in dependability, cleanliness and ease of operation to engines using low grade distillates. Its only drawback in comparison is the cost of its fuel. Gasoline is now too expensive for irrigation pumping under all but exceptional conditions, and the prospect is that its cost can only increase as time advances. The heavier distillates on the contrary are more plentiful and cheaper now than ever before and they bid fair to be produced more plentifully in the future. Specifically, the difference in price between low grade distillates and gasoline makes it possible by using the former to raise irrigation water at a cost one-third to one-half less than the cost will be when gasoline is used and it appears likely that future prices of the two fuels will increase rather than decrease this saving.

In another section we publish an estimate, based on unusually careful studies, of the cost of irrigation pumping by gasoline engines, oil engines and electricity. These costs must be interpreted with the conditions closely in mind. The tests and other data on which they are based are for conditions in one state. The geographical location of this state in respect to climate and other natural conditions must be kept in mind and also its situation in respect to available oil producing centers. For the conditions as they are, the use of oil engines instead of gasoline engines shows a saving in cost per acre irrigated of from 25 to 30 per cent, according to height of lift. In comment on the figures the author of the article asserts that they fairly present the relative costs of pumping for irrigation in Arizona generally.

Considering only the comparison between

gasoline engine and oil engine pumping costs, the significance of recent developments of the oil engine is readily understood. Irrigation by pumping is at the best, generally speaking, an intensive farming or a high grade crop proposition. A reduction of 25 to 30 per cent in the cost per acre of pumping makes possible either the bringing of large additional areas of land under irrigation or profitable farming with less intense cultivation or the profitable growing of less valuable crops. Either result is an economic gain.

The development of the low grade distillate engine or more concisely the oil engine is a noteworthy advance in irrigation pumping economics. There are possible other mechanical improvements. The power and the pumping unit will be co-ordinated more perfectly in general practice and more important than this there will be more perfect co-ordination of pumping plant to height of lift. These and other mechanical refinements are certain. Finally, however, the competition in irrigation pumping is bound to be between the individually owned, isolated small power plant and the large central power plant, generally hydroelectric, which transmits its power to hundreds of isolated pumps. Indeed this competition already exists in many irrigated sections of California and other states where irrigation is practiced. In this fact lies one reason for reduction of fixed charges which the article being considered urges upon irrigators operating individual plants. Herein too lies the weakness of the plan of irrigation by pumping with individually owned isolated power plants.

Bond Issues and Hard Roads.

The people in many sections of the country desire to obtain first-class roads by a more rapid method than that of securing a small mileage each year by a process of "saving up." To accomplish this result they use the credit of the county or some other political unit and secure the necessary funds by issuing bonds. The desirability of this procedure may be argued, but it is a fact that this method of financing has been adopted by many progressive communities. The results obtained have frequently been so satisfactory that additional bond issues have been made.

It is desirable, however, that borrowed money be used so as to yield the greatest return from the investment. In the case of roads it would appear that this condition is obtained when the roads improved remain in first-class condition for the greatest length of time after improvements with a minimum expenditure for maintenance—it being a well-known fact that maintenance is necessary on all types of roads.

A highway is made up of four parts: the location or right-of-way, the earth grade, the drainage structures and the pavement or road surface. The relative degree of permanence of each element is in the order in which they are named. But while the pavement or road surface is the least permanent it is the reason for existence of the other parts. The object in making a road is to permit convenient and rapid travel and enable heavy loads to be hauled.

As a rule, the cost of providing permanent right-of-way, earth grade and drainage structures seldom exceeds one-third of the total cost of completed paved roads. Two-thirds of the cost then goes to make the pavement and in the selection of the most suitable pavement lies a large factor in pavement economy.

The question arises as to the economy of any pavement at all, since it is the least permanent part of the work accomplished with the bond money, and upon first thought it would appear economical to omit the pavement entirely. But the return in improved roads from the money invested is quite small since the surface traveled is but little better than before the money was spent. Interest is paid each year for an improvement that does not permit more rapid and convenient travel and enable heavier loads to be handled. Some counties have expended money in this way. The investment is safe but the benefits will be derived by the children and paid for by the fathers. The children will have the roads at less cost some future day.

In order that immediate benefits may be derived from the expenditure of bond issue money in a large majority of cases some type of paved roads has been constructed. Paving is taken to mean the use of some foreign material to improve the road surface.

Many types of paving have been used, the cost and life of some of which between wide limits are as follows:

Type.	Cost per mile. 15 ft. wide.	*Life in years.
Sand-clay	$1,000-$2,000	2 to 12
Gravel	1,000- 4,000	5 to 15
Bituminous macadam	4,000- 6,000	5 to 15
Bituminous concrete	6,000- 8,000	8 to 15
	8 ft. wide.	
Portland cement concrete	5,000- 7,000	8 to 20
Brick	8,000-10,000	15 to 30

*Probable age at which the yearly cost of maintenance will exceed the yearly cost of maintaining a new pavement by a sum sufficiently large to pay interest on the cost of a new pavement.

Sand-clay and top soil roads are not, strictly speaking, hard roads but they are vastly superior to the ordinary dirt road. After prolonged rains they generally become muddy and holes develop. They require constant attention. Gravel roads are superior to sand-clay and top soil roads, but the first cost is greater. They do not need as much attention as sand-clay or top soil roads and holes are not so apt to develop in wet weather. Macadam roads treated with a light bituminous binder that is renewed yearly have proved satisfactory for ordinary volumes of combined motor and horse traffic. A heavy binder appears to be more desirable where there is a preponderance of motor traffic. Bituminous concrete, Portland cement concrete and brick pavements are adapted to heavy traffic. Sand-clay and top soil roads are seldom built less than 15 ft. wide and unless the traffic is very light gravel, bituminous macadam and bituminous concrete roads are usually made at least that width. Brick and concrete roads are frequently built 8 ft. wide, an earth road being provided along one side. It should be noted that the cost of grading and drainage structures for sand-clay, top soil and gravel roads is frequently as much as the cost of the road surface. The figures given are averaged from the actual cost of work in a number of counties and include only the cost of the pavement.

There appears to be but a slight difference between the various types of road paving, providing care is taken to select for use on each road that type of pavement best adapted to withstanding the traffic upon that road. The higher first cost of some types is offset by the shorter life or more expensive maintenance of those types lower in first cost. There is, however, some difference in the degree of satisfaction derived from the smooth, hard surface more pronounced in those types highest in first cost.

WATER WORKS

The Functions of a Water System With Respect to Domestic Service and Fire Protection.

(Staff Abstract.)

Considering the water supply of a water works system as applied to fire protection versus domestic supply, it is seen that the requirements for fire protection are considerably greater in small towns than are those for domestic supply. On the other hand, for large towns or cities the domestic supply is generally the ruling consideration. Unlike the conditions for domestic service, the requirement for fire protection is by no means constant, but varies from time to time according to the extent of the fires, and is, therefore, a variable quantity and one hard to determine with any degree of accuracy.

Three separate and distinct systems of operation are now in use in this country. Ranking them according to their merit and reliability, they are: First, the high pressure gravity system. Second, the combination low pressure gravity and direct pumping pressure system. Third, the direct pumping pressure system.

It is rarely the case that the location of a town is such as to secure its water supply from a source near enough and at the same time sufficiently elevated for water to flow into a distributing reservoir and thence into the distribution system.

It is frequently the case, however, that hills or points of land are near by and elevated sufficiently above the general level of the town on which distributing reservoirs can be constructed and kept filled through mains by pumping units drafting from a nearby stream, lake or wells. Whenever this arrangement can be secured, the gravity system should be installed.

It should be remembered that the pumping units and mains used for filling these distributing reservoirs must be in duplicate, and the reservoir should have two or more separate compartments, so arranged that either one or all compartments can supply either or both of the mains to the distribution system.

The capacity and elevation of such a distributing reservoir should be ample to supply the combined maximum rate of flow for domestic consumption, together with the maximum fire flow, at fire pressure, for a period sufficient to extend over the time of a probable conflagration. The maximum fire flow is generally based on the population, size and extent of the town. The time a conflagration would probably last depends upon the construction, extent and congestion of the closely built up districts.

As I have just stated, it is not frequently the case that a high pressure gravity system can be secured with economy, and we therefore turn to the second or low pressure gravity and direct pumping pressure system for consideration.

It is frequently found that the location of the town, the elevation of the reservoir or its distance from the town is such that the gravity head or pressure developed would be too low for fire service from hydrant streams without the use of pump or steamer. Such a supply should be augmented by having pumps connected to the force mains or distribution system with valves, so arranged that the reservoir can be cut off and water pumped under high pressure direct into the distribution system, thus securing the combination low gravity and direct pressure system.

The third or direct pressure system of supply is not nearly so efficient or reliable as either of the two previously described systems. The efficiency of this system depends entirely on the ability of the pumps to respond to the constant demand for domestic supply and the instant and maximum demands for fire service.

For this system the water supply is generally from surface streams, lakes or wells. The raw water, in case of surface supply, is pumped to storage or coagulating basins, passed through various filtration processes and into a clear water storage basin; while from artesian wells it either flows under natural pressure or is pumped to the surface and into a storage basin or reservoir. These clear water storage reservoirs should have a capacity and be arranged similarly to that described for a high pressure gravity system, except that the supply mains from the reservoir in this case do not extend to the distribution system, but are suction mains direct to the pumps, and these, too, should be in duplicate. For fire protection purposes only an additional arrangement should be made whereby the filters can be by-passed and the total amount of raw water from the coagulation reservoir passed quickly to the clear water or suction reservoir. This will be necessary only in cases of emergency, and the valves controlling such a by-pass should be securely closed and sealed.

All pumping units, whether used in connection with filling high pressure distributing reservoirs of a gravity system, or with a combination gravity and direct pressure system or with a direct pressure system, together with their sources of power supply, should be in duplicate. For the two latter systems each of the pumps should have a capacity sufficient to deliver the maximum fire flow at fire pressure in excess of the maximum rate of flow for domestic consumption.

The sources of power, ranked according to their reliability, are water, steam, electricity and internal combustion engines. It is seldom that water power can be employed. Steam pumps should be supplied from duplicate boilers or sets of boilers, each having a capacity sufficient to operate the pumps at full rated capacity and pressure.

When installing pumps to be operated by electric power it should be borne in mind that duplicate and independent power lines should be provided, and preferably from separate sources of supply, but in any event to be from a thoroughly reliable source, which can be depended upon to provide power at any time of day or night. These precautions are necessary because of the almost constant occurrence of interruptions to electric supply lines and equipment from causes which cannot be anticipated or controlled.

Because of the unreliability of internal combustion engines for emergency demands the use of this source of power for municipal pumping stations has not been generally recommended or encouraged by the best water works engineers. Although the many new features introduced by the use of electric and internal combustion engine pumps have no doubt been well designed and worked out, they have not as yet created that confidence as to safety enjoyed by other sources of power of established reputation and field service. In other words, we feel that the defects and difficulties in steam and water power pumps have been found and overcome by experience and long practice; while the electric and internal combustion engine pumps for emergency fire service purposes are still somewhat of an unknown quantity, from a practical experience and service point of view.

Mains supplying fire hydrants should be at least 6 ins. in diameter, while for domestic service, smaller pipes are entirely adequate since large flows, and especially for emergency demands, do not prevail as is frequently the case for fire protection.

In small towns or cities where the fire flow exceeds the maximum domestic flow, and where the distribution system is not so extensive as to require excessively high initial pressures to overcome friction in the pipes, the distribution system should be designed in such a manner as to deliver the necessary quantities of water for fire flow in the various districts, at from 75 to 100 lbs. pressure at the hydrants. These pressures are based upon the assumption that hydrants will be spaced at such distances apart as to require not more than 350 ft. of hose to be used for a single stream and that 1⅛ in. nozzles will be used.

On the other hand, where in large towns and cities the domestic supply is the ruling consideration over the maximum fire flow, it is generally more economical and satisfactory to maintain a moderate pressure of from 50 to 75 lbs., and depend on pumpers or steamers to furnish the desired fire pressure and flow, drafting from the hydrants.

Section gate valves are a very important feature of any system, and a sufficient number should be installed and so located that not more than 800 ft. of pipe in the congested district nor more than 1,200 to 1,500 ft. in the outlying districts will have to be cut from service in the event of leakage, repairs or breaks in the mains.

COMMON DEFECTS IN SOUTHEASTERN WATER WORKS.

During the past four years I have had occasion to visit a number of the towns and cities represented in Carolina and Georgia for the purpose of investigating the water works and fire fighting facilities. I have also recently had occasion to examine and read reports of similar investigations made by other engineers of our Department, covering about 125 towns in Georgia, North Carolina and South Carolina, and I find that in a large majority, especially in small towns, no provision has been made for duplication of force or supply mains; that in only a few instances are the pumping units in duplicate and very few of adequate capacity to supply the maximum water flow, both for domestic service and fire protection; that generally, the storage reservoir's capacity is inadequate, and very few reservoirs are in duplicate or divided into separate compartments with arrangements for draining and cleaning and at the same time reserving a reasonable storage supply on hand in case of emergency; that where pumps are electrically operated few are provided with duplicate power supply lines.

I have also recently had occasion to examine a number of blue prints and layouts for proposed new water works systems, which were submitted to us for criticism and suggestions for the betterment of the system. It appears to be the tendency on the part of some of the engineers who have recently designed and installed a number of water works systems for small towns in this territory, to disregard some of the important features I have just mentioned.

In all fairness it may be said, however, that the practice is probably due to the lack of available funds on the part of the towns, but this is false economy. It has frequently happened that the loss from a single disastrous fire would have more than compensated for the difference in cost of the system which would have insured safe protection, and the one which failed when emergency service was demanded.

ACKNOWLEDGMENT.

This discussion is abstracted from a paper by E. B. Proctor, Inspector Southeastern Underwriters' Association, Atlanta, Ga., before the latest annual meeting of the Tri-State Water and Light Association.

Six Years of Softened and Purified Water at McKeesport, Pa.

(Staff Abstract.)

The ultimate satisfaction or dissatisfaction given by a water supply, or its suitability for domestic purposes, is not determined by laboratory tests nor by a few months use of the water and the opinions voiced by a few persons, but is gradually built up and cannot be determined until the supply has been in use for several years. The experience at McKeesport with the use of softened Youghiogheny River water for more than six years should go far in determining the desirability of a softened water for a domestic supply. The McKeesport plant performs two separate and distinct functions: one is to soften the water, the other to filter the water thus softened. The portion of the plant devoted to the softening of the water is at once the more complex and from a commercial standpoint, the more important.

The softening of water for domestic supply has not been widely practiced in this country. The advantages of softened water have not generally been considered commensurate with the expense involved. It can be stated as a general proposition, however, that the greater the cost of treating the water, the more need there is for softening and the greater will be the advantages derived from soft water.

In Southampton, England, a softening plant has been in operation since 1888. The hardness of this water is due almost entirely to carbonate of lime held in solution by carbonic acid and amounts to about 260 p. p. m. This is reduced by the softening process to about 60 p. p. m. and the water is said to be entirely satisfactory.

The first softening plant for municipal purposes in this country was built in Winnipeg, Manitoba. In September, 1897, Mr. Rudolph Hering, consulting engineer, made a report to the city of Winnipeg, recommending the softening of the very hard artesian well water then in use. In Mr. Hering's report the advantages of a soft water over a hard water were set forth as follows:

> Hot water is obtained more quickly and less fuel is required. The saving of soap and soda in the household is considerable. The labor of washing is much reduced. The wear and tear of clothing is diminished. Flannels last longer and do not become harsh and felted. Cooking is facilitated. The same quantity of tea that will make three cups with hard water, will make five cups with softened water. The palatability of the water is often increased. The softening process does not make water insipid.

The city council of Winnipeg accepted Mr. Hering's recommendations and the softening plant was accordingly built and put into operation in July, 1901. The water was very satisfactory, but on account of the extremely rapid growth of the city, the plant soon became inadequate to supply sufficient water and has not been in use for several years.

The softening of water for domestic supply is now practiced in the following American cities: Oberlin, Ohio; Freeport, Ill.; St. Louis, Mo.; New Orleans, La.; Columbus, Ohio; Grand Rapids, Mich.; Owensboro, Ky., and McKeesport, Pa.

Conditions at McKeesport are radically different from the other cities mentioned on account of the character of the raw water. For a number of years following the construction of the water works pumping station in 1881 the supply was as good or somewhat better than the average river water. The rapid increase in the coal mining industry in the Connellsville district with the attendant discharge into the river of the highly acid mine drainage has changed entirely the character of the water. At present the river water contains free sulphuric acid at all times, except a few days during the year when the river is high and the acid mine water largely diluted and neutralized with flood water. When it is taken into consideration that water containing 1 grain per gallon of free sulphuric acid is very corrosive in its action on metals, etc., and that during the past year the average acidity was more than 3 grains per gallon with a maximum of 17 grains, some idea of the condition of this water can be gained.

The change from an alkaline mountain stream to the present condition of the river was, of course, gradual and covering a period of many years. At first it was only during a very low stage of water in the summer or autumn that free acid was present. These periods of acidity became of more frequent occurrence until at the present it is only on rare occasions that the water is alkaline.

While the water in the river is usually clear it is occasionally extremely turbid. The water shed is mountainous and the run-off is unusually large, especially of late years, as the country has largely been denuded of its forests. This results in floods and low flow in dry weather, and is partly responsible for the violent changes in flow and in the quality of the water. In a year's time water of every degree of hardness and acidity is encountered, from a turbid alkaline water with a hardness of 40 p. p. m. to a perfectly clear dilute sulphuric acid solution with a hardness of 800 parts and an acidity of 390 parts.

Much has been said regarding the taste of softened water, and the impression prevails to some extent that the softening process imparts to the water a disagreeable taste. This is far from correct. It is true that when a water requires heavy treatment with lime and soda ash there may be sufficient sodium sulphate formed to produce a somewhat flat or alkaline taste to which some persons are more sensitive than others. This taste is not usually considered unpleasant and is rarely noted by regular users of the water. In fact, after becoming accustomed to drinking softened water, it is considered by many more palatable than other supplies. The fact that the softened municipal supply in McKeesport, which is at times probably the most heavily treated domestic water supply in the world, is used almost exclusively for drinking purposes in the city is very strong proof of the potability of a softened water. It is believed that in no city is the public water supply more generally used for drinking purposes and the per capita consumption of bottled table water so small.

So the experience in McKeesport indicates that softened water is not only satisfactory for drinking purposes, but that it is highly desirable and superior in a number of respects to a great many other supplies. It is entirely free from the earthy and fishy taste noticed in many surface supplies, and there seems to be no disadvantages or objections to the water for drinking purposes.

The experience in McKeesport has been along the same lines as in other cities where a sudden change has been made from an unpurified river water to a safe purified supply. An inspection of the typhoid statistics shows the death rate to have been excessive in the years previous to the introduction of purified water in October, 1908. In Table I the typhoid statistics for McKeesport are given for the years 1906-1914.

TABLE I.—TYPHOID STATISTICS FOR McKEESPORT, PA.

Year	Total Number of Cases.	Total Number of Deaths.	Death Rate. Deaths per 100,000 Population.
1906	512	46	115
1907	330	29	73
1908	230	26	68
1909	128	7	18
1910	165	9	21
1911	51	6	14
1912	41	3	7
1913	29	2	5
1914	22	5	12

It is noted that while the death rate in 1914 is higher than in the two immediately preceding years, the number of cases is lower. Of the 22 cases occurring during 1914, 15 of the patients were shown to have been habitually drinking water of questionable character and had not been using the city water supply.

In view of the above facts the cost of treatment which appears at first to be a tremendous item can well afford to be overlooked. Money and health cannot be measured by the same standards. Of other advantages the saving effected in the use of washing compounds, soap, and the wear and tear of clothing, are items that can scarcely be even approximated, but they are no doubt very great—greater even than would seem possible.

In regard to the financial aspect of water borne diseases in their relation to the water supply, Mr. George C. Whipple has worked out a very conservative formula to determine the "increase in sanitary value" of a purified water over a previously unpurified supply. Taking into consideration the six years immediately preceding and the six years following the introduction of purified water in McKeesport and applying Mr. Whipple's formula, it is found that the "increase in sanitary value" amounts to $370,000 per year, or $8.22 per capita. This means that there is added annually to the wealth of the community by this one item, the healthfulness of the supply, the sum of $370,000.

If there is a disposition to question this calculation, it must be taken into consideration that this matter has been very carefully worked out by leading sanitary authorities from all the available data and the figure given is, if anything, probably lower than the actual amount.

ACKNOWLEDGMENT.

Condensed from 1914 annual report of Edward C. Trax, Chemical Engineer, McKeesport water department, to D. M. White, Superintendent of Water Works.

The Success or Failure of Wells.

(Staff Abstract.)

A great deal of light can ordinarily be obtained in advance on the question whether a well at a given location will be successful or not. Still more certain answers to this question could be obtained if more effort were made by well drillers, engineers and geologists to obtain accurate logs of the strata and materials passed through in drilling wells. The sand pumpings from an ordinary churn drill taken alone form a very unsatisfactory basis of determination of the character of the material passed through. In the first place, material from different beds is very often mixed; second, it all comes to the surface finely pulverized and, especially in the case of sandstone or shale, it is sometimes impossible to tell from the drillings whether the natural material was in the form of earth or was cemented and consolidated into rock. The drillings from sandstone are frequently identical with those from sand, and those from shale are the same as those from clay containing shale fragments or gravel. Additional information can be obtained: First, from the rate of drilling; second, a well driller can form judgment of the character of the material from the "feel" of the drill as the work is going on.

It is not always true that when the drill passes through material of a certain thickness, a bed of that thickness actually exists. Of course, if the bed happens to be inclined, its actual thickness may be very much less than the thickness drilled through. Whether or not the strata or beds penetrated by the drill are probably horizontal or inclined, and if so, about how much, can generally be determined from observations on the surface or in nearby railroad cuts or other deep excavations. This valuable source of information, always sought after by geologists, seems to be generally overlooked by well drillers.

Other conditions affecting the probable success attainable by drillings are the presence or absence of faults in the locality, the presence of nonconformity in the strata, and in the case of materials other than firm rocks, the presence of local beds or pockets of impermeable material mixed in with materials capable of storing a water supply. Lenses of clay and pockets of nearly impervious conglomerate are both common in water-bearing beds of sand and gravel.

There is one set of conditions where wells will always fail, and that is obviously where there is no ground-water supply. This may result from five principal causes:

1. The available rainfall is deficient or is entirely lost by surface run-off and evaporation, leaving nothing for percolation beyond the reach of plant roots.
2. Lack of absorption capacity of the soil or surface. This may be due to the existence of impervious rocks or clay at the surface.
3. Lack of adequate transmission capacity. Owing to sparseness of fisures in rock or fineness of soil materials, it may be impossible for the soil to transmit enough water to deep-seated water beds to furnish a permanent adequate supply for wells.
4. Lack of storage capacity. The infiltration or supply to the water beds being intermittent, the yield of the wells will also fail unless the water beds have enough storage capacity to provide water supply during periods of insufficient infiltration.
5. Inability of the water-bearing material to yield its supply to the well. This is a common cause of difficulty in securing adequate water supply from very fine sands and clays. These materials commonly contain from 25 to 40 per cent of voids which are filled with water, but only a little of which will flow into a well because a large portion of the water is permanently held in the fine pores by capillary attraction and the artesian flow or transmission of water through such materials is exceedingly slight. It is evidence that none of these causes exists to prevent obtaining a satisfactory well in a given locality when it is known that there are several successful wells all obtaining satisfactory water supplies under the same conditions as those which apparently exist where the new well is to be drilled. If, now, most of the wells in a certain locality are successful, and it is known that there is a water horizon generally existing in the place where a new well is desired, the presumption is very strong that a successful well will be obtained at about the same depth as in the other wells in the vicinity.

Failures not infrequently occur under just these conditions. It is also the existence of such failures and the existence of marked success where failure is the general rule which have created in a marked degree the popular feeling that there is great mystery, if not something supernatural, about the occurrence of underground water.

It seems certain that failures to secure water supply in wells drilled under the conditions described, i. e., where there are other successful wells in the vicinity and where there is known to be a generally diffused ground-water horizon, are due to only a few causes and can readily be explained in most cases from evidence either existing on the surface, in railroad cuts or other excavations, or obtainable directly from the records of wells drilled.

In analyzing the causes of such failures, it is convenient to consider three cases:

1. Where ground-water is generally diffused through the pores of the water-bearing medium, usually sand or sandstone.
2. Where the ground-water is contained in fissures in more or less fractured rock, such as granite, trap rock, or shale.
3. Where the only underground water available generally is that contained in solution channels or other definite open passages such as often occur along fault lines.

Discussing these cases in their inverse order, it may be said that where water is only contained in solution channels or definite passages along fault lines, the chances of success in any given bore made at random are very small. The presence of solution channels in limestone may, however, sometimes be detected at the surface by the presence of sink holes, and their presence would naturally be expected from the existence of caves, and from brooks or springs issuing from limestone strata and in general where limestone is prevalent throughout the region. The existence of fault lines is often apparent at the surface, where they may be traced by any one, and where not so apparent, they can often be traced by geologists. We are here presuming that wells have been generally successful in the locality. This could be true where the source of water supply is in solution channels or along fault lines only when the existing wells are located along such lines. The natural location for new wells would be in line with existing wells. They will fail where, as is often the case, the direction of the fault line or solution channel suddenly changes or comes to an abrupt end.

In the first two cases mentioned, where wells are generally successful, it may be said that there are five and only five principal reasons why a new well in the same locality put down to the depth at which ground-water is supposed to exist should be a failure.

1. The existence of a pocket or included mass of non-water-bearing materials.
2. Local pinching out of the water beds or water-bearing strata by thickening or interfoliation by overlying and underlying non-water-bearing beds.
3. Termination of the water beds by nonconformity.
4. Termination of the water-bearing beds by faults or trap dykes.
5. The failure of the well to strike a fissure in cases where the water is contained in rock fissures.

The conditions which bring about the failure of a new well in a locality where other wells are successful in cases where such failure is due to pinching out of the water beds, or the existence of dykes, faults or nonconformity, are well understood and need not be further discussed here except to remark that the well which is a failure will in such cases usually be located on the side of the obstruction which cuts off the water supply, which is opposite to the side on which the successful wells are obtained.

ACKNOWLEDGMENT.

This discussion is from a paper by Robert E. Horton, Consulting Hydraulic Engineer, Albany, N. Y., before the Connecticut Society of Civil Engineers.

Galesburg Freeholders Guarantee Payment of Water Bills.

(Staff Article.)

The city of Galesburg, Ill., recently enacted a water ordinance which took effect on July 1 of this year. The provisions of this ordinance insure the payment of all water bills. A person desiring to use water from the mains of the city water works must sign an application of the following form:

City of Galesburg, Ill.
Water Department.
APPLICATION FOR SERVICE.

Water Department:

Permission is requested to connect a service with the city water mains in.................. street, at No. .... Size of tap......in. Size of service pipe......in. Kind of service pipe............ Owner............ Occupant .... Water to be used for............ It is expressly understood and agreed that the undersigned are bound by all the ordinances, rules and regulations of the city governing the use of water, now in force or which may hereafter be adopted by the city council.

....
Applicant.

....
Plumber.

GUARANTEE: I hereby guarantee the payment of all assessments for water service levied in connection with this application.

....
Guarantor.

If the applicant is not the owner of real estate in the city he must furnish a guarantor, to be approved by the city clerk, guaranteeing the payment of all assessments for water service levied in connection with the application. All unpaid water bills after becoming due become a continuing lien upon the property of the applicant or the guarantor, as the case may be, until paid.

Analysis of Elements of Cost of a Complete Plant Unit.

(Staff Abstract.)

In the valuation of public utility property we are confronted in general by two classes of cost, direct or structural cost and indirect or overhead cost. These two fundamental divisions are recognized by all engineers, and the classification of most of the items entering therein would probably be agreed upon. However, there is considerable difference of opinion and, it would appear, some confusion in this connection. For this reason it seems worth while to make an analysis of the various factors entering into the cost of a completed unit, whether such items are commonly considered as direct or as indirect expenses. The various expenditures which may be incurred in the purchase and installation of a given item of equipment, whether it be an engine, pole, transformer or a length of pipe in a distribution system, may be included under the following heads:

1. Selection.
2. Purchase.
3. Transportation.
4. Storage.
5. Installation.
6. Testing.
7. Restoration of premises.

It should be said in the beginning that not all of the items of cost enumerated herein would be incurred in every case, or even in the majority of cases, but that they all may enter, and a proper unit cost and a proper overhead must consider whether or not such expenditures would be incurred in the case under consideration.

Selection—In the selection of a given unit it is necessary to make a study of existing types available for the given purpose. This may involve visits to other properties where such equipment is in operation, conferences with manufacturers and engineers. Frequently a special design may be necessary. In any case, it is necessary to prepare specifications and drawings.

Purchase—After the type has been decided upon and has been designed and all necessary drawings and specifications have been prepared, negotiations for purchase are entered into. This may be done by those who had to do with the selection, or as is the case very frequently, may be performed by an entirely separate department. Frequently competitive bids are secured from a number of manufacturers and these must be submitted to the engineer and gone over and carefully compared before final decision is made. In connection with purchase, factory inspection and often a factory test is necessary to determine whether specifications have been adhered to.

Transportation—In general, the purchase price of such equipment as here considered would include boxing and loading. Where not so included this would be a portion of transportation cost. Besides bare freight from factory to destination such traffic department expenses as routing, tracing shipments, checking up of bills, filing and adjusting claims, etc., are involved. Many articles are transported with limited liability for damage so that the element of insurance during transit may enter.

Unloading and Cartage—The unloading and cartage need not be discussed in detail. For special equipment, however, it may be necessary to build temporary scaffolds or to erect derricks. Such charges are, of course, part of the unloading charge. If the cartage is done by the purchaser with his own equipment, maintenance and depreciation of such equipment, stable or garage expense, etc., should be added to the direct cost of labor and teams, consideration being given to lost time of teams and men.

Storage—While in many cases equipment may be taken directly from cars to the site of installation and immediately erected, it must generally be stored for at least a short period. Large machinery may not go to the regular store room, but a place must be made for it either in existing buildings or a temporary shed provided. Generally such equipment would be under the general charge of the storekeeper. To him would fall the duty of checking up the shipment and he would be responsible for its safe keeping while in storage. Aside from payroll,—rent, storeroom supplies, insurance, shortage and breakage enter into store room cost. These, of course, affect different items in varying degrees but must receive consideration.

Installation—The first step in installation is the preparation of the necessary installation plans and specifications. In many cases official permits from public authorities must be secured. Next comes the preparation of the site. Frequently obstructions must be removed or alterations made to equipment and structures already occupying the ground. Then we have the actual preparation of the ground for receiving the equipment. This includes excavation, the placing of foundation or the digging of holes or trenches. After the ground is prepared, such work preliminary to erection as the placing of derricks, scaffolds, runways and staging occurs.

At this point another important matter may arise for consideration; that is, provision for the continuance of service during the installation of the new unit. Very frequently extensive alterations in existing equipment are necessary preliminary to such installation.

Now comes cartage from storeroom to site, which is followed by the actual erection of the unit. This includes not only the unit itself in its final assembled condition but also the placing and attaching of all accessories and auxiliaries. The next step is the mechanical connection of the new unit with other existing units, such as the connecting of an engine or dynamo into the steam or electric system or the tying in of distribution units.

Testing.—Under this we may include the final inspection of the completed unit and such tests as may be required under the specifications, and final adjustments preliminary to throwing the unit into regular service.

Restoration of Premises.—Finally, it is necessary to remove temporary work, to clean up the premises, remove rubbish, excess earth, etc. Where it has been necessary to open walls of the building for bringing in machinery, such walls must be restored. If emergency machinery or other temporary work was installed this must be removed and all premises restored to the final operating conditions.

The above outline points out the more important operations connected with the putting into use of an item of equipment. These operations include labor and material, or preferably labor, material and tools. Material would include all incidental material used in the installation of the unit under consideration, either for the temporary work or as a part of the finished installation. Such material would in general pass through the storeroom and would be subjected to the storeroom charges discussed above.

Under tools would be included not only hand tools but construction equipment including derricks, tackle, etc. The fixed charges on these tools (including interest, depreciation, taxes and insurance), necessary repairs, allowance for loss and breakage become a part of the cost of the unit under consideration.

Labor, while at first sight simple, is very complex. We have first the direct labor, which is the manual labor actually used on the job. This, however, must be adjusted to cover time lost due to the conditions under which the work must be done (considering such elements as continuity of service, safety to employes and the public, etc.), climatic conditions, time consumed in going to and from the job, etc. Aside from this direct labor we have insurance, sick benefits, pensions and premiums which may have to receive consideration. Supervision of the labor would include the time of foreman and superintendent, the expense of superintendent's department, such as stable and garage expenses and other transportation of superintendent and his assistants, timekeeper's and paymaster's time and expense. Frequently, there is in addition to this the cost of transportation and maintenance of payroll. In work on the distribution system, some transportation expense, usually in the form of street car, garage or stable expense actually occurs.

No mention has been made of interest and taxes during construction or the general expenditures for organization and legal services on the property in general. These are somewhat further removed from unit cost and need not be discussed here.

By glancing over the outline above, the greater number of the above items may be roughly classified. Under "Selection" the charges are mostly of an engineering nature. Purchasing department expense might be grouped as an engineering charge or it might be considered a general organization charge. "Transportation" is practically uniformly considered in unit price. Traffic department expense, however, would ordinarily go to the purchasing department. This is an item which may frequently be omitted. Storage expense should in general be included in unit cost, although this includes fire insurance and all insurance is frequently considered in general overhead. Under "Installation," the securing of permits, the drawing of plans and specifications are for the most part engineering charges. In general, superintendence is considered an overhead, although it is doubtful whether engineers clearly include the greater portion of indirect labor charges in the general item "engineering and superintendence." Tool expense should, it would appear, be considered in unit cost. "Testing" is largely an engineering charge. Some of the items under this caption are probably frequently omitted. It is believed that the "Restoration of Premises" is, in general, overlooked in the valuation work, and while not a large item, should not be omitted.

It has been the writer's effort to point out the various elements and items which may enter into unit cost, with the view of raising some questions which will lead to a somewhat better separation between structural cost and overhead by rendering more definite what is to be meant by the term "unit cost."

ACKNOWLEDGMENT.

The foregoing paper was read before the Indiana Engineering Society by Mr. W. J. Huddle of the firm of Sloan, Huddle, Feustel & Freeman, Consulting Engineers, Madison, Wis. and Indianapolis, Ind.

BUILDINGS

Design and Construction of a 400-Foot Steel Stack at the United Verde Copper Co.'s Plant, Clarkdale, Ariz.

(Staff Abstract.)

The steel stack at the plant of the United Verde Copper Co., Clarkdale, Ariz., is the largest self-supporting steel stack in the world, its total height being 400 ft. and its inside diameter 30 ft. The following data refer to the design and construction of this stack:

DESIGN.

In designing, the wind load was taken at 50 lbs. per square foot, or 25 lbs. per square foot of projected diameter, and the weight of the lining was taken at 3,750 lbs. per vertical foot of stack. The following unit stresses were used: Steel in tension, 16,000 lbs. per square inch; steel in compression, 10,000 lbs. per square inch, gross section; shop rivets in shear, 10,000 lbs. per square inch and in bearing, 20,000 lbs. per square inch; field rivets in shear, 8,000 lbs. per square inch and in bearing, 16,000 lbs. per square inch.

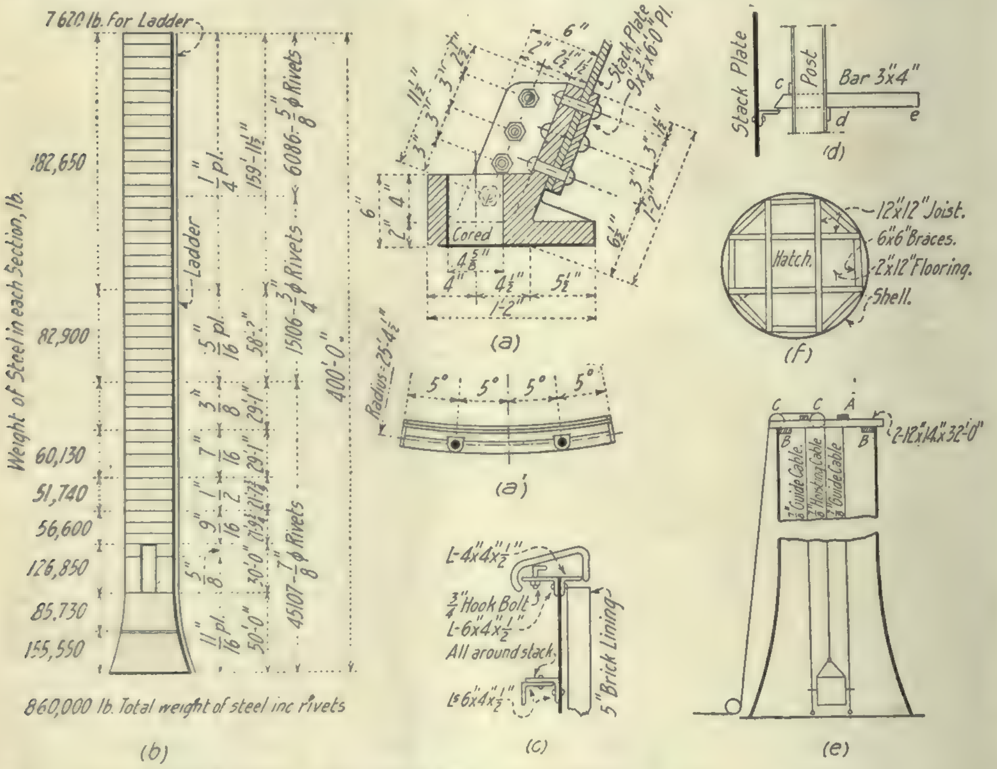


Fig. 1. Details and Erection Devices for 400-ft. Steel Stack at Plant of United Verde Copper Co., Clarkdale, Ariz.

Steel Stack.—The stack is cylindrical in shape, with the exception of the lower 50 ft., this portion being belled out to form a rigid base (see Fig. 1). There are three flue openings in the stack at the same level, necessitating radical strengthening features in the base and a three-way partition to prevent back pressure in the different flues. The bell is composed of two sections of 11/16-in. plates riveted vertically and butt jointed both vertically and horizontally, each plate being 25 ft. long by 53 ins. wide. This gives 36 plates in each section. The butt plates are 7 ins. x ⅝-in., with a single row of ⅞-in. rivets in each plate. The bottom edge of the lower section of plates is riveted to a cast iron base flange and to a splice plate, the latter being symmetrical about the joints of the cast iron segments (see Fig. 1a). The splice plates are 9 ins. x ¾ in. x 6 ft. long, and the length of the flanges is twice that of the plates. The flange sections are bolted together, end to end, with four 1-in. machine bolts, as shown in Fig. 1 (a). In addition, each flange section is bolted to the concrete foundation with two anchor bolts, placed 5° from the end of each section. This spacing gives 36 anchor bolts in the base. Each bolt is 4 ins. in diameter, and is upset to give 18 ins. of 4¼-in. diameter threads, with a standard square nut on the lower end. The stack plate is riveted to the flange and to the splice plate with two rows of ⅞-in. staggered rivets on a 2-in. spacing.

The reinforcement around each opening consists of a combination of plates, angles and channels to give, in effect, a plate girder across the top and bottom and a column down each side. In this manner the stress in the plates above the opening is transferred through the columns and back through the plate girder to the plates below the opening.

From the top of the openings to the top of the stack the construction consists of cylindrical sections, butt jointed, the sizes of the plates and rivets and their weights being as given in Fig. 1 (b). At every other joint, on the inside, there is a 4x3-in. angle riveted to the shell to support the lining. The ornamental top consists of a series of cast iron segments set on two angles, riveted to the top as shown in Fig 1 (c). These segments are held in place by ¾-in. hook bolts.

Lining.—The lining of the stack is made of brick, set in a cement clay mortar, the mortar being mixed in the proportions of 1 sack of Portland cement to 4 barrows of brick clay similar to that from which the bricks were made. Each barrow was carefully filled and scraped off to insure as uniform a mixture as possible. The mortar was tested when it was later found necessary to remove some of the brickwork to provide a working space for the pneumatic riveters used in attaching the baffle walls to the shell. It was impossible to break the brickwork from the mortar, the cleavage plane running irregularly through the bricks and the mortar.

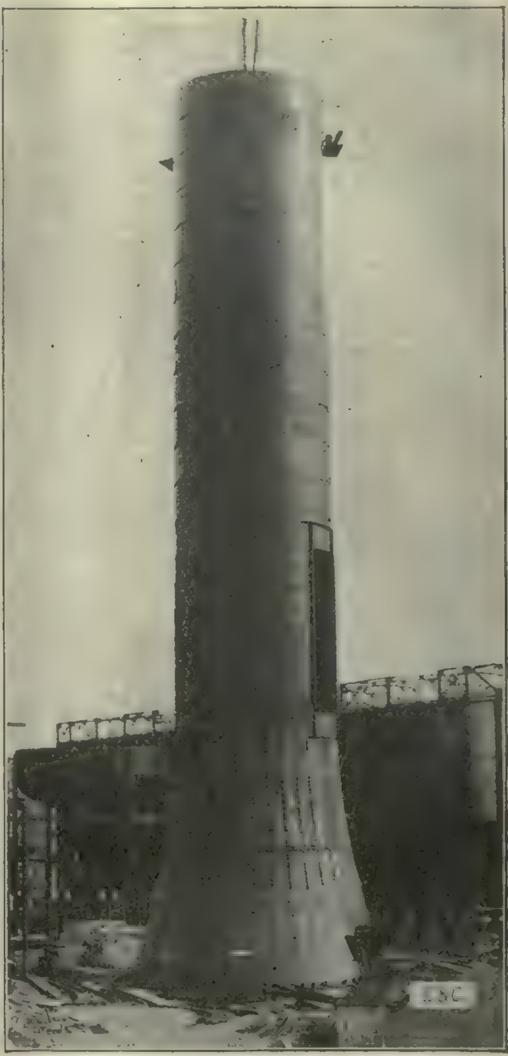


Fig. 2. View of Lower Portion of 400-ft. Steel Stack Showing Erection Cages and Derrick—Note Details of Lower Sections of Stack.

The lining in the bell consists of 9 ins. of brickwork, with 1 in. of mortar between the brickwork and the steel plates. The 1-in. layer of mortar was used merely to keep the bricks clear of the rivet heads, thus avoiding irregularities in the lining. The original design called for a 5-in. lining in the base, but it was found that the increased diameter—50 ft.—made it necessary to use at least two layers of bricks, bonded together, to insure the lining remaining in place. This double thickness was carried up only to the plane of constant diameter. Above this plane only 4 ins. of brickwork were used, the lining being supported at 15-ft. intervals by a 4x3-in. angle riveted to the steel shell.

Foundation.—The foundation is concrete, octagonal in shape, with a short diameter of 58 ft. and a thickness of 15 ft. The concrete is a 1:2½:5 mix, large stones being embedded in the mass in addition to a grillwork of heavy rails set at right angles to each other in about the center of the mass. Three large truck loads of scrap iron were also incorporated in the concrete. The sand and gravel were thoroughly washed and graded. The thirty-six 4-in. anchor bolts were spaced 10° apart on a 25-ft. 4½-in. radius. The bolts were embedded in the concrete to a depth of 6 ft. and they projected about 18 ins. above the foundation.

CONSTRUCTION.

Foundation.—The concrete for the foundation was mixed in a ½-cu. yd. "Milwaukee" mixer. This mixer was set up on one side, and by means of a movable spout it was possible to concrete the entire foundation at one setting. The concrete was placed in thin layers, each layer being thoroughly tamped and spaded before more concrete was added. It was necessary to use great care in setting the 36 heavy anchor bolts.

Steel Shell.—To start the erection of the steelwork it was first necessary to build falsework, hexagonal in shape, conforming to the lines of the concrete foundation. The posts were 4x6-in. timbers, with 2x12-in. cross braces and ledgers. On top of this falsework, which was about 40-ft. high, there was placed the working platform, which supported the platform used in handling the sheets. This platform was used throughout the erection of the shell. It was supported on six posts, each composed of two 6-in. channels 10 ft. long, these channels being placed with their backs toward each other and separated by 3-in. fillers. Fastened to the tops of these posts were 6-in. curved channels, which formed the circumference of the floor-supporting frame. This frame consisted of fifteen sets of two 4-in. channels, placed back to back, these channels radiating from a plate located at the center of the system. The bottoms of the posts were connected by 5-in. channels, which were also attached to a center plate by 2x½-in. flat bars. The top and bottom center plates were joined by a 6-in. pipe, which was attached by means of pipe flanges bolted to the plates, and through which ran the cable used to operate the derrick. The cross bracing was formed of 1-in. round bars. Near the top and bottom of each post there were riveted two 2x½-in. bars, as shown in Fig. 1 (d), these bars being set 4 ins. apart vertically. This spacing of bars was just sufficient to permit bar *C* to be inserted. These trip bars were so placed that the center of gravity came on the inside of the post, thus preventing the bars from falling; they held the platform in a manner which will be explained later.

Two cages were used in erecting the stack, these cages being handled by the derrick. They were equipped with two large hooks, placed at the top, by which they could be hung to the stack plates while the latter were being riveted. Figure 2 is the view of the partially completed stack showing the cages and a part of the derrick.

When the bell was completed the rigging was moved upward with the addition of each new section. These sections were about 7 ft. 6 ins. in height, and, as has been noted, on every other joint there was riveted a 4x3-in. angle to support the lining. As soon as one section had been added to the bell, one of the angles was riveted to the bottom of the plate. Six three-ton chain blocks were then hooked to the platform and to the top edge of the shell, and the platform was thus drawn up until the trip bars near the upper ends of the posts were resting on the upper side of the angle. This held the platform so that the chain blocks could be removed; but after the riveting was completed the blocks were again hooked to the top of the plates and the platform drawn up until the trip bars near the bottom of the posts rested on the supporting angle. A new section was then added, and the above procedure repeated until the top was reached. The working cages were also used to raise and lower the workmen.

Lining.—The lower 5 ft. of brickwork were laid from the concrete foundation. Above this level a hoisting rig and platform were used. The frame was built of two 12x14-in. x 32-ft. Oregon pine timbers, placed across the top of the stack and anchored there by blocks, *B* (see Fig. 1e), the latter being firmly bolted to the main timbers, *A*. Two 18-in. diameter steel sheaves, *C*, were placed between and on top of the timbers and served as a guide for the hoisting cable. This cage was boarded up on three sides and covered, to prevent accidents from falling debris. The platform consisted of four main timbers, each 12x12-in. (see Fig. 1f), placed as shown and dapped to give a plane surface. These timbers were connected at the ends by 4x6-in. struts, to give additional support to the 2-in. floor planking. As the supporting angles were 15 ft. apart it was necessary to use solid 1-in. iron rods, 8 ft. long, turned at each end to form a hook, to reach from the ends of the chains to holes in the angles.

The operation of this platform, although seemingly awkward, was in fact exceedingly simple and efficient. Starting at the bottom of one of the 15-ft. sections of brickwork, with the platform hanging from the rods and blocks, about 4 ft. of brickwork were laid, bringing the wall up as high as could be worked conveniently. Then the bricklayers and helpers each took hold of a block and pulled the platform up to within 6 ins. of the top of the wall, which, on the average, required about one minute. This operation was continued until the platform was within 10 ft. of the supporting angle, when one by one the blocks were loosened, the rods removed, and the blocks replaced, directly connected both to the angle and platform. One man was able to make this change without interfering in any way with the bricklayers or tenders. When the blocks had been pulled up together the reverse operation was carried out and the rods replaced. On the last raise special hooks were used to fit over the cast iron ornament at the top.

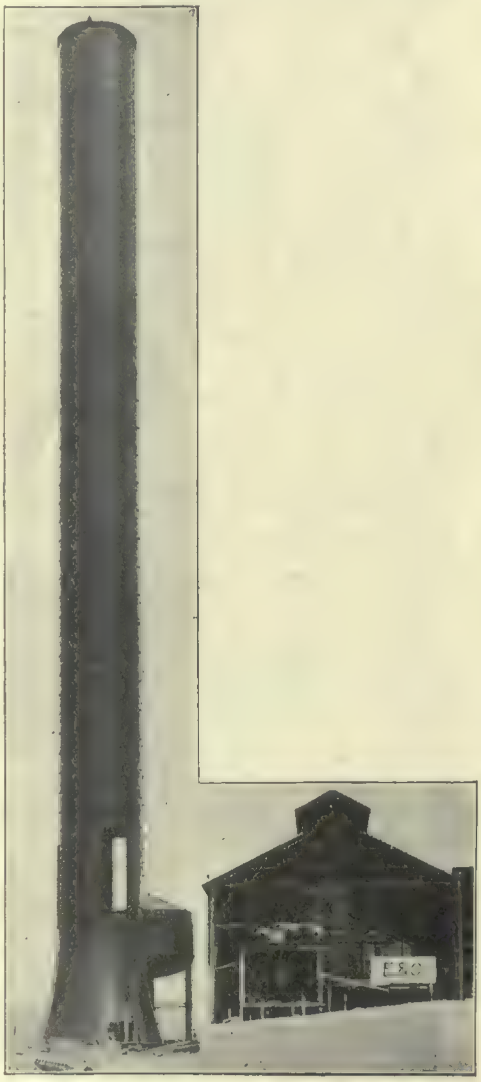


Fig. 3. View of Completed 400-ft. Steel Stack—Note 38-ft. Diameter Water Tank in Background.

Removal of Platform and Rigging.—When the lining had been completed it was necessary to remove the rigging. As the angles had been covered the method used in raising could not be used in coming down, and it was necessary to devise a new scheme. By calculation, it was found that the weight of the staging, exclusive of all loose material, was about six tons. Theoretically, the timbers at the top could support only four tons, concentrated at the center, so it was necessary to strip the platform of all except the main timbers. This reduced the weight to about two tons, and the platform was then lowered as far as the flue openings, where it was anchored by hooks and chain blocks to the edges of the openings and the construction of the baffle walls completed.

The final operation consisted of removing the two beams at the top. It was not considered advisable to drop them, as they weighed about two tons. The ladder on the outside of the stack was on the opposite side of the engine, and the two timbers were in approximately the same plane. One block was rigged solidly to the top of the ladder and another was placed between the timbers on the opposite side. The main hoisting cable was then run through the block on the ladder and back to the timber, to a point just short of the center, where it was attached. A stub line was run through the block on the opposite side of the ladder, with one end attached to the front end of the timber and the other back to the ladder, where a man was stationed to handle the line. As tension was produced in the hoisting cable the timbers moved away from the engine until their front ends were clear of the stack wall. The stub line was then slowly loosened until the timbers hung vertically in the inside of the stack. They were then lowered to the bottom and were taken out through the clean-out door. The entire operation required about three hours. The small blocks and tackle were then lowered with a tag line, and the hoisting cable allowed to drop over the side, leaving the stack clear of all obstruction. Figure 3 is a view of the completed stack.

ACKNOWLEDGMENT.

The stack was designed by Repath and McGregor, Consulting Engineers, Douglas, Ariz.; it was fabricated and erected by the Chicago Bridge & Iron Works, to whom we are indebted for the views shown. The article is based on a paper by L. W. Barker, in the Journal of Engineering of the University of Colorado.

Data on Test Borings and Test Piles at Site of Field Museum of Natural History, Chicago, Ill.

(Staff Article.)

The following data give the results of some investigations and tests made to determine the character of the subsoil and the bearing power of wood piles at the site of the Field Museum of Natural History, now under construction in Chicago. The site of the building is in Grant Park, just south of Twelfth St., its east-and-west axis being 1,977 ft. east of the west line of Michigan Ave., and its north-and south axis 517 ft. south of the present south line of Twelfth St. extended. The building will be supported on concrete pedestals founded on wood piles. It is located on filled ground, the site originally being a part of Lake Michigan. The elevation of the surface of the ground at each test pile and boring is given in Fig. 1, all elevations being referred to Chicago City Datum. The elevation of the original lake bottom was about —17.0. The bottom of the concrete pedestals will be at elevation —2.5, while the basement floor will be at elevation +34.0, or 34 ft. above the level of the lake.

TABLE I.—ELEVATION OF GROUND AT PILE, SIZE OF PILE AND NUMBER OF BLOWS TO SECURE PENETRATION TO CITY DATUM.

Pile No.	Elevation of ground surface at pile.	Diameter of pile, inches. Tip.	Diameter of pile, inches. Butt.	Number of blows to secure penetration to city datum.
1	+ 6.92	8	14	10
2	+ 6.72	8	14	[illegible]
3	+ 6.63	[illegible]	14	4
4	+ 6.48	8	15	11
5	+ 6.79	[illegible]	14	6
6	+ 5.96	[illegible]	15	7
7	+ 9.40	9	16	[illegible]
8	+ 9.65	[illegible]	14	[illegible]
9	+ 6.03	9	17	1
10	+ 4.89	8	15	1
11	+ 7.55	8	16	1
12	+ 8.32	8	15	7
13	+ 9.72	8	15	15
14	+ 3.52	8	15	1*
15	+10.86	[illegible]	14	11
16	+ 8.90	8	15	1†
17	— 0.18	[illegible]	14	..
18	+ 1.30	8	15	..
19	+ 2.30	8	16	..
20	+ 4.55	8	15	4
21	+ 8.90	8	15	1‡
22	+ 5.10	8	15	1†
23	+ 3.60	8	15	1*
24	+ 8.60	8	14	1†

*Drove pile to 5 ft. below city datum.
†Drove pile to 2 ft. below city datum.
‡Drove pile to 7 ft. below city datum.

TEST BORINGS.

Six test borings were made at the site, the location of each boring being shown in Fig. 1. With the exception of boring No. 5, all borings were carried to bedrock; boring No. 5 was carried down to a large boulder, which was found at a depth of about 82 ft. below City Datum. The depth to bedrock at the

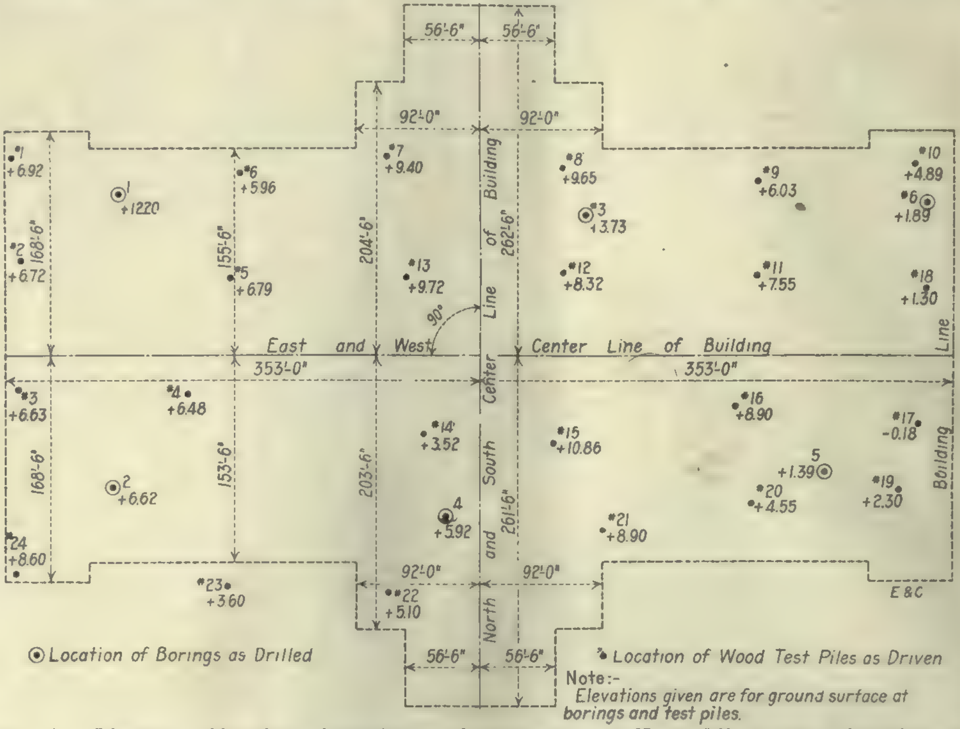


Fig. 1. Diagram Showing Locations of Borings and Test Piles and Elevation of Ground Surface at Site of Field Museum of Natural History, Chicago, Ill.

TABLE II.—NUMBER OF BLOWS REQUIRED TO DRIVE EACH PILE FROM CITY DATUM TO DEPTH INDICATED

Increment.	Depth below city datum.		Reference No. of pile — Number of blows to secure penetration shown: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
20'	20'	0"	24	57	41	32	28	[illegible]	24	21	32	29	50	73	84	10	62	39	4	3	10	37	33	34	14	29
5'	25'	0"	8	18	[illegible]	11	8	12	14	15	10	11	16	34	23	3	23	16	..	6	..	18	15	13	5	16
5'	30'	0"	8	19	13	14	9	11	15	17	13	11	20	28	27	10	31	17	1	8	4	25	20	14	7	18
5'	35'	0"	10	19	14	16	11	17	13	21	14	17	26	27	36	11	34	21	12	11	5	37	26	16	10	23
5'	40'	0"	14	19	19	20	15	21	15	24	19	25	34	35	61	14	45	29	12	11	10	33	32	22	14	25
1'	41'	0"	3	[illegible]	4	7	6	5	4	4	4	5	7	9	15	3	9	5	4	3	3	5	7	5	3	6
1'	42'	0"	3	5	5	7	[illegible]	8	4	6	5	[illegible]	8	9	14	3	10	5	6	3	3	8	[illegible]	5	3	6
1'	43'	0"	3	5	5	[illegible]	4	6	4	[illegible]	[illegible]	5	8	9	14	4	11	5	4	[illegible]	5	8	8	5	3	7
1'	44'	0"	5	5	5	7	4	7	4	[illegible]	5	6	[illegible]	10	15	5	10	7	4	4	2	8	9	[illegible]	4	7
1'	45'	0"	5	6	7	8	[illegible]	7	4	[illegible]	6	6	[illegible]	10	13	5	13	7	3	3	3	[illegible]	10	[illegible]	[illegible]	8
1'	46'	0"	5	[illegible]	5	[illegible]	6	7	[illegible]	7	7	[illegible]	9	10	15	10	12	7	9	4	4	10	10	7	[illegible]	[illegible]
1'	47'	0"	6	6	5	9	6	7	5	7	6	7	10	11	14	10	13	7	19	3	[illegible]	19	10	6	[illegible]	9
1'	48'	0"	6	7	7	8	[illegible]	7	5	10	[illegible]	7	10	12	15	9	13	8	16	4	3	33	10	7	[illegible]	8
1'	49'	0"	5	9	8	8	7	7	5	14	7	7	12	16	15	9	13	14	13	4	3	38	10	[illegible]	5	10
1'	50'	0"	6	9	[illegible]	9	9	8	5	12	8	8	13	21	18	10	13	23	12	6	8	32	18	7	9	12
1'	51'	0"	6	[illegible]	[illegible]	9	9	9	[illegible]	14	[illegible]	8	13	25	24	14	13	42	15	10	12	29	14	[illegible]	10	12
1'	52'	0"	6	13	12	10	[illegible]	[illegible]	6	16	12	10	13	19	19	14	15	18	17	10	18	30	15	11	12	15
1'	53'	0"	7	16	13	18	9	9	7	18	12	11	14	21	20	15	17	15	15	10	15	46	20	8	17	17
1'	54'	0"	13	17	13	13	10	13	7	16	16	18	16	21	10	14	16	13	18	15	13	50	18	15	15	17
1'	55'	0"	15	18	14	13	10	15	7	19	15	15	17	19	†..	16	14	15	18	15	11	60	20	18	13	18
3"		3"	6	5	[illegible]	3	[illegible]	[illegible]	..	[illegible]	..	4	..	4	..	5	3	3	5	..	..	¶..	3	3	[illegible]	4
3"		6"	5	[illegible]	5	3	3	3	..	4	..	4	..	4	..	4	4	[illegible]	5	..	..	..	6	3	4	5
3"		9"	5	[illegible]	4	[illegible]	3	3	..	[illegible]	..	5	..	6	..	5	4	4	5	..	..	..	5	3	4	6
3"	56'	0"	5	4	4	4	3	3	7	4	12	4	27	5	..	6	3	3	6	14	12	..	5	4	[illegible]	5
3"		3"	5	4	[illegible]	3	2	3	..	4	4	4	..	5	..	7	[illegible]	4	6	..	..	..	5	[illegible]	5	4
3"		6"	5	4	[illegible]	4	3	[illegible]	..	5	5	4	..	5	..	10	3	4	[illegible]	..	..	..	5	4	4	5
3"		9"	5	5	5	[illegible]	[illegible]	3	..	5	5	4	..	6	..	12	4	3	6	..	..	..	5	4	3	5
3"	57'	0"	5	5	5	4	3	[illegible]	8	5	4	4	27	5	..	14	4	4	6	16	14	..	5	4	4	5
3"		3"	5	5	4	4	[illegible]	3	..	6	[illegible]	4	..	4	..	18	3	4	6	..	..	..	6	4	4	5
3"		6"	6	6	5	[illegible]	[illegible]	4	..	7	4	4	..	[illegible]	..	27	[illegible]	5	7	..	..	..	5	4	4	5
3"		9"	6	6	4	[illegible]	3	[illegible]	..	5	4	3	..	6	..	‡..	4	6	7	..	..	..	6	**..	4	5
3"	58'	0"	6	5	4	4	[illegible]	[illegible]	9	6	[illegible]	4	26	5	..	..	4	4	7	40	15	..	6	..	[illegible]	5
3"		3"	5	[illegible]	5	[illegible]	3	3	..	6	5	4	..	6	..	..	[illegible]	5	8	..	..	..	6	..	[illegible]	6
3"		6"	6	6	6	[illegible]	3	[illegible]	..	6	[illegible]	4	..	6	..	..	3	4	8	..	..	..	6	..	4	5
3"		9"	6	6	5	4	3	4	..	7	4	5	..	5	..	..	4	5	8	82	..	..	5	..	[illegible]	5
3"	59'	0"	4	6	5	[illegible]	3	3	10	6	4	[illegible]	27	6	..	..	5	5	9	..	19	..	7	..	4	6
3"		3"	6	6	[illegible]	4	[illegible]	3	..	7	4	4	..	7	..	..	4	5	9	..	..	..	6	..	4	6
3"		6"	6	7	5	5	2	3	..	7	5	4	..	5	..	..	5	6	10	..	..	..	6	..	5	6
3"		9"	6	[illegible]	4	5	4	4	..	8	5	5	22	6	..	..	4	10	12	..	..	..	7	..	5	[illegible]
3"	60'	0"	7	8	6	5	4	4	8	9	4	5	*..	[illegible]	..	..	5	10	12	..	20	..	7	..	6	6
3"		3"	7	9	6	..	7	..	3	16	5	5	..	6	..	..	..	..	..	..	5	..	[illegible]	..	..	..
3"		6"	7	9	8	..	..	..	3	18	5	..	..	[illegible]	..	..	..	..	..	..	6	..	7	..	..	..
3"		9"	8	9	..	..	..	..	2	..	5	..	..	6	..	..	..	..	..	..	7	..	7	..	..	..
3"	61'	0"	8	12	..	17	..	..	2	..	5	..	..	8	..	..	..	..	..	..	6	..	..	..	..	..
3"		3"	10	11	..	..	..	..	3	..	[illegible]	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
3"		6"	14	11	..	..	..	..	3	..	5	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
3"		9"	19	15	..	..	..	..	3	..	5	..	..	..	..	..	..	..	..	..	7	..	..	..	..	..
3"	62'	0"	24	..	..	19	..	..	3	..	5	..	..	..	..	..	..	..	..	..	7	..	..	..	..	..
3"		3"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	21	..	..	..	..	..
3"		6"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	23	..	..	..	..	..
3"		9"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	§..	..	..	..	..	..
3"	63'	0"	..	..	..	21	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		3"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		6"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		9"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"	64'	0"	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		3"	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		6"	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"		9"	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3"	65'	0"	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

*Pile split or broke. †Pile broke. ‡No movement in pile. §No movement last 10 blows. ¶No downward movement in pile; head moving around in circle. **Head of pile was 6" south at 55' 0" and 14" south at 57' 6".

various test holes was found to vary from about 78 ft. below City Datum at boring No. 1 to about 90 ft. at boring No. 4. The character of the subsoil and the depth of the various subsoil strata at each test hole are shown in Fig. 2.

TEST PILES.

Twenty-four test piles were driven at the building site, the location of each pile and the elevation of the ground surface at the pile being as shown in Fig. 1. The lengths of the piles were as follows: Piles No. 11, 18 and 19, 70 ft.; pile No. 7, 65 ft.; all other piles, 60 ft. The piles were driven with a drop hammer weighing 5,000 lbs., the length of drop being 3 ft. 6 ins. Each pile was first driven to City Datum, the number of blows required to drive it to that depth being recorded; driving was then continued. Table I gives the elevation of the ground surface at each pile, the diameter of the pile at each end, and the number of blows required to secure penetration of the pile to City Datum.

Table II gives the number of blows required to drive each pile from City Datum to each depth indicated. The piles were driven to the depths indicated by the last figure given in each column. Difficulty was experienced in driving some of the piles, and in a few cases the piles broke or could be driven no further. The following data refer to piles which should be considered as special cases; the driving of all other test piles except those noted below was stopped at the depth indicated by the last recorded number of blows; all depths are measured from City Datum.

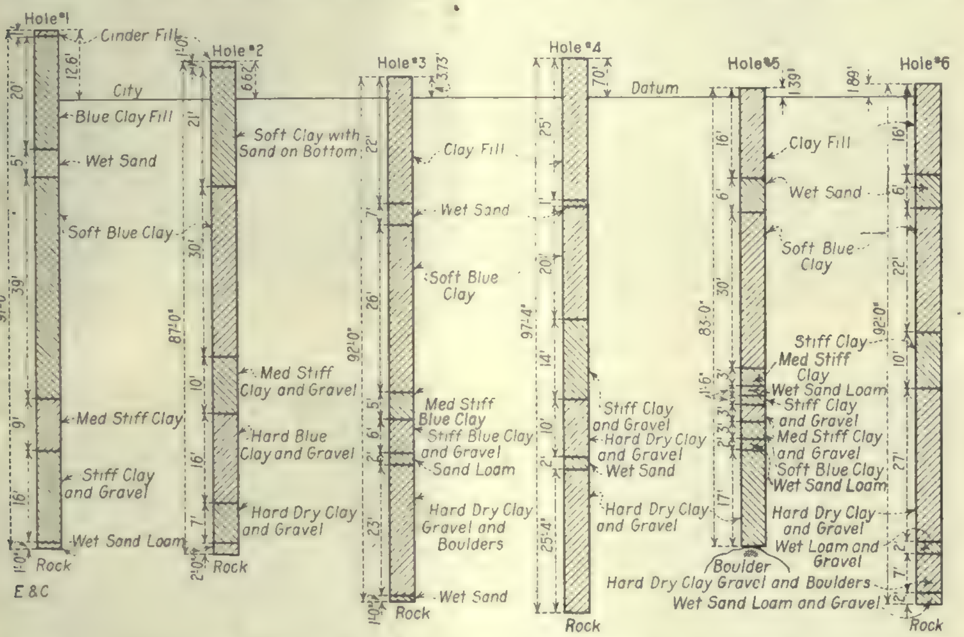


Fig. 2. Results of Test Borings Made at Site of Field Museum of Natural History. For Locations of Borings See Fig. 1.

Pile No. 7 was driven to the greatest depth, 65 ft. Pile No. 11 broke or split after being driven to a depth of 59 ft. 9 ins. After being driven to a depth of 54 ft. pile No. 13 broke. After reaching a depth of 57 ft. 6 ins. pile No. 14 could not be driven further. There was no movement of pile No. 19 under the last ten blows after it had been driven to a depth of 62 ft. 6 ins. There was no vertical movement of pile No. 20 after being driven to a depth of 55 ft., the pile head moving around in a circle. The head of pile No. 22 had moved 6 ins. south from its original position after the pile had been driven to a depth of 55 ft.; at a depth of 57 ft. 6 ins. this movement had increased to 14 ins.

ACKNOWLEDGMENT.

We are indebted to Graham, Burnham & Co, Architects, for the foregoing data.

Water-meter installation is planned by the Honolulu municipal water works; a resolution appropriating $8,500 therefor is before the City Board.

Special Details in Reinforced Concrete and Steel Building Construction.

(Staff Abstract.)

Special details appearing on plans for large buildings are of two kinds; those designed to meet conditions actually existing, and those designed to meet conditions which exist only in the designer's imagination. That the latter class does exist to a considerable extent will be shown by an examination of plans and specifications which come into the offices of contractors. The following suggestions concerning the use of special details were made by Louis W. Bruck in a paper before the Indiana Engineering Society:

Economy has become the most important factor in present-day building construction; it determines almost without exception the size, the type and the design of every building. Hand in hand with it, as a great aid, comes standardization of material and methods. The size of all building materials has been well standardized, and steel of any except the standard shapes and minimum weights is not obtainable except on special and very expensive order. The most efficient engineer designs accordingly. Details involving the use of special material, special shop work, etc., are used by him only as the last resort. Any work out of the regular line of materials and methods that the ordinary workman is acquainted with becomes very expensive, and the contractor studies religiously to avoid such, and when he finds a different solution he insists on its use, or an allowance of extra time to obtain the material detailed.

However, every building does have features which require very careful attention. Every building has certain parts designed for an unusual purpose, which neither the specifications nor the general drawings explain adequately to the contractor and to the various craftsmen employed in its construction. Throughout the entire building there are details of construction on which two or more separate crafts must be agreed. For example, the location of terra cotta anchor holes in the steel frame is vital to both steel and terra cotta contractors, yet neither may establish it for the other. Details of such items in the work do, and should, form a large part of the special details in building plans. The following enumeration, classified in a very general way, covers the principal subjects for detail usually required:

REINFORCED CONCRETE CONSTRUCTION.

(a) Design of footing reinforcement.
  1. Bending of reinforcing bars.
  2. Location and size of shear reinforcement.
  3. Disposition of bars in tension face of heavy cantilever or combined footings.
(b) Detail of column base, showing dowels in footing, method of securing vertical bars, and hooping in the case of hooped columns.
(c) Detail of column splice in reinforcement, and disposition of slab reinforcement around column.
(d) Location of all brackets.
  Anchor bars.
  Hangers, shafting, etc.
  Pockets in slab or column.
  Holes in slab for mechanical equipment.
(e) Location in slab for pipes of steam fitter, plumber, electrician and other mechanics.

STEEL SKELETON FRAME.

(a) Detail of column base (steel grillage or cast iron base).
(b) Connection of frame to foundation, anchor bolts, etc.
(c) Column splice and typical beam connection.
  Location of splice.
  Material in same.
  Material for beam connections.
(d) Location and detail layout for all wind bracing in the building.
(e) Design of plate girders with:
  1. Line diagram of girder to scale.
  2. Loads designed for.
  3. Stresses.
  4. Material, lengths, etc.
(f) Design of trusses with:
  1. Line diagram of truss.
  2. Panel loads, designed for.
  3. Stresses in each member.
  4. Material.
  5. Lateral bracing, etc.

The details of the footing and column bases in the reinforced concrete work are essential largely because they are needed at the beginning of operation in the field, at the stage when the contractor's organization is not acquainted with the design or scope of the work, and extra care to make the beginning clear to them is well worth the effort in the time gained.

The location of brackets, etc., called for in item (d) is intended to eliminate, so far as possible, one of the objectional features of reinforced concrete work, as it is not easy to add to or alter anything about the structural frame, after it is erected. Machinery brackets on columns, for example, are so easily forgotten and so hard to attach afterward that a separate and elaborate detail for them is a wise precaution.

The location of pipe holes in the slabs is important. Usually a slab is hardly dry before every craft on the work starts to cut away at it. Seemingly pipes have never been thought of before that time. Not only is disregard for these dangerous to the construction, but it is expensive to cut through a 6 or 8-in. concrete slab to provide space for a pipe. This expense must in the end be borne by the owner. When one reflects how comparatively easy it would be for the designer to locate these holes in the plans in advance of the pouring it seems all the more serious that it is done so infrequently.

Most of the items in the steel framing are self-explanatory, but mention may well be made of plate girder and truss design. A great many designers record their designs for plate girders and trusses in a private notebook, and give very meager data on the plans. A single cross section through a plate girder is often considered sufficient for the detailer. The material list accompanying such a drawing is of little value to the man who must order the material for a girder. He finds it necessary to duplicate nearly all the work that the designer has recorded in his notebook. A small line diagram, if only to ⅛ in. scale, showing dimensioned lengths of all members of the girder, is easily added to a drawing, and such a diagram makes it possible to order the material for it without delay.

So many items appear for each building under these various headings, and attention at the proper time means so much to the men who execute the work, that they deserve thorough study. He is indeed a valuable man in any office who can indicate clearly every difficulty in the way of the workmen and can avoid the use of special materials, special tools, or expensive operations.

ROADS AND STREETS

An Investigation to Determine the Relative Resistance to Wear of Concrete Made of Different Aggregates.

(Staff Abstract.)

The tests reported here were made to determine the influence on resistance to wear of concrete of the character and quality of stone for the coarse aggregate. The cement and sand used were the same. To insure uniformity throughout the specimens pertaining to any particular stone or gravel of a given size, the specimens were all moulded from a one batch mix.

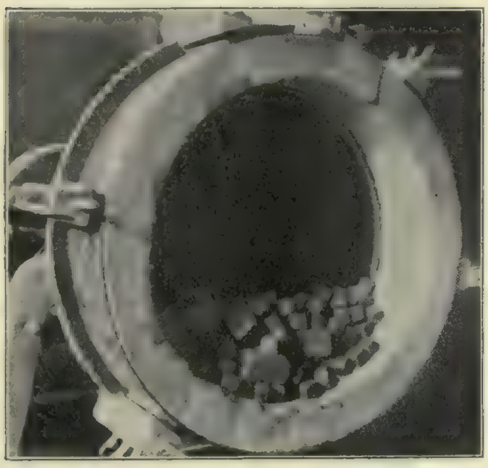


Fig. 1. Concrete Ring as Mounted in Rattler for Abrasion Test (cover removed.)

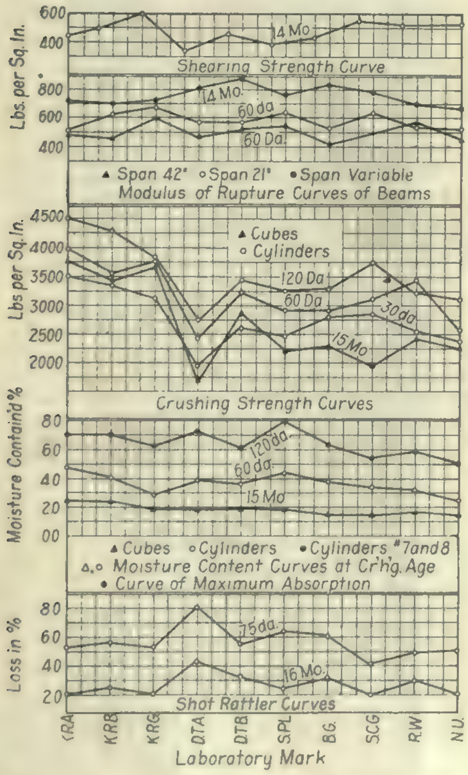


Fig. 3. Comparison Curves of First Series of 1913.

The concretes for the first and second series comprising all the one course experiments were hand mixed. The concrete was of a 1:2:4 loose volume proportion, all the material for each batch was weighed, the weight of each constituent being calculated from the weight of a cubic foot of the loose material. The cement used for each batch mix was taken from forty sacks in equal amounts from each sack.

In preparing the concrete the cement and sand were first mixed dry until it presented a uniform color, water was then added until a stiff mortar was secured; the stone which had been previously wet down was next introduced into the cement mortar and then the batch was very rapidly and thoroughly mixed to the consistency of what is classed as a quaking mass.

In the third series of tests comprising the two coat work experiments, the mixing was done by a motor-driven batch mixer. In this work the quaking mass consistency used in the one-course work was reproduced as nearly as conditions would permit. The cement for this series was sampled from thirty sacks, an equal amount being taken from each sack. The specimens were cured by wetting down under burlap sacks each day for a period of seven days. These specimens were then allowed to air cure until the time of testing in a room in which the temperature varied from 60 to 80° F. This method of curing was the same for all specimens, excepting the cylinders used for the absorption test, and the special concrete rings and cylinders of tests 16 and 17.

Abrasive test of concrete.—For this test concrete rings were made to fit a Talbot Jones Brick Rattler, Fig. 1. These rings had an external diameter of 36 ins. and an internal diameter of 28 ins., with an 8½-in. face.

The rings were reinforced by two ⅜-in. steel rods bent to form a 34-in. circle. This reinforcing permitted of a more or less rough handling of the specimens without danger of cracking.

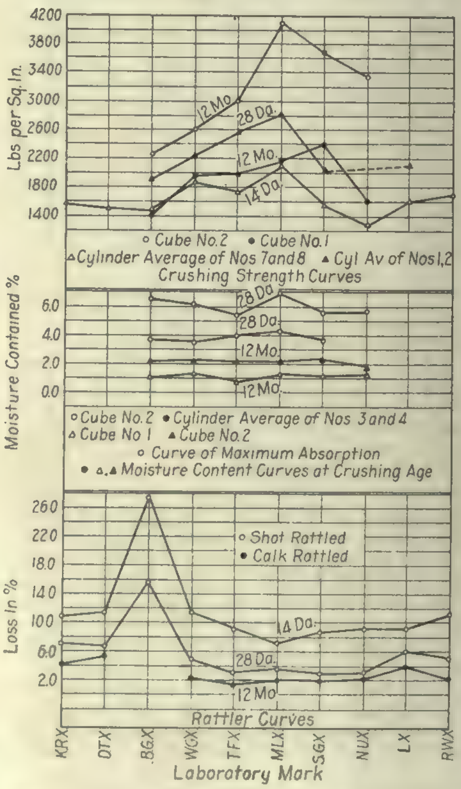


Fig. 4. Comparison Curves of Second Series, 1913-14.

The abrasive charge used was composed of the standard cast-iron shot recommended for brick rattling tests, consisting of 2½ x 2½ x 4½ in. cast-iron blocks and 1½-in. cast-iron cubes, the shot having slightly rounded edges. The number of shot comprising a charge has not yet been standardized, in these tests 9 large and 114 small shot were used, representing a weight of 64.35 lbs. and 86.80 lbs. respectively, or a combined charge of 151.15 lbs.

The speed of the machine was 30 revolutions per minute. This speed was found to impart a tumbling action to the shot in addition to the sliding or pure abrasive action. It was the intention, however, to produce this combined impact and abrasive effect, which in part determined the volume of the charge to be used. The speed of 30 revolutions per minute has been used in many recorded brick

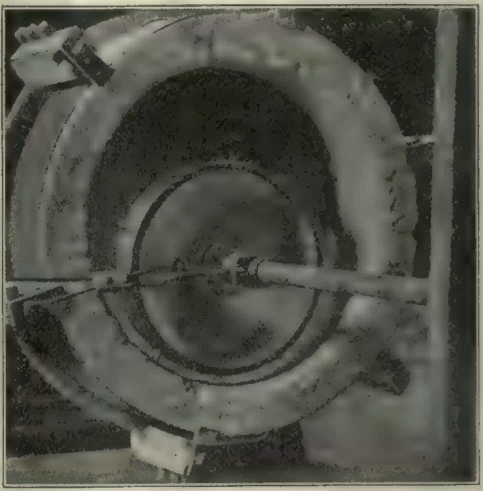


Fig. 2. Concrete Ring as Mounted in Rattler for Calk Test (calked wheel in place).

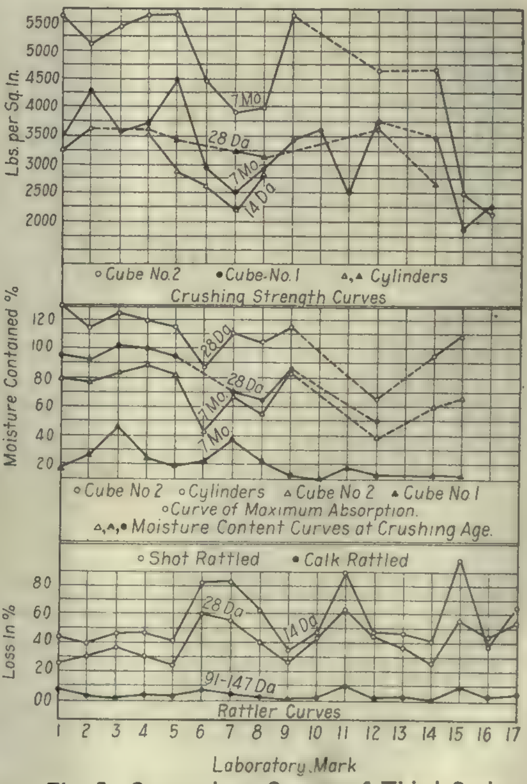


Fig. 5. Comparison Curves of Third Series, 1914.

rattling tests, and designated as producing abrasive wear. I have used the extended meaning attached to this word throughout in this report.

After mounting the ring in the rattler, the charge was placed on the inner or abrasive surface of the ring and the cover replaced ready for rattling. In Figs. 6 to 21 is given a series of photographs of the different rings showing the character of the surface, after being subjected to this kind of wear.

Calk or gouging tests.—In addition to the abrasive test the rings were also subjected to the gouging action produced by calks. These calks were a commercial product designated by the trade name of the diamond brand never-slip horse shoe calks. They were the ⅞-in. size having a hard center with slightly softer body. The calks were studded on the face with a heavy cast-iron pulley of 18¾ ins. diameter and with a 4½-in. face; this pulley was free to turn on a fixed supporting shaft. In this case no cover was provided for the rattler. See Fig. 2. The supporting shaft was weighted down so that the total dead weight on the set of calks in contact was 184.1 lbs. The calks were spaced in such a manner as to cause the wheel to drop about ½ in. between the disengaging contact of one set of calks and the making of contact with the next set.

The tests for crushing, flexure and shear made for comparison were concluded by the usual processes.

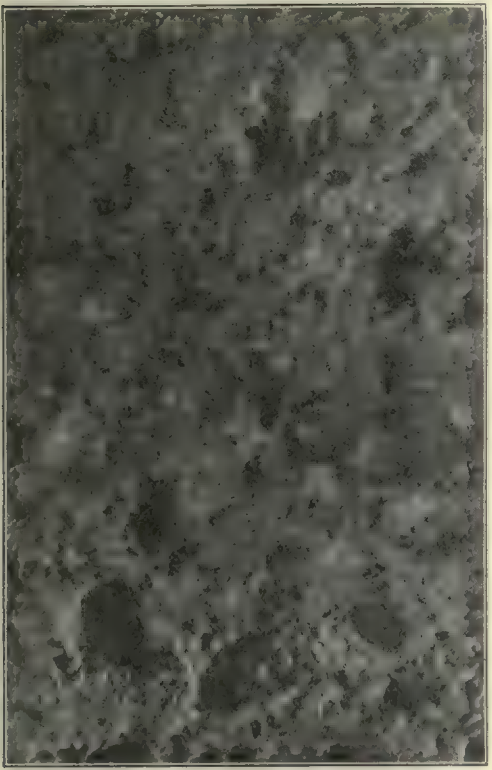


Fig. 6. Photograph of Concrete Road.

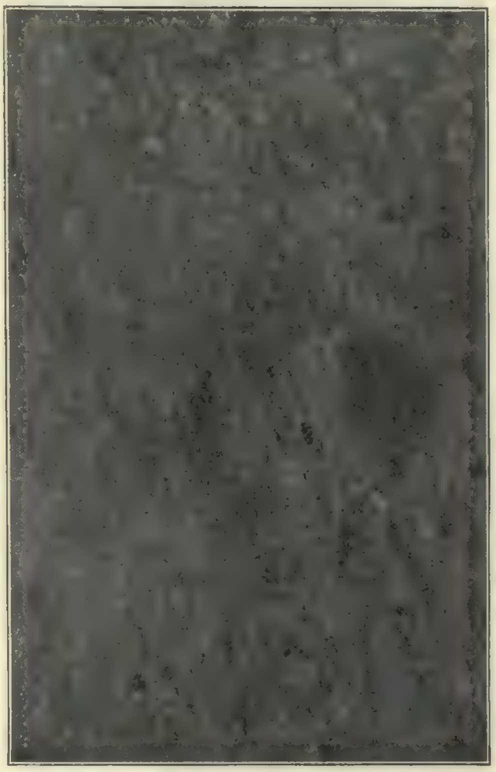


Fig. 7. Kettle River Sandstone. Spec. K. R. B.

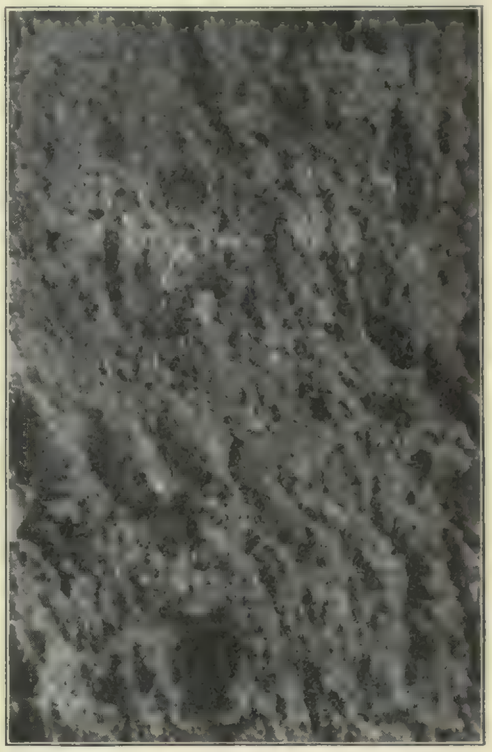


Fig. 8. Duluth Trap Rock. Specimen D. T. B.

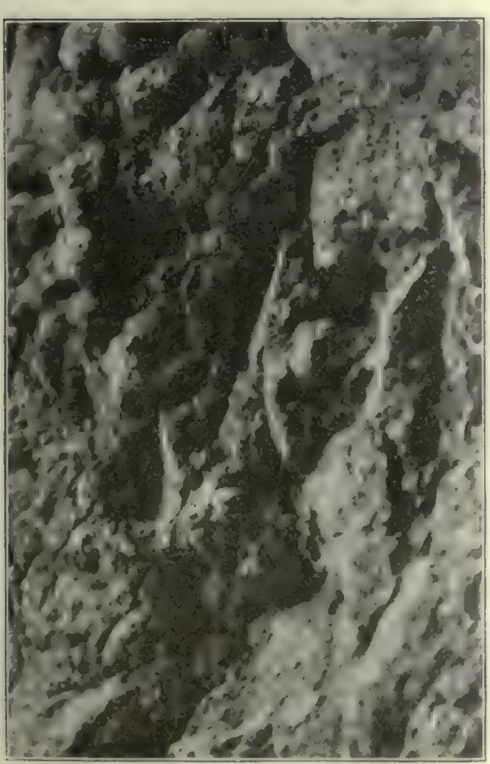


Fig. 9. St. Cloud Granite. Specimen Sc. G.

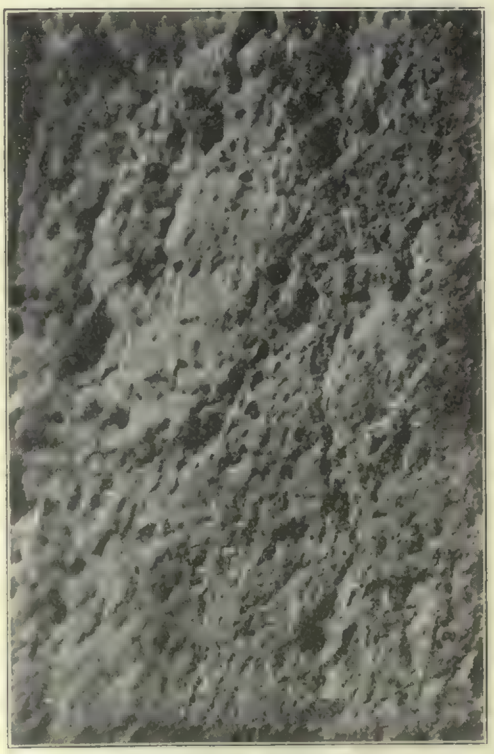


Fig. 10. St. Paul Limestone. Specimen S. P. L.

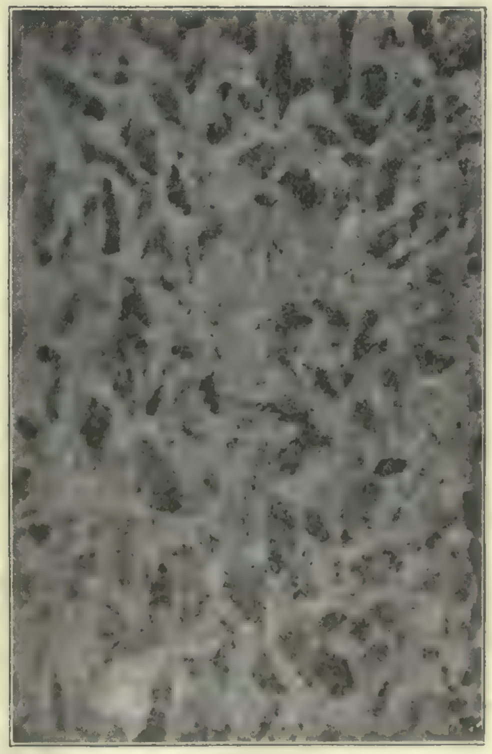


Fig. 11. Duluth Trap Rock. Specimen D. T. A.

RESULTS OF TESTS.

The results of the tests are shown quantitatively by the diagrams Figs. 3, 4 and 5. The kind of aggregate indicated by each laboratory mark is given in Table I. Figures 6 to 21 show the comparative appearance of the worn surfaces and should be studied in connection with the discussion which follows and with the diagrams Figs. 3, 4 and 5.

DISCUSSION.

Ring rattling with shot.—It has been stated that many of the failures of concrete roads in the past have been due to improper methods of curing. With this criticism in mind, the above tests were made to check up if possible the variation in wear under the three methods of curing. Ring No. 15 in curing was allowed to dry out rather rapidly. Ring No. 16 being immersed, cured in the presence of an excess of water, while ring No. 17 being hermetically sealed retained all the moisture present in the green concrete.

It is observed that there is a marked difference in the percentage of wear for these rings.

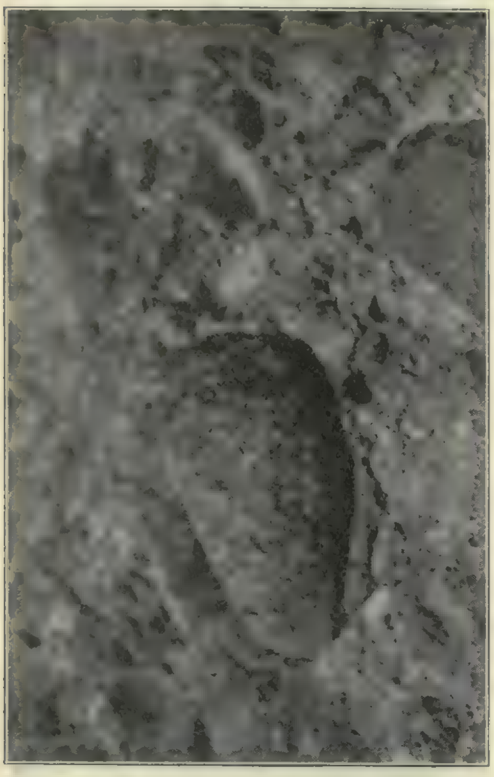


Fig. 12. Red Wing Gravel. Specimen R. W.

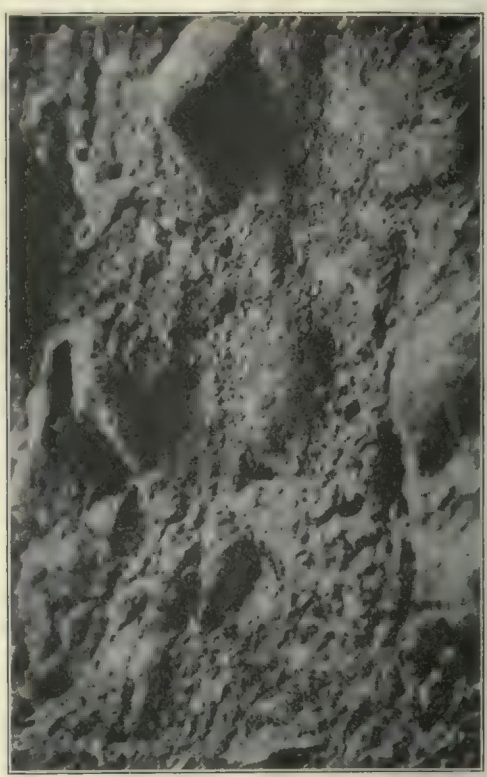


Fig. 13. New Ulm Granite. Specimen N. U. X.

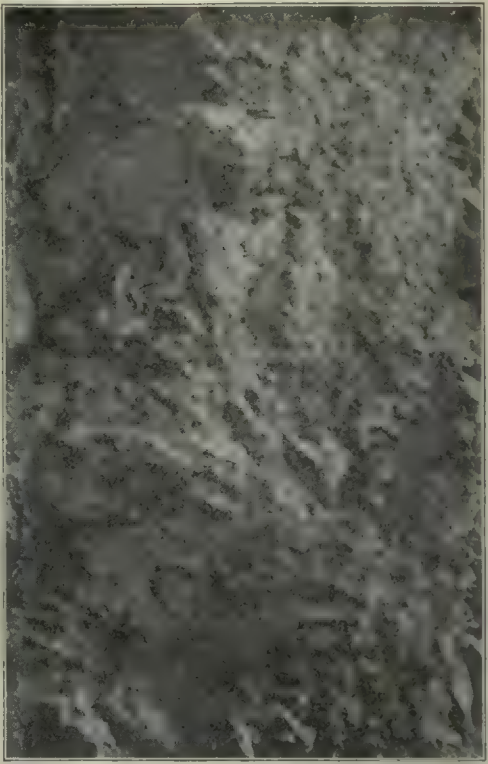


Fig. 14. Duluth Trap Rock. Specimen D. T. X.

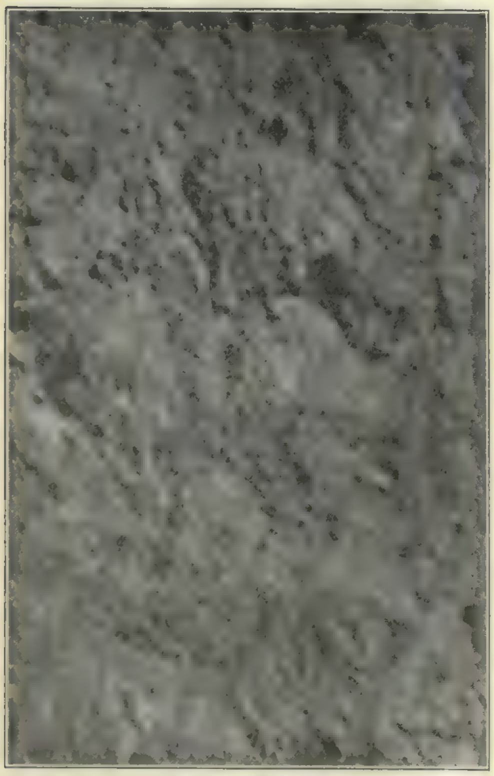


Fig. 15. Mankato Limestone. Specimen M. L. X.

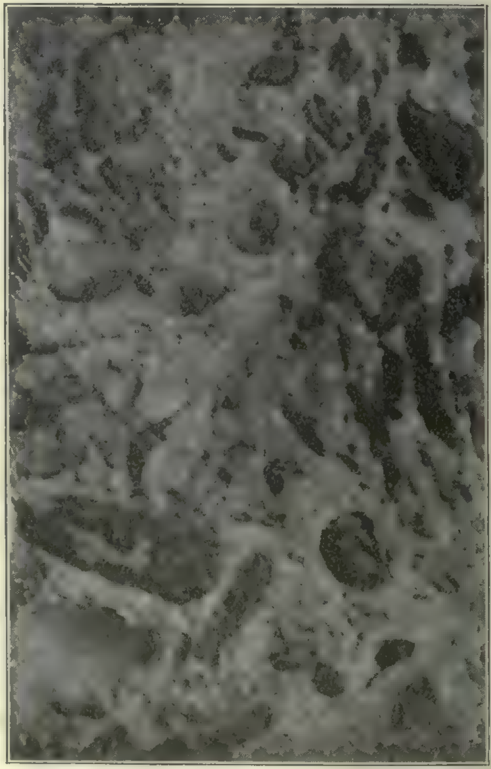


Fig. 16. Duluth Beach Gravel. Specimen B. G. X.

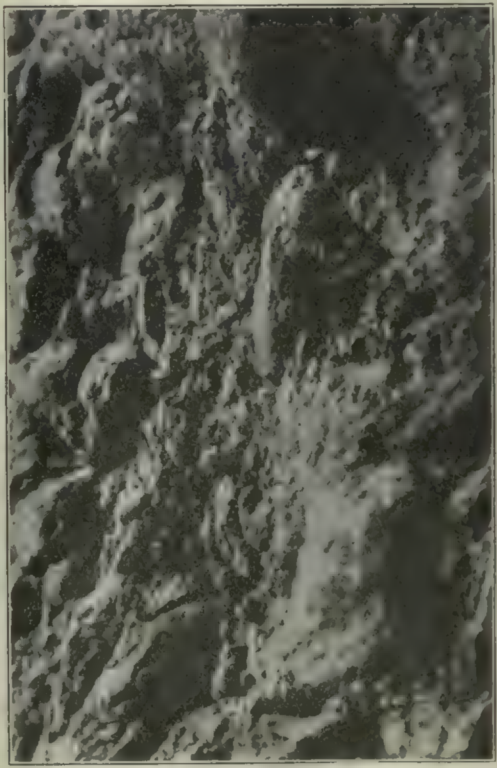


Fig. 17. St. Cloud Granite. Specimen Sc. G. X.

It was found in rattling No. 16, the immersed ring, that a coating of paste from the wet grindings, covered the shot. This paste coating served as a cushion to the impact action of the falling shot and the percentage of wear was consequently less than recorded for air cured ring specimen No. 15. Ring No. 17 received a preliminary rattling to crack off the coating of pitch, it was then reweighed and the comparative recorded rattling, was made. The presence of moisture was very noticeable in the damp dust of the wearings at the fourteen day rattling. The ring was then recoated with pitch and again rattled at the end of twenty-eight days. The presence of moisture at this date was also noticeable.

It was found in the case of the gravel specimens that when subjected to the action of the shot the gravel would kick out and produce pockets and that once formed these pockets would quickly develop into holes.

It was also noted that for the hard and tough stones, when used in comparatively large sizes, the bonding mortar would wear away and allow the rock to protrude, making an uneven and bumpy surface.

When a road has reached this stage in its life, the hammering action produced by the heavy traffic rolling over the protruding stones will greatly increase the rapidity of its future wear. The proper grading of the material for a wearing coat, to minimize the development of this condition of surface has not been considered in this report.

It was further found that where the stone presented lines of cleavage, as is present in many hard stones, that the protruding stones would laminate and then kick out. Deep pockets were formed when the laminations ran vertically, the part of the stone between the laminations being dislodged and the remainder of the broken stone having no backing of material resulted in its being dislodged. The softer mortar would then break down, followed by the stones surrounding the pocket and the small pocket would very speedily develop into a much larger pocket. When the laminations ran horizontally the pockets formed were more or less shallow and the unevenness of the surface was not so pronounced. In the crushed stone specimens this condition of surface was developed at a much later period in the course of rattling than in the case of the gravel rings.

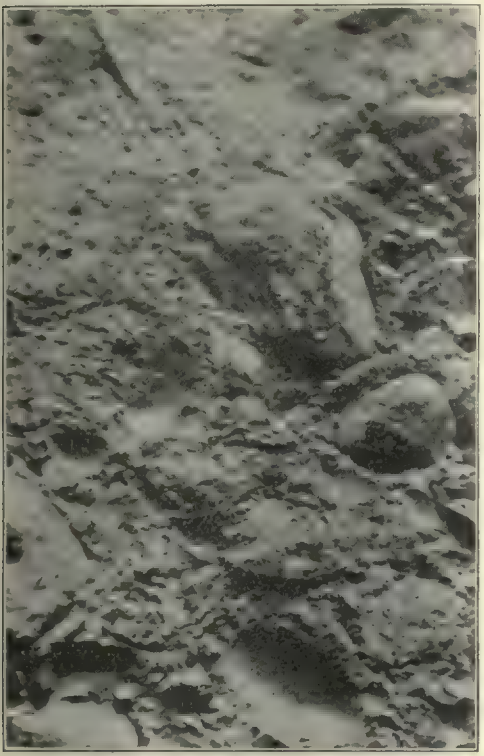


Fig. 18. Red Wing Gravel. Specimen R. W. X.

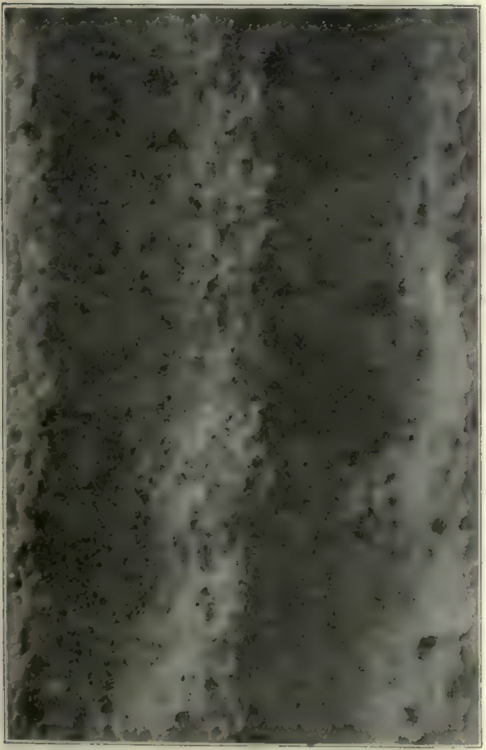


Fig. 20. Surface of Ring Number 6, 3rd Series, Showing Action of Calks. Typical of All Rings of the 3d Series.

In general, the tests show that crushed stone makes a better wearing surface than the gravels, this advantage being due to the better bond.

It was demonstrated in the case of the sandstone specimens, that the stone wore down with approximately the same rapidity as the bonding mortar, producing a smooth, even surface. It is also to be noted that the percentage of wear was normal.

This normal, even wear will not necessarily be true concerning all sandstones but for the one tested the evidence presented substantiates the statements made.

Where the surface coat is of fine material, hard and tough stones should be used. The proper size and grading to maintain a practically smooth wearing road with a minimum of wear has not been determined.

It is believed that a material which will wear at about the same rate as the cement mortar itself, insuring a smooth pavement, will in the end be the most economical, even though its coefficient of wear (which is not true in this case) be greater. This probable increased coefficient of wear will be more than counter-balanced by the wear due to the hammering action produced by the heavy traffic rolling over the protruding stones and tending to break up the road bed. In all probability, therefore, the maximum life of such a road bed will be greater and in addition afford an ease and pleasure in travel together with the absence of unsightly and annoying pockets.

TABLE I.—GENERAL DATA CONCERNING ROCK AND GRAVEL.

Laboratory mark.	Kind of material.	Commercial size.	Weight per cu. ft. as shoveled. Lbs.
	First Series, 1913.		
K. R. A.	Sandstone	1 to ¼	71.71
K. R. B.	Sandstone	2 to ¼	75.86
K. R. G.	Sandstone	2½ to ¼	73.97
D. T. A.	Trap	1 to ¼	80.70
D. T. B.	Trap	2 to ¼	82.09
S. P. L.	Limestone	1 to ¼	74.50
B. G.	Beach gravel	2 to ¼	96.76
S. C. G.	Granite	2 to ¼	85.45
R. W.	Gravel	2 to ¼	104.40
N. U.	Gravel	2 to ¼	103.60
	Second Series, 1913-14.		
K. R. X.	Sandstone	1 to ¼	71.71
D. T. X.	Trap	2 to ¼	82.09
M. L. X.	Limestone	1 to ¼	82.11
B. G. X.	Beach gravel	1½ to ¼	107.15
Sc. G. X.	Quartzite	1 to ¼	87.43
R. W. X.	Gravel	1½ to ¼	104.40
W. G. X.	Gravel	1 to ¼	109.54
T. F. X.	Trap	1 to ¼	87.40
L. X.	Limestone	1 to ¼	74.50
N. U. X.	Quartzite	1½ to ¼	89.49
	Third Series, 1914.		
1	Limestone	Screenings	100.00
2	Sandstone	Screenings	91.41
3	Sandstone	Screenings	69.90
4	Quartzite	Screenings	72.50
5	Quartzite	Screenings	74.40
6	Quartzite	Screenings	72.50
7	Sandstone	Screenings	69.90
8	Limestone	Screenings	74.80
9	Limestone	Screenings	74.80
10	Trap	Screenings	81.30
11	Gravel	Screenings	94.90
12	Lake Gravel	Screenings	94.17
13	Lake Gravel	Screenings	94.17
14	Sand	Screenings	102.56
15	Limestone	Screenings	74.45
16	Limestone	Screenings	74.45
17	Limestone	Screenings	74.45

If the stone used is harder than the cement mortar, it should possess the property of gradually wearing away and not crack off in spalls running below the bonding surface of the encasing mortar, producing pits, which later develop into pockets.

It is understood that this discussion covers only the cases where the concrete itself receives the direct wear of traffic. When the surface is protected by a special coating or covered by loose material the condition and amount of wear would be vastly different.

Ring rattling with calks.—In rattling with calks the percentage of wear is not a direct measure of the value of a stone for concrete roads. The condition the surface presents after being subjected to the gouging action of the calks reveals its true worth and is the proper criterion by which it is to be judged. Again, the percentage of wear is not directly comparable with that of the shot rattlings as the condition of wear is distinctly different. As anticipated, the kicking out of the gravel was more marked when the calks were used, also the laminated stones were dislodged much more rapidly.

ACKNOWLELGMENT.

Extracted and rearranged from a bulletin of the University of Minnesota Studies in Engineering by Prof. C. F. Shoop.

Wooden passenger coaches are rapidly becoming obsolete as a result of the safety program of the railroads. A recent report of the Railway Committee on Operation of Lines in the United States and Canada shows that of the 956 coaches under construction on Jan. 1 only three were of wood and only two were to be used in the passenger carrying business. The report indicates 4,614 wooden cars have been retired in the last three years.

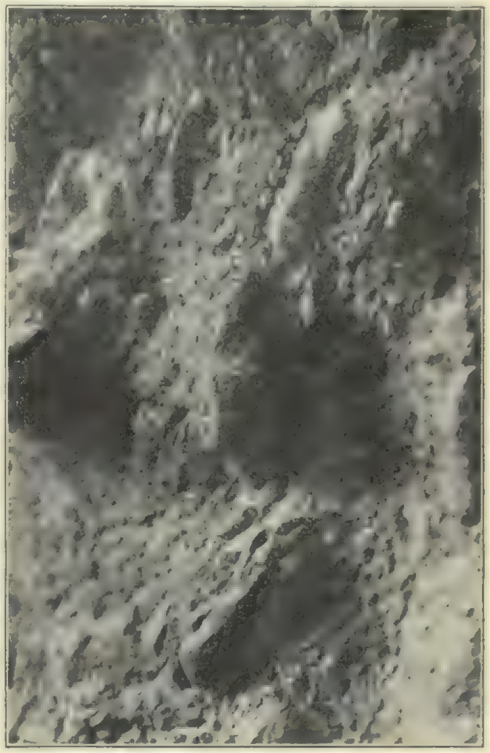


Fig. 19. Taylors Falls Trap. Specimen T. T. X.

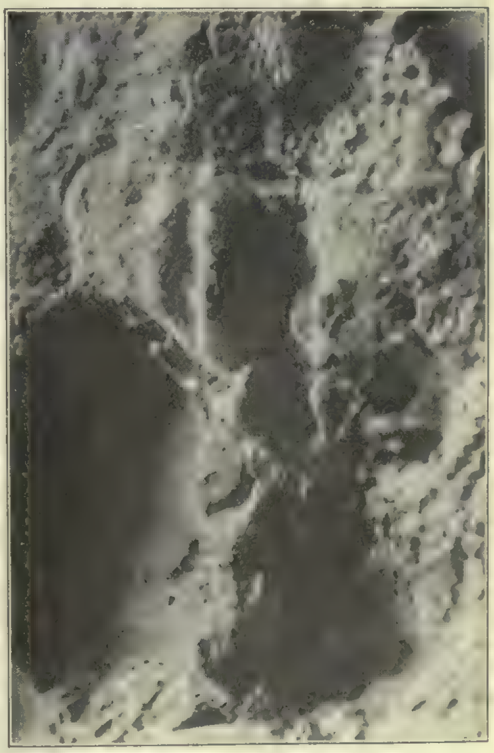


Fig. 21. Surface of a Gravel Ring Showing Action of Calks. Typical of All Gravel Rings.

Cost of Concrete Pavements.

(Staff Abstract.)

The most satisfactory method of arriving at the probable cost of a concrete pavement is first to ascertain by careful measurements and computations the quantities of the materials to be used and the various kinds of work to be done. An itemized estimate based on these quantities and the unit costs which prevail in the community for such materials and work may then be made. To this estimate should ordinarily be added a reasonable amount to cover unforseen contingencies, and, also, if the work is to be done by contract, a fair profit for the contractor. From 15 to 20 per cent of the estimated cost is usually considered sufficient to cover these items.

In order to appreciate the importance of considering the different items separately in preparing an estimate of cost, it is necessary only to consider briefly the great amount of variation in unit costs.

The grading is usually paid for by the cubic yard of excavation, and the cost varies not only with the quantity but is greatly influenced by the character of the soil. In light, easily loosened soils grading may usually be done at from 25 to 40 cts. per cubic yard. In hard earth containing more or less loose rock the cost per cubic yard generally varies from 40 to 75 cents, while grading in solid rock may sometimes cost as much as $1.50 per cubic yard. It is well to consider the cost of the rough grading entirely apart from the cost of the pavement. The drainage structures, however, may be considered together with the grading. The cost of these varies over such a wide range that no attempt will be made to discuss them here.

The cost of shaping and rolling the subgrade after the rough grading is completed is generally from 5 to 10 cents per square yard. This cost should be included with the other items which make up the cost of the pavement proper.

The cost of the concrete depends largely on the cost of the materials of which it is composed. These materials, delivered on the work, vary in cost according to the location of the work and the freight rates about as follows: Cement, from $1 to $2.50 per barrel; sand, from $0.60 to $2 per cubic yard; and broken stone or gravel, from $0.60 to $2 per cubic yard. The cost of mixing, placing, and finishing the concrete ordinarily varies from $0.60 to $1.25 per cubic yard, and depends on the efficiency of the organization and on whether the mixing is done by hand or machine. For machine mixing and labor at $0.20 per hour, $0.80 appears to be a fair average cost per cubic yard, including all overhead and incidental charges. The cost of constructing forms, contraction joints, etc., including the materials, is usually from $0.03 to $0.10 per square yard. Where simple types of joints and forms are used this cost should not exceed about $0.05 per square yard of pavement.

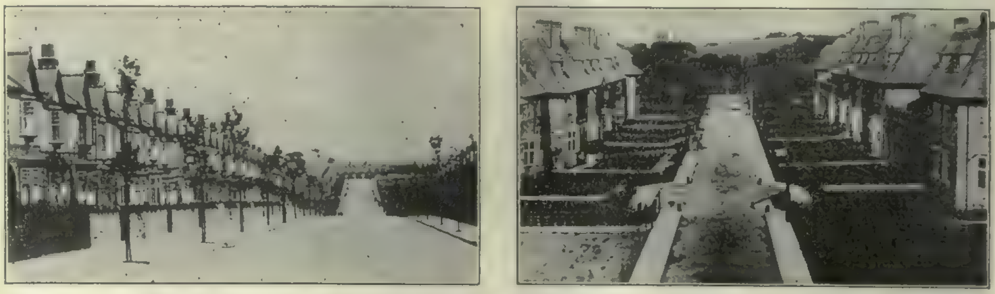
ACKNOWLEDGMENT.

Extract from Bulletin 249, U. S. Department of Agriculture, by C. H. Moorefield and J. T. Voshell.

Narrow vs. Wide Paved Roadways in Residential Districts.

(Staff Article.)

When a city is laid out it is not always easy to forecast accurately the character of the development likely to occur eventually in any given district. For that reason it is well to lay out wide streets upon which wide paved roadways can be constructed in case the district is built up with business houses. However, the majority of streets will always be lined with residences and for that reason paved roadways should be kept narrow until the local need of wide roadways is clearly apparent.



Views Illustrating Wide and Narrow Paved Roadways on Streets of the Same Width.

Considerations of economy and of living conditions both show the desirability of narrow roadways in residence communities. The economic advantages of the narrow roadway over the wide one are: lower first cost of pavement, lower cost for pavement maintenance and lower cost of street cleaning. The living conditions are bettered by the narrow roadway in these particulars; the wide parkings are virtually substantial additions to the front lawns abutting on the street; houses are farther from the roadway and therefore are more easily kept clean and afford greater privacy on the verandas and lawn; speeding is discouraged.

We are indebted to Mr. Charles Henry Cheney, Secretary of the California Conference on City Planning, San Francisco, Calif., for the two views shown herewith to illustrate how the narrow roadway saves waste. The view on the left shows a typical wasteful wide pavement on a residence street. Half the roadway width shown would be ample. By keeping the width of the street the same and widening the parking or lengthening the lawns, the effect shown in the other view is obtained. In the latter view the roadway is 20 ft. wide. This is sufficient for all local traffic. The actual distance between the houses on opposite sides of the street is the same in both cases.

Mr. Cheney is authority for the statement that the examination of one square mile of residential property in Berkeley, Calif., showed nearly $200,000 worth of needless pavement, that is, pavement wider than any requirements of traffic could possibly demand had been put down at the expense of abutting property owners. At this rate there is about $3,000,000 waste pavement in Berkeley and $15,000,000 worth of the same kind of waste in Los Angeles. This needless overhead expense deters many from becoming owners of small homes and increases the financial burdens of those who do hold title to real property.

DRAINAGE AND IRRIGATION

Cost of Pumping for Irrigation.

(Staff Abstract.

There is a wide difference oftentimes between the actual cost of pumping and what it ought to cost. It is best, perhaps, to assume a set of conditions conforming to good practice and to exhibit the costs under these conditions. This will be done for two separate cases, one in which the actual or static lift is 40 ft. and the other in which the lift is 100 ft. For our purpose the former may be called a low lift proposition and the latter a high lift. In each case the costs will be shown for three plants, namely a gasoline engine plant, an oil engine plant and an electric plant. The following assumptions will be made regarding the cost of wells, the pumps, the engines, the fixed charges, the acreage and duty of water, the fuel and the attendance.

ASSUMED CONDITIONS.

Cost of Wells.—This cost is exceedingly variable. In Pinal and Maricopa counties from $800 to $2,000 is paid commonly for drilled wells, while in the township northwest of Willcox equally good wells are obtained for $300. Prices for drilling at San Simon vary from 50 cts. to $1 a ft., while in the Santa Cruz Valley the usual prices are from $3 to $5 a foot. A well which was drilled at Pantano for the Southern Pacific Co. cost over $8,000 and was abandoned because no water was developed.

The cost for the low-lift well will be taken arbitrarily at $800 and for the high-lift well at $1,200.

Pumps.—Centrifugal pumps will be assumed for both cases, a 5-in. horizontal single-stage pump for the low-lift and a 5-in. vertical two-stage pump for the high-lift. The horizontal type is preferable wherever the conditions permit its use. By depressing the engine in a pit and using an inclined belt, a horizontal pump can be set as deep as 25 ft. below the surface. The suction lift can be as much as 25 ft., but preferably not over 15 ft. Single-stage pumps with lifts of 100 to 110 ft. have been installed recently in several localities, but it is bad practice. On lifts greater than 70 ft. two-stage pumps should be used.

The size of the pumps adopted makes them suitable for irrigating any acreage up to 100 acres in Maricopa County or up to 150 acres at altitudes of 4,000 ft., as in the Sulphur Spring Valley.

It will be further assumed that pumps of superior design are selected. A 5-in. pump recently purchased for the University Farm showed 68.4 per cent efficiency when tested. Very few centrifugal pumps in Arizona, however, are giving more than 50 per cent efficiency, for the average rancher is not discriminating when he purchases pumps. A good rule is to buy an efficient pump and, if economy is necessary, then economize on the engine. For the present estimates, 60 per cent efficiency will be assumed for the pumps and 92 per cent for the belt transmission. The friction head in the piping will be taken at 2 ft. for the low-lift and 4 ft. for the high-lift.

Engines.—Gasoline and oil engines of the four-cycle horizontal type, with magneto ignition, will be assumed, each engine to be set in a heavy concrete foundation and to be housed in a small building of plastered adobe with galvanized iron roof. The equipment for the electric plant is to consist of an induction motor, a transformer, a meter and a small switchboard. The rated capacity of engines and motors will have 10 or 15 per cent margin above the load requirements. Fifteen horsepower will be required for the low-lift and 35 for the high-lift.

Fixed Charges.—These are depreciation, maintenance, interest, and taxes. These charges must be met whether the plant is used much or little. They are stated as percentages of the first cost and will be assumed as in Table I (p. 149).

Acreage.—The acreage considered will be 40 acres. Most Arizona pumping plants serve smaller areas than this, but as a rule the plants are operated much less than half the time. Pump irrigation implies intensive agriculture and high-priced crops, and under those conditions 40 acres is amply large for one ranch, but there is no reason why the plant described should not suffice for two adjoining ranches except for the difficulty of securing co-operation between the ranchers.

TABLE I.—FIXED CHARGES FOR PUMPING PLANTS STATED AS PERCENTAGES OF THE FIRST COST.

	Well.	Gasoline engine plant.	Oil engine plant.	Electric plant.
Depreciation ...	3.0	7.0	7.0	5.0
Maintenance ...	0.0	2.0	2.0	1.0
Interest	8.0	8.0	8.0	8.0
Taxes	0.5	0.5	0.5	0.5
Total	11.5	17.5	17.5	14.5

It may be argued that for 40 acres a smaller plant should be installed, say a 4-in. pump. But, any advantage in lower first cost is counterbalanced by the necessity of building a reservoir or the manifest waste of the irrigator's time in taking care of a small stream of water. It is difficult to get a small stream over 40 acres without a large percentage of loss by seepage from the ditches. Then, too, pumps of small size are of lower efficiency than larger pumps.

A different case is that of supplemental irrigation, in which the rainfall is depended upon in large part to raise one or possibly two crops a year. Under supplemental irrigation the plant described can serve a larger acreage than that already stated.

The fixed charges per acre are obtained by dividing the total fixed charges by 40, the number of acres irrigated. The larger the acreage irrigated from a plant, the smaller will be the cost per acre.

6. *The duty of water* will be assumed at 4 ft. depth per year, that is, 4 acre-feet of water per acre per year. Here again is illustrated the difficulty in stating costs of pumping. Were such costs to be based upon tests made in one locality they would be misleading to residents in other parts of the state where the conditions are radically different. As a basis of comparison the duty of water for alfalfa at five different places can be stated tentatively as in Table II.

TABLE II.—DUTY OF WATER FOR ALFALFA IN ARIZONA.

Locality.	Altitude. Ft.	No. of cuttings.	Depth of irrigation per year. Ft.
Yuma	100	8	6.0
Phoenix	1,100	7	4.5
Tucson	2,400	6	4.0
Benson	3,500	5	3.0
Willcox	4,000	4	2.5
Lakeside	7,000	2	1.0

The average duty of water in the Salt River Valley is higher than as stated in the table, due to the diversity of crops. Cotton and grain sorghums require less water than alfalfa, while the nearly worthless runout pastures of shallow-rooted grass require the most of all.

This Station measured the amount of water applied to one alfalfa field of 18 acres irrigated from a pumping plant. The total depth of application in 1914 was 9 ft. The stand of alfalfa was exceptionally fine and the yield was 8 tons per acre. But it is undeniable that much less water would have been ample if the field had been properly prepared to receive the water. Another field, on which 3.1 ft. of water were applied, yielded 4.5 tons of hay per acre. This field suffered for water.

Fuel.—It will be assumed that the engine distillate used in the gasoline engine costs 14 cts. a gallon at the nearest railway point, and 1 ct. a gallon will be added to cover hauling and waste, making 15 cts. a gallon at the ranch. Tops can be purchased at 5 cts. a gallon at the railway, making the cost 6 cts. a gallon at the ranch. The fuel consumption in both cases will be taken at 8 horsepower hours per gallon, an assumption which implies an engine in good condition and intelligent operation.

The charges for electric current will be computed according to the schedule of rates fixed by the Arizona Corporation Commission for all public service corporations. The rates per month are as follows:

First 100 kilowatt-hours, 10 cents per kilowatt-hour.
Next 100 kilowatt-hours, 8 cents per kilowatt-hour.
Next 100 kilowatt-hours, 6 cents per kilowatt-hour.
Next 200 kilowatt-hours, 5 cents per kilowatt-hour.
Next 250 kilowatt-hours, 4 cents per kilowatt-hour.
Next 250 kilowatt-hours, 3.5 cents per kilowatt-hour.
Excess 1,000 kilowatt-hours, 2.8 cents per kilowatt-hour.

The rates of the United States Reclamation Service in the Salt River Valley are considerably lower.

Lubricating Oil.—The cost will be taken at one-seventh the cost of fuel for the oil engine and an equal amount for the gasoline engine. For the electric plant the cost of lubrication of the motor will be quite insignificant, less indeed than that of the pump. Hence, a very small charge per acre will be made.

The Attendance.—It will be assumed that one-sixth of a man's time, at 25 cts. an hour, is required for the small gasoline and oil engines, and one-fourth of his time for the large engines, while for the small motor and horizontal pump one-fifteenth of his time is required, and for the motor-driven high-lift plant one-tenth of his time.

TABLE III.—COST OF PUMPING PLANTS OF SIX TYPES.

	Low lift—40 feet			High lift—100 feet		
	Gasoline engine.	Oil engine.	Motor.	Gasoline engine.	Oil engine.	Motor.
Well	$ 800	$ 800	$ 800	$1,200	$1,200	$1,200
Pump installed	200	200	200	720	720	720
7-in. piping and valve....................	65	65	65	120	120	120
Engine or motor installed.................	675	700	625	1,350	1,400	925
Belt, 6-in. and 10-in.....................	25	25	25	60	60	60
Oil tank, 3,000-gal. capacity..............	.....	100	.....	.....	100	.....
House	110	110	70	200	200	100
Total	$1,875	$2,000	$1,785	$3,650	$3,800	$3,125

TABLE IV.—COST OF PUMPING PER YEAR PER ACRE WITH SIX TYPES OF PUMPING PLANTS.

	Low lift—40 feet			High lift—100 feet		
	Gasoline engine.	Oil engine.	Motor.	Gasoline engine.	Oil engine.	Motor.
Fixed charges	$ 7.00	$ 7.55	$ 5.87	$14.17	$14.83	$10.43
Fuel (or current).........................	7.80	3.12	16.65	19.30	7.70	32.75
Lubricating oil	.45	.45	.20	1.10	1.10	.40
Attendance	1.33	1.33	.53	2.00	2.00	.80
Total cost per acre.......................	$16.58	$12.45	$23.25	$36.57	$25.63	$44.38
Cost per acre-foot........................	$ 4.15	$ 3.11	$ 5.81	$ 9.14	$ 6.41	$11.09
Cost per acre-foot per foot lift.............	$ 0.104	$ 0.078	$ 0.145	$ 0.091	$ 0.064	$ 0.11

COST OF PLANTS.

The cost of the six plants, based on the foregoing assumptions, are exhibited in Table III. The costs are based on current prices in 1914.

COST OF PUMPING.

The investment in the pumping plants being now shown in Table IV, it is possible next to compute the fixed charges per year for each plant and the fixed charges per acre. These fixed charges with the operating expenses, are itemized in Table IV. Besides the total cost per acre, the table gives the cost per acre-foot of water pumped and the cost per acre-foot per foot of lift. Thus, for the first plant the total cost per acre-foot is $4.15 and the cost of lifting that foot through each foot of lift is 10.4 cts.

Table IV shows at once the reduction in cost of pumping by substituting low grade distillates for gasoline. For the low-lift plant the reduction is $4.13 per acre, which is 25 per cent of the total cost of pumping with gasoline engines. For the high-lift plant the reduction is $11 per acre, about 30 per cent of the total cost with gasoline engines. With staple crops, the value of which is less than $75 per acre, these reductions are of critical importance. Under the assumed conditions, electric power cannot compete with either gasoline or oil engines.

For comparison, the cost of irrigating water in the Salt River Valley project of the U. S. Reclamation Service will be stated. The annual charge for four acre-feet is $2. To this must be added the interest at 8 per cent on the value of a water right, which, under the Tempe Canal, and doubtless throughout the valley, is not less than $100. The cost of water, therefore, is about $10 per acre annually. Under the Yuma project, also, and in the Upper Gila Valley the annual cost of water is about $10 per acre. In the case of large gravity systems with reservoir storage, the interest charge is the largest item of cost. The total cost shown in Table IV for oil engines on the 40-ft. lift is very little more than the total costs under the gravity projects. The slight difference is wiped out by other advantages of the pumping plant, especially the freedom from weed seeds. Pumping with lift of 100 ft. cannot compete with gravity projects.

It is observable that the cost per foot lift is slightly lower for the high-lift than for the low-lift. With the data given in the table it is possible to make close estimates for other lifts than 40 and 100 ft.

An alternative proposition for the high-lift plants is for a high efficiency double-acting plunger pump such as the Luitwieler or the Pomona. The heart-shaped cams of the Luitwieler pump produce a discharge of water that is continuous and steady and the load on the engine is uniform. Pumps of this class have efficiencies of 70 to 80 per cent. In the present instance a 14-in. cylinder with 18-in. stroke would be required, and a 25-H.P. oil engine would give sufficient power. The total cost of the pump and piping would be $3,100, and of the engine and belt $1,100. Comparing now with the centrifugal pump, the fixed charges on the increased investment of $1,900 would be $8.31 per acre, while the reduction in the cost of fuel would be only $2 per acre. Under other conditions, with higher lift and smaller capacity, the advantage would lie in favor of the reciprocating pump. The so-called propellor pumps that are on the market are as costly as the two-stage centrifugal pump. Their efficiency is not known.

THE FIXED CHARGES.

Reference to Table IV reveals the fact that the largest item of cost when oil engines are used is that of fixed charges. The total cost per acre with the oil engine on the low-lift is $12.45, and of this amount $7.55 is for fixed charges. Now it is not always clear to the rancher that there is any such item of cost. He may think that the only expense is for fuel oil, lubricating oil, repairs and maintenance, and possibly attendance. But, let it be supposed that he has borrowed the $2,000 required to sink the well and purchase the plant. Then every year he will have to pay the interest charge, at least $160, and this money must be charged against the gross income from the 40 acres just as truly and surely as the cost of the fuel oil. The interest cost, then, is $4 per acre, greater even than the cost of the fuel. Likewise the depreciation of the plant cannot be ignored. An internal-combustion engine will find its way to the scrap heap in 10 or 15 years whether it is used much or little. Engines and pumps soon become obsolete. At least 7 per cent of the cost of an engine should be earned each year as a sinking fund, so that in 10 years the engine will have paid for itself, or, so that the first cost will be available again for the purchase of a new engine. A rancher should not deceive himself by ignoring these fixed charges. As pumping is now practiced in Arizona the fixed charges are greater than all the other costs put together.

Suppose, however, that the pumping plant is used to irrigate 100 acres instead of 40 acres. The plant is amply large for 100 acres, but it must be run continuously night and day through the hot months of May, June and July. The fixed charges are a definite amount per year, and, if this amount is divided among 100 acres instead of 40, the charge per acre will be $3.02 instead of $7.55, and the total cost will be reduced from $12.45 to about $8 per acre.

Now comes a most important deduction. A pumping plant should be used all possible. This is the farmer's opportunity to reduce the cost of pumping. Manufacturers have made a big reduction by modifying their engines so as to burn cheap low grade distillates. The farmer can make another reduction equally large by using his plant instead of giving it so much rest and idleness.

It may be argued that, with the intensive agriculture usually practiced under pumping plants, a rancher cannot operate 100 acres. Then two or three ranchers should co-operate in one pumping plant. Under gravity systems each rancher does not have his own ditch from the river. One diversion dam and ditch suffices for a whole community. So, too, a 5-in. pump will deliver as much water as three families can use economically. Or, if a man wishes to apply all the water on his own quarter-section, let him lease parcels of land with water. A common contract is for providing land, water, and seed to a tenant and receiving half the crop.

In conclusion, it should be repeated that Table IV is based upon many assumptions. But the author personally is familiar with the majority of pumping plants in Arizona; he has tested many of them during the past eight years, and has consulted with hundreds of ranchers and has consulted with hundreds of therefore, that the above discussion is the fairest presentation that it is possible to make of the cost of pumping in Arizona.

Extract from a bulletin by G. E. P. Smith, Irrigation Engineer, University of Arizona Agricultural Experiment Station, Tucson, Ariz.

An Interesting Example of Ditch Digging by Blasting.

Contributed by F. W. Wilson, Manager Agricultural Division, E. I. Du Pont de Nemours Powder Co.

For several years it has been quite a problem for farm owners to find labor to dig open ditches. It is hard, disagreeable work, which the ordinary laborer will not accept if he can find any easier way to earn his daily bread. As a consequence, many farmers have lately taken to blasting their ditches with dynamite. The hard work is done by the powder. Contractors haven't taken hold of the new idea to any great extent as yet, probably because a contractor considers it necessary always to figure costs very closely before bidding on a job and and, as a result of widely differing soil conditions, it is difficult to estimate in advance what it is going to cost to blast a ditch.

It has remained for Lee W. Acheson, a Salem, Ore., ditch contractor, to take the bull by the horns with characteristic western nerve. He took the contract for digging a ditch measuring 5 2/10 miles in length on the Miller Drainage District tract in Marion County, Ore. The contract price agreed on was $1.41½ per rod for digging ditch where the right of way was cleared. Cost of clearing right of way was to be $300. The contract was awarded and the contract price fixed upon as a result of a series of demonstrations or tests made by the Watt Shipp Powder Co. of Salem. The latter concern were given the contract to furnish the explosives.

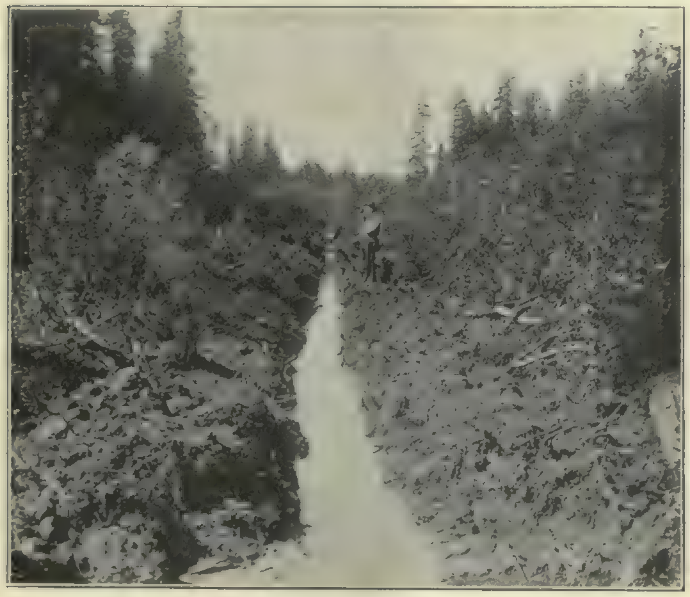


Fig. 1. Ditch Blasted Through Thick Underbrush.

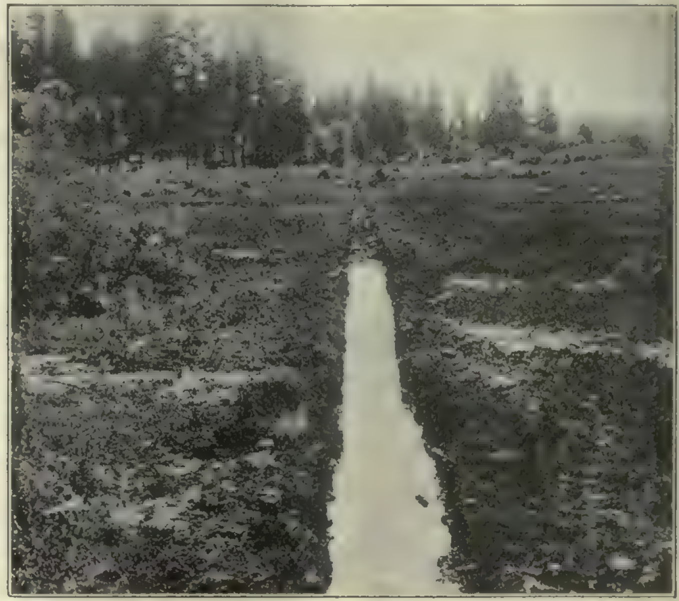


Fig. 2. Ditch Blasted Through Open Swamp.

There were four other bidders for the contract, the bids ranging from $1.43 to $2.65 per rod.

The finished job consisted of approximately five miles of main ditch and about a mile and a half of laterals. A little over 6,000 lbs. of 60 per cent Straight N. G. dynamite were used. One-half a stick weighing ¼ lb. was loaded in each hole. The holes were spaced 18 ins. apart and were 18 ins. deep, excepting where stumps and matted roots were encountered. At such places heavier charges were used. This loading resulted in a ditch 4 ft. wide at the top and 3½ ft. deep.

Illustration, Fig. 1, shows a mile stretch of the ditch blasted through thick underbrush and plainly indicates the practicability of disposing of stumps, roots and logs, as well as dirt, by single chain blasts. Imagine digging a ditch through this tangle with machinery or by hand! Illustration, Fig. 2, shows a section blasted through an open swamp. While working on this section of the ditch, 600 ft. were blasted out in two hours by a crew consisting of one powder man, two men placing the charges and one man connecting up the electrical connections.

On account of the many logs encountered under the soil, it was deemed advisable to use three electric blasting caps, placed at intervals in each 150-ft. section to prevent a hidden log checking the propagation of the charges. This crew of four men blasted 1,800 ft. of ditch in eight hours under very adverse conditions.

The success of this experiment has induced favorable consideration of the formation of another drainage district in Marion County, Ore., that will involve the blasting of about 25 miles of ditch.

Doubtless a little experience will enable contractors to estimate costs of proposed blasted ditches as closely as they are now able to figure on hand and ditching machine work. This point settled, blasting will probably become an established method of digging ditches of dimensions not to exceed 6 ft. in depth and 15 ft. in width, for there are advantages connected with it that make it worthy of attention. When labor is scarce, when time is a factor and when soil conditions, or stumps or underbrush in the right of way, make the use of ditching machines impossible or difficult, blasting can be resorted to with every prospect of success.

Method of Computing Run-off in Draining Irrigated Lands.

Contributed by H. C. Miller, Bishop, Calif.

The drainage of irrigated lands, in localities of little rainfall, present difficulties much more complicated than those which allow the use of precipitation records and run-off formulas and factors.

The source and movement of the damaging water are the most important factors affecting the design of a drainage system. In the southwestern part of the United States the amount of rainfall is practically negligible and may be disregarded entirely. Percolating water moving laterally through pervious strata resulting from the seepage of canals, ditches and laterals, the downward movement of irrigation water from the tract being irrigated and the upward movement through pervious strata having considerable depth and a distant source at a high elevation, are usually the causes of the injury.

The writer has used various methods in determining the source and movement of this damaging water and has finally adopted, as the most satisfactory, the following method:

In all drainage investigations a survey should first be made, from which a contour map can be drawn, showing the amount and direction of the slopes, the location of natural and artificial features that may influence the design of the system and the dimensions of the tract as a whole.

The source of the water which enters the land under consideration must next be determined and to best secure this information, a series of borings should be made at regular intervals of 200 feet or less, beginning at the upper edge and working down. A fence post auger, constructed like a clam shell bucket, with an adjustable handle, has proved the most satisfactory. This auger bores a smooth even hole and allows the soil to be brought to the surface without being very much disturbed, a point well worthy of consideration in subsoil investigations. Two men can bore 300 feet of holes in a working day, through soil varying from sandy to clay and gravel. By means of these test borings the position of the water table and the depth to and of the various strata can be determined and recorded.

Usually the fluctuations of the water table reach their maximum in spring and investigations should be carried on at this time. All calculations should be based on the rise of the plane of saturation within the period of average maximum rise, and field observations extending over this period may take from two to four weeks.

Carefully plot the positions of all of the test holes on the contour map along with the various data obtained during the field work.

This done, we are now prepared to begin our calculations. For the sake of illustration let us assume that the average maximum rise of the water table in the lowlands where drainage is required was found to be 3 ft. and that the average porosity of the soil was 25 per cent, then a rise of 3 ft. in the water table corresponds to a depth of 0.75 ft. on surface. Taking this rise as a basis, the quantity of water to be drained from one acre is 43,560 × 0.75 or 32,670 cu. ft. and

$$\frac{32{,}670}{30 \times 24 \times 60 \times 60} = 0.01260 \text{ cu. ft. per second,}$$

or inversely removing 1 cu. ft. per second we will drain a little less than 80 acres.

It is now an easy matter, knowing the quantity to be discharged and the grade of the proposed drain lines to figure the size of ditch or tile required to carry the water. The most satisfactory formula for the flow of water in canals or tile lines is that of Kutters, which when substituting the proper value for "n" allows a wide range of use. Care must be taken to keep the velocities down to such a point that no damage will result from erosion.

Method of Rock Drilling for Dredge Excavation in Land Drainage.

Contributed by C. N. Olson, Duluth, Minn.

Work on part of a system to drain a large acreage of rich agricultural land has been in progress during the past winter at Dancy, Marathon County, Wisconsin. This is being prosecuted by private enterprise, and consists in widening and deepening the Little Aux Plain River, a tributary of the Wisconsin River, commencing at the County Road Bridge, near the old Altenberg & Stoddard Mill, and extending a little over one mile west.

Owing to the cold weather ranging down to 20° below zero, the contractor had many difficulties to overcome as most of the work was through rock of varying qualities. A distance of about 600 ft. was through solid granite, and it was comparatively easy going through this, but then they ran into an extremely hard quartzite, which was very much fractured, making it difficult to get the drill holes to the required depths. The contractor, Mr. Arthur E. Buzzo, of Ishpeming, Mich., used Jackhamer drills on this work.

The Butterfly Jackhamer, as this machine is called, was found very satisfactory for this rock work, on account of its light weight, ease of handling, and speed of drilling. The drill weighs about 45 lbs. and is fitted with a T-handle permitting the operator to get a good grip on it. The steel, which is hollow of ⅞-in. hexagon stock, is rotated automatically through the medium of a rifled piston mechanism. Cushion springs take up the hammer blow, and a steel retainer spring, which is detachable, is fitted to the end of the cylinder. As the steel used is fitted with a collar, this retaining spring is effectively used in working the steel up and down in the drill hole and preventing it from binding. The retainer is also used to good advantage when withdrawing steel from the hole.

After running into the quartzite, the Jackhamer showed its superiority over the heavier piston tripod drills, which, on previous jobs, this contractor had always used; for, as soon as they ran into a split in the rock, another hole could be started immediately with the small machine, whereas to start a new hole with the piston drill mounted on a tripod, would have taken considerably longer time. Moreover as the men were always working in from 1 to 2½ ft. of water, one readily sees the advantage of the light hand drill over the heavy and awkward tripod machine. A constant air pressure of about 100 lbs. was maintained at the machines.

As the rock was covered with sand and gravel for most of the distance, it will be interesting to note the method used to prevent this impedimenta from getting into the drill holes. A 2-in. casing, as shown by Fig. 1, was used to surround the steel, and a steel ring was shrunk loosely onto the collar of the drill steel, just tight enough so that the steel would not bind when rotating, and this effectively protected the collar of the hole from sand washing into it.

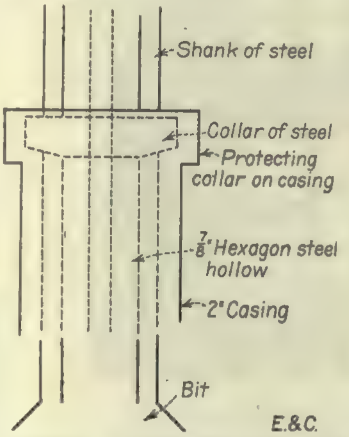


Fig. 1. Sketch of Protecting Collar Used on Drills to Prevent Wetting Operator.

The main trouble encountered in using the machine drill with the casing was due to the water and cuttings spurting up through the pipe and getting the operator wet. This, however, was finally best overcome by cutting a slot about the diameter of the steel in an old shovel, and holding this over the top of the casing. It must be remembered that the steel is hollow and that the exhaust air shoots down through it clearing the bottom of the hole and throwing the cuttings, and, in this case, water as well, out through the top of the casing.

A further difficulty encountered on account of the seamy nature of this quartzite was due to the bits having a tendency to stick in the bottom of the hole, and, as a result, an extra man had to be employed with each drill, with a couple of 24-in. Stillson wrenches, to turn the steel when the bits would stick; whereas, ordinarily but one man is required with each machine. Sometimes, also, the hollow steel would plug and freeze, but a fire was kept constantly going on the river bank to thaw it out in such an emergency. With all these unusual difficulties, the contractor figures that his drilling costs were only about one-half as much as they would have been had he used the heavier tripod piston drills. The average depth of holes was 6 ft.

A 60 per cent gelatin was used, as 40 per cent had been tried with very poor results. An idea of the hard weather conditions they worked under may be gathered from the fact that they operated a 45-ton dredge on the river ice from Jan. 5 to Feb. 25.

Outlook for Irrigation Construction.

Contributed by F. H. Newell, Head of Department of Civil Engineering, University of Illinois.

Contractors and engineers have been discussing the probability of a revival of construction work in irrigation such as prevailed several years ago. A careful study of the present situation gives little hope of any considerable amount of work being undertaken for a number of years. There will be of course the ordinary maintenance and extension of existing systems and the gradual replacement of temporary wooden structures by others, more permanently built of concrete, but there is nothing to encourage the belief that millions of dollars will be poured into new works.

The reason for this lies in the present economic situation, resulting from the rapid, almost mushroom-like growth of large irrigation systems during the past decade. While in one sense these only begin to touch the opportunities, and we may predict in the distant future other and larger works, yet today the country may be said to be over-developed in the sense that the effective use of these works has not kept pace with their construction. Literally millions of acres have been provided with irrigation systems (and the same is true of drainage), which are lying unused or only partly cultivated.

The owners of these lands either do not have the necessary capital to develop them and put them to use, or else do not find that they can raise and market their crops with profit.

The recent investigation by the Department of Agriculture, particularly by the Bureau of Farm Management, is showing that the average farmer, under irrigation, is earning only meager day's wages with perhaps 5 per cent on his investment. This includes usually the living obtained by the family. There is little to attract the purchaser toward the ordinary irrigated farm. This condition must prevail until there has been a better method of agriculture widely practiced, with the establishment of better markets and the creation of a more effective system of rural credit.

The present and the near future must be the time for slow, systematic growth and development of lands already irrigated, rather than, as in the past, of rapid building of additional works and bringing water to additional areas of desert lands. There are, of course, individual exceptions, but this statement applies to conditions in general. That this is generally known by financiers is shown by the fact that irrigation bonds and securities are no longer salable, and even meritorious projects are held back by the fear that when the lands are irrigated, there will not be an immediate market for the lands nor a system of agriculture such that the crops can be disposed of at a profit.

The system of agriculture which will win out, and which will enable the building of more works, is one which is based upon the principles now being studied and applied by manufacturers big and little. The successful farm is in part a factory conducted with reference to all of the details of economy of time, labor and materials which are employed elsewhere. The raw products are as a rule worked up into condensed form so that when sold the best price may be received. The irrigator who year after year raises and sells from his farm the field crops—alfalfa, grain, etc.,—is mining the soil and gradually consuming his investment. On the other hand, the "intensified" farmer, putting the labor of all members of his family to effective use, diversifying his crops, feeding them on the farm, producing the entire living of his family, and manufacturing any surplus into beef, pork, mutton, poultry, butter, eggs, etc., is making a good living and adding to the value of his investment. This process however, is a very slow one. Ten or twenty years or more may be required to get well started. In the meantime with this slow development, as above stated, there are available but unused millions of acres provided with water. Hence there is little inducement for investors to take up new schemes.

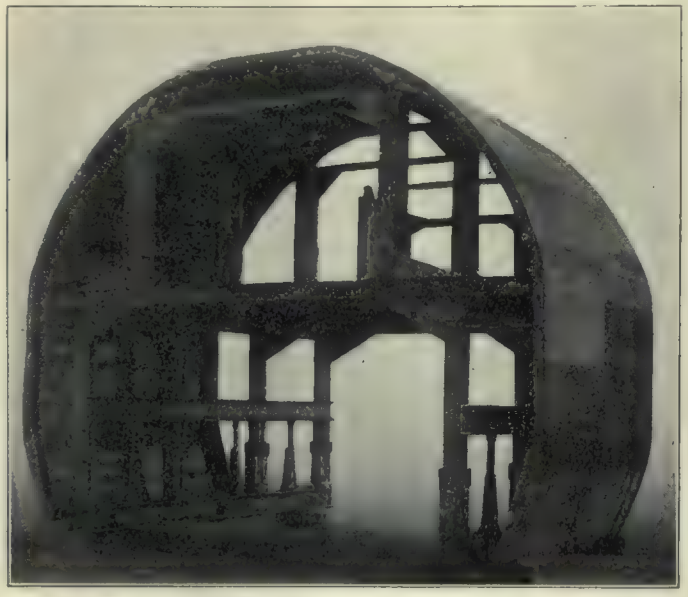
The present may be said to be the period in western development when efforts are concentrated on completing projects already begun or nearly finished, and on getting settlers upon the farms and putting lands to full use. This is probably the most difficult part of the undertaking and under present financial conditions doubly so. The order of the day is what may be called "salvage" of many wrecks. In the course of a few years the rubbish will have been cleaned away and well planned and constructed irrigation works will be on such sound basis as to justify additional undertakings. In the meantime the engineers may well turn their attention to more attractive opportunities.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A Large Telescopic Steel Form for Tunnel Lining.

The illustration shows a steel form 18x18 ft. constructed for subway work in Boston. This form is unusual because of its size and also because it is telescopic; the form is collapsible and capable of being moved through other forms while concreting is being carried on. The interior structural work seen in the illustration is not a part of the form proper, but is a carriage 15 ft. long, which is used entirely to transport the form proper. This form proper will stand and hold the concrete without any interior bracing. After the concrete has been placed around a 15-ft. section of these forms, the traveler, which is run on wheels on tracks in the base of the subway, is pushed underneath the form. The screw jacks at the bottom of the traveler are raised until the traveler engages the form itself; the turnbuckles are attached from the traveler to the form, and are then collapsed, pulling the form away from the concrete; the screw jacks are lowered, lowering the form away from the roof of the tunnel, and the 15-ft. section of form is rolled forward through the other forms, which are in position, and which are being concreted, and is re-erected in the next position.



Telescopic Steel Center for Lining Tunnel.

The plates on the forms are removable plates, that is, they are attached to the angles after the concrete is placed. These plates are 5 ft. long with the exception of the top plate, which is a key plate, and which is 2½ ft. long. At the top the concrete is rammed in from the end.

These forms are to be used by Patrick McGovern, Contractor, for constructing a single track trolley car subway in Boston.

They were built by the Blaw Steel Construction Co., Pittsburgh, Pa.

A Water Power Sewer Cleaning Device.

The helical cleaning blades of the Stevenson sewer cleaning device, illustrated herewith, are operated by water power. These blades revolve at about 600 revolutions per minute. A water pressure of 50 lbs. at the fire hydrant is sufficient to operate the power wheel, which is geared to a spider on which these cutting and scraping blades are attached. The machine is designed to remove deposits of any nature in the sewer barrel.

The operation of the machine is as follows: A cable is first passed through the sewer to be cleaned, from one manhole to the next one, by means of jointed sewer rods. The cable is then attached to the eye at one end of the machine and a fire hose is attached to the hose coupling shown at the other end. The cleaning device is then lowered into one manhole by a windlass and is slowly pulled to the other manhole by means of the cable passing over a second windlass over the second manhole. The water to actuate the cleaning blades and to wash the sewer wall is admitted through the fire hose. The cleaner is adjustable to clean sewers ranging in diameter from 6 to 30 ins.

View of the Stevenson Improved Sewer Cleaning Device.

The sewer rods accompanying the machine are made of Oregon fir dipped in carbolinum to make them waterproof. The clamp castings on the rods are made of malleable iron. The rods float and it is claimed that they do not become uncoupled and do not wabble while in service. The windlasses used are of all-steel construction with detachable gears. They are mounted on suitable 4-wheel trucks.

The device has been successfully used in varous cities during the last year. It is manufactured by W. J. Stevenson, 1720 Cedar St., Milwaukee, Wis.

A Gasoline Engine Shovel for Light Excavation.

(Contributed.)

The field for gasoline shovels obviously must be confined to the medium and lighter forms of excavating; and so, thus far this firm has confined itself to the revolving type of shovel. Marion gasoline shovels should be known as the single motor type, in which all operations are performed by power from one main engine and controlled by frictions of the outside band type. These frictions are operated by hand power and are so arranged with knuckles and toggles as to minimize the effort on the part of the operator. The frictions will be described in detail later.

The motor is of the constant speed, four cylinder, four-cycle, vertical marine type, with throttling governor control, jump spark ignition and high tension magneto. It is provided with water circulating pump and splash lubrication; and, by fitting it with the proper carburetor, can be operated on any fuel down to 39° Baume. It is designed for a medium high speed. A fly wheel is fitted between the engine and load to relieve the crank shaft of the inertia strains, due to sudden changes in torque.

Power is transmitted from the engine to a bevel pinion mounted on an extension of the engine shaft. The gearing is enclosed in a dust-proof casing and is run in heavy oil or grease.

The reverse motion necessary for propelling is obtained by means of frictions on a "re-

"versing" shaft, i. e., the right-hand friction turning in one direction, while the left-hand friction turns in the opposite direction. The lever for operating these frictions is so connected that moving it forward will propel the shovel ahead, placing it on center or neutral position will release both frictions, and moving to the rear position will propel the shovel backward.

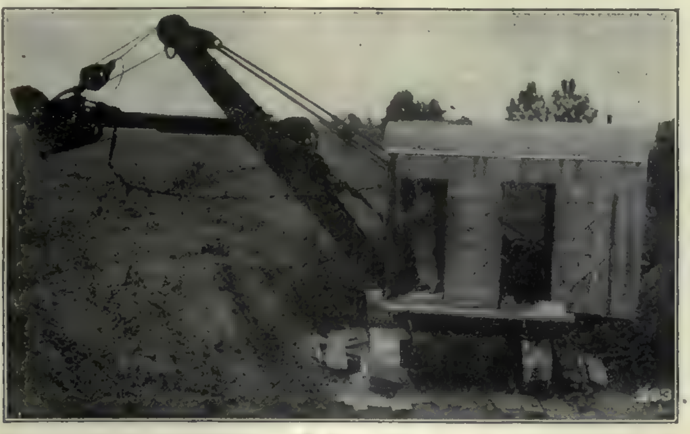


Fig. 1. Revolving Shovel Operated by Gasoline Engine.

While the primary purpose of the reversing gears is to impart a forward and backward propelling motion to the shovel, the hoisting, swinging and crowding motions must be transmitted from this same reversing shaft; and it is evident, therefore, that further means must be provided for throwing the propelling in and out of gear. This is done by a friction and gear mounted on the end of the hoisting drum shaft. The gear meshes with a gear keyed to a horizontal shaft running directly over the rotating center; the opposite end of this shaft carries a bevel pinion which engages the bevel gear on the vertical propelling shaft, the lower end of which is designed exactly as on a steam shovel.

The swinging mechanism, while not at all intricate in design, is rather difficult to describe, and is not easily shown either by blue print or photograph. The reversing shaft also carries a spur gear engaging a gear on the swinging or bull pinion shaft. On each end of this shaft is mounted a driver keyed to the shaft and a friction housing which is keyed to a gear mounted loosely on the shaft, and fitted with bronze bushings. This gear is actuated by an outside band friction—a duplicate of the one on the reversing shaft—and engages a gear keyed to a shaft directly below and forward. On the other end of this shaft, then, is keyed a bevel pinion meshing into the swinging crown gear, which, in turn, is keyed to the vertical swinging shaft. On the other end of this vertical swinging shaft—which is exactly as on a steam shovel—is keyed a spur pinion, which, in turn, meshes into the large rotating gear on the lower frame of the shovel.

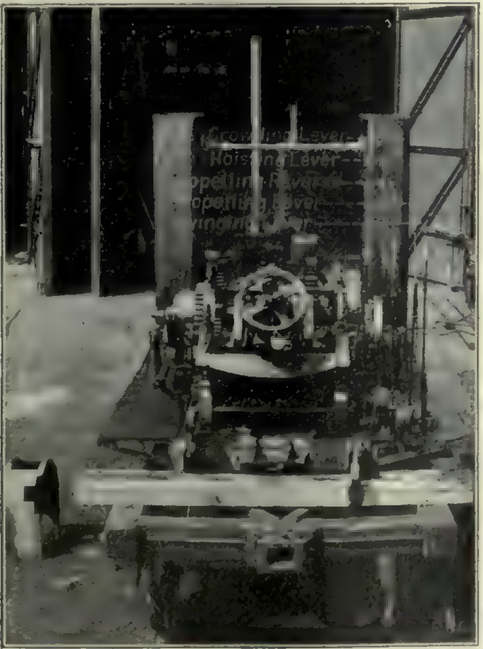


Fig. 2. End View of Operating Mechanism Showing Lever Arrangement.

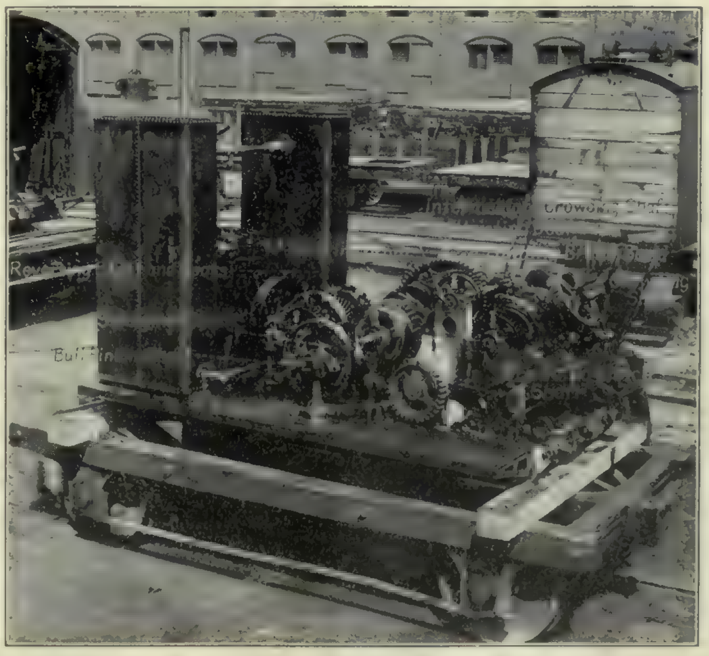


Fig. 3. Side View of Operating Mechanism Showing Essential Parts.

Now, since the same mechanism is applied at each end of the bull pinion shaft, and since the bevel pinions engaged the swinging crown gear at opposite sides, a reverse motion is obtained—as in the case of the propelling mechanism—simply by throwing in the opposite friction.

The hoisting drum is of the differential or "stepped" type instead of straight barrel, as used on the steam shovel. In steam shovel operation, where throttling engines are used, the speed of the engines and of the dipper can be varied; but, a gasoline engine is essentially a constant speed motor, and speed must be stepped down or up. Therefore, by designing a drum of small diameter on one end and large on the other a hard pull and slow speed can be obtained when the dipper is in the pit and an increased speed with lighter load when the dipper clears the bank. The hoisting friction is very similar in design to the frictions previously described.

Forward of the hoisting drum shaft, and connected to it by means of an intermediate shaft, is a set of reversing frictions, similar to the reversing shaft frictions previously described. These frictions control the movement—the crowding—of the dipper handle. These frictions are both controlled by a single lever arranged so that when it is in central position both frictions are released and a brake is set to hold the dipper handle in any position. The shaft leading from the frictions to the boom is provided with a telescopic joint to allow for the variation in height of the boom. It carries bevel pinions on each end, engaging bevel gears. The balance of the boom, being exactly the same as on a steam shovel, needs no further comment.

The control of gasoline shovels is identical with the control of the corresponding types of steam shovels, the levers having the same position and operating in the same manner. It is obvious, also, that the Marion gasoline shovel is a "one-man" shovel in the strictest sense, for the use of a gasoline engine instead of boiler makes a fireman unnecessary—neither is it necessary for the operator to leave the levers to look after the engine, for all control levers are within easy reach.

To convert the shovel into a single-motor electric shovel, it is only necessary to substitute an electric motor of the proper capacity for the gasoline engine; the rest of the mechanism is identical.

The shovel described is built by the Marion Steam Shovel Co., Marion, Ohio.

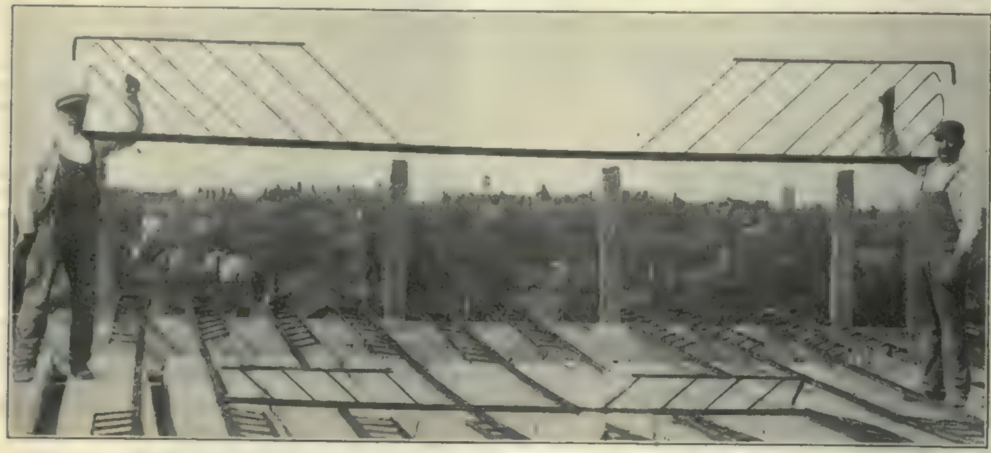
Fabricated Unit Reinforcement.

(Contributed.)

A detailed history of the development of concrete reinforcement would fill a good sized volume. In going over the development as a whole, certain features stand out most strongly. One thing always sought after apparently was mechanical bond. Rigidly attached web members were another. All endeavors seemed directed along the line of producing a true reinforcing unit, a rigid one-piece frame with no loose parts, so fabricated as to pass through the severest field handling. The idea was always to bring into the field a complete unit, reducing field fabrication with all its attendant uncertain factors to a minimum. Of interest in this connection is a new system of reinforcing recently placed on the market. In this system the auxiliary reinforcing members, such as diagonal tension and shear members, tie rods for walls, columns, etc., can be fastened to the main reinforcing members rigidly, safely and at a very low cost. The standard bar of this system is a troughed section. The upper or troughed part of the bar is a constant. Increased area is developed by simply making the section deeper as required. The bar used as auxiliary is practically a standard flat

¼x9/16-in., rolled, however, with knobs or corrugations on each edge.

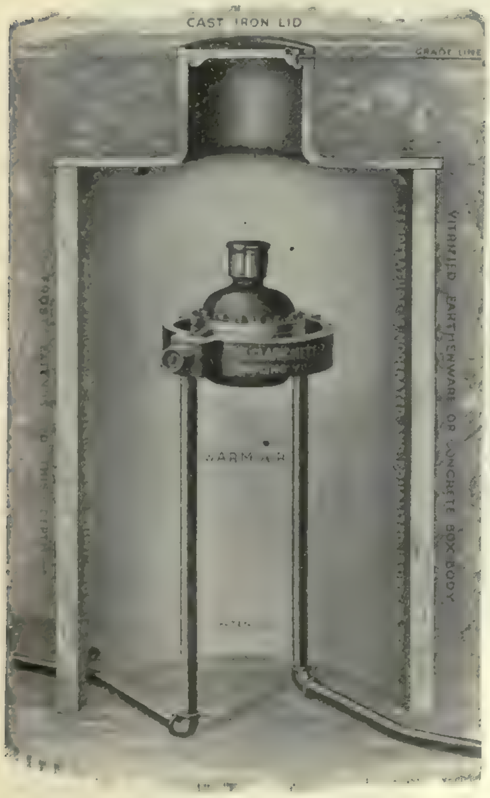
Fabrication is effected by placing a portion of the auxiliary flat, properly bent, within the trough and with a bulldozer or other pressure machine squeezing the wings of the main bar, gripping the knobs of the flat, practically riveting the auxiliary bar to the main section. Repeated tests, which have been carried on at Case School of Applied Science, demonstrate that this rivet grip, as it is called, is greater than the ultimate strength of the auxiliary member.


A New Fabricated Unit Reinforcement.

This material, which is known as Shop-Fabricated Reinforcement, has been used on high school and hospital work in Cleveland, Ohio. It has been invented by Armen Tashjian, consulting engineer with Walker & Weeks, Architects, Cleveland. The material is being marketed by The Shop-Fabricated Reinforcement Co., Cleveland, Ohio; Charles S. Beardslee, General Manager.

A Water Meter Coupling Yoke.

The Clark meter coupling yoke is made of cast iron and brass. It provides connection to the pipes without the use of union or right and left fittings. Meter and riser pipes are held rigidly and contact with the walls of the meter box is avoided. This protects the meter from freezing. The yoke facilitates expansion and contraction and relieves the pipes and meter of strains. There is a sliding adjustment for taking care of meters of different lengths. This device is used with any make of meter for ⅝, ¾ and 1-in. sizes. The yoke is particularly well adapted to service in the South, where the meter is placed on a line with the pipe. Instead of the risers shown street ells may be connected to the service pipe and screwed into the coupling yoke, and the parts may again be assembled without unions or right and left fittings. In installing the yoke in basement it is tapped on one end for the outlet side of the house supply.



Clark Meter Coupling Yoke.

In installing the yoke the service pipe is cut at one point and the ends of the service are bent in opposite directions until they are separated by a distance approximately equal to the length of the meter. These ends are then threaded, ells are screwed on and the risers are attached. The two parts of the coupling yoke, separated, are then screwed to the two risers. The brass slide section is then inserted in the yoke section. The yoke is manufactured by H. W. Clark Co., Mattoon, Ill.

Duluth Buys Privately Owned Water Meters.—All privately owned water meters in Duluth will be purchased by the city. The meter-owning consumers will be given credit for the value of the meters and will not be billed for water service until the credit so given is consumed. Mr. D. A. Reed, manager of the Duluth water department, recently told the city council that the city must own and furnish water meters to avoid embarrassment and inefficiency and the commissioners thereupon authorized the water department to take over the privately-owned equipment. Starting August 1, credit allowances are being made. It is calculated that the average meter will bring the owner from $5 to $8, while those that have been in use for more than four or five years will have a smaller value. There are about $8,000 worth of meters now privately owned. After the ownership of these meters is changed, the water and light department has agreed to bear the expense of ordinary repair and maintenance. Damages due to carelessness, however, will have to be paid by the consumers.

The Clark Water Meter Tester.

The Clark water meter tester tests all meters from ⅝ to 2-in. size. It is furnished complete as shown herewith, the outfit comprising the tester beam and percentage bar, the Fairbanks standard scale, the 100-gal. galvanized iron tank, and the tester table. The machine tests from one to six meters at a time. Self-cleaning valves are provided through which 1/32, 1/16 or ⅛-in. flow tests can be made. These valves are said to be free of the clogging trouble experienced with orifice plates. Gages for determining the pressure at both outlet and inlet are provided.

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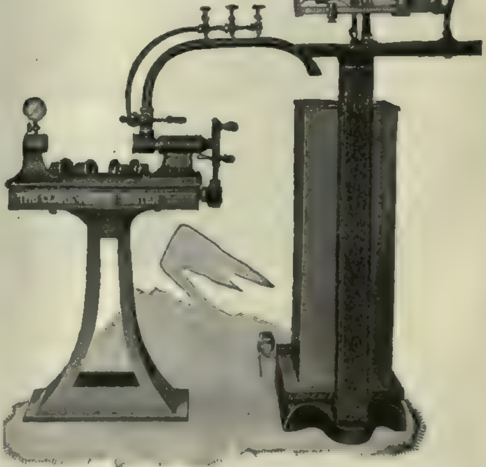
An important feature of the device is the quick acting percentage attachment for determining the percentage of error in the meter, especially equipped where desired with scale running up to 100 per cent. The tester is made in nine standard models in addition to special constructions to fit any unusual condition. The price ranges from $38 up. The Clark water meter tester is manufactured by the H. W. Clark Co. of Mattoon, Ill.


Clark Meter Tester.

CURRENT NEWS

8-19-14.

The Doings of the Week.

Business activities in general were well sustained during the past week. The torpedoing of the Arabic was the principal unfortunate happening of the week, although the storm at Galveston and other Texas cities caused great damage to property. Favorable developments in leading industries were conspicuous. It is expected announcement will be made in a few days of the consummation of plans for relieving the foreign exchange situation. In the construction field there has been little apparent slowing up of activities. Bids were opened the past week on many large developments and many other undertakings of considerable size reached call for bids stage. The first contracts for work in connection with the rapid transit developments of Philadelphia, Pa., were let and other sections of this improvement are being advertised. County road construction in the South and street paving for middle Western cities are offering many opportunities for contractors. Municipal water works and sewerage developments also are showing up well. In the metropolitan district of New York City building construction is much more active. The iron and steel trade showed further gain during the week. The U. S. Steel Corporation's ingot capacity is now over 94 per cent. For the first time in two years all furnace and rolling mill capacity at South Chicago and Gary is active. Foreign buying is still increasing and there is evidence that the export business will continue for many months. The demand for structural work is on the increase, and the Bridge Builders and Structural Society reports July business amounting to 86 per cent of the country's capacity. Domestic buying by the railroads was light. The Chesapeake & Ohio ordered 7,000 tons of rails: the Baltimore & Ohio placed orders for 1,000 steel hopper car bodies and the Atlantic Coast Line bought 800 box cars. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Aug. 18, were as follows:

Finished Iron and Steel— Per lb. to large buyers.	Aug. 18. Cts.	Aug. 11. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.........	1.459	1.40
Iron bars, Pittsburgh..........	1.30	1.30
Iron bars, Chicago	1.25	1.20
Steel bars, Pittsburgh	1.30	1.30
Steel bars, New York..........	1.469	1.469
Tank plates, Pittsburgh.......	1.25	1.25
Tank plates, New York........	1.469	1.419
Beams, etc., Pittsburgh........	1.30	1.30
Beams, etc., New York........	1.469	1.469
Skelp, grooved steel, P'gh.....	1.25	1.25
Skelp, sheared steel, P'gh.....	1.30	1.30
Steel hoops, Pittsburgh........	1.30	1.30
Sheets, Nails and Wire— Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.85	1.85
Galv. sheets, No. 28, P'gh....	3.60	3.85
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh..........	1.60	1.60
Fence wire, base, P'gh........	1.40	1.40
Barb. wire, galv., P'gh........	2.50	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15-in.; channels, 3 to 15-in.; angles, 3 to 6-in. on one or both legs ¼-in. thick and over, and zees, 3-in. and over, 1,30 cents.

Railways—No particularly interesting developments looking to the immediate undertaking of any large amount of railway construction manifested themselves during the past week. The Southern Railway is understood to have taken bids on double tracking between Greenville, S. C., and Center, 26 miles. It also is probable the Seaboard Air Line Railway will award contracts soon for the 85-mile extension from Charleston to Savannah, Ga. Plans for about 58 miles of railway for the city of San Francisco for its Hetch Hetchey water supply development are about completed and bids may be asked in the near future. The contract for the first section of the new rapid transit system of Philadelphia was awarded to the Keystone State Construction Co., at about $1,737,000. The Dock Construction Co., New York City, won a $1,692,371 contract for Section 2 of Route 29, in the dual system of rapid transit of New York City. The Vaughn Construction Co., Roanoke, Va., secured a $200,000 contract for an electric railway between Petersburg and Hopewell, Va. The Astoria Realty and Construction Co., New York, at $860,636 was low bidder for station finish on Route 16 and 18 of the New York rapid transit system.

Roads and Streets.—The usual amount of highway improvements and street paving came up for bids during the week. Ohio is asking proposals on a number of contracts. Massachusetts is advertising two sections and Illinois four sections. The County Commissioners at Pittsburgh, Pa., are asking bids for several miles ofroad work and the County Freeholder at New Brunswick and Newark, N. J., have some good jobs on which theyare now asking bids. Advertised street paving work includes 30 blocks of paving for Guthrie Center, Ia., 48,000 sq. yds. for Fremont, Neb., and about $500,000 worth of work for Philadelphia, Pa. Contracts for about 100,000 sq. yds. of asphalt pavement were let by Chicago. Other contracts let include 19 miles of gravel road in Mt. Carmel Road District No. 3 of Illinois; 4.8 miles of concrete road in Penn Township, Indiana; $88,000 worth of work for Lewiston, Mont.; and $76,500 county road job at Tacoma, Wash.

Bridges.—A considerable amount of bridge work reached the call for bids stage during the past week. Much of this is for small structures, but several good sized undertaking also are included. Hartford, Conn., is asking bids on a 160 ft. long, 55 ft. wide, concrete and brownstone bridge; New York state superintendent of public works, Albany, N. Y., opens bids Sept. 14 on two bridges over Cayuga and Seneca Falls canal; County Commissioners at Hamilton, O., are asking proposals for bridge over Miami river at Chestnut St., Hamilton. Provincial Road Commissioners, Halifax, N. S., are asking bids on 378 bridges and culverts for Victoria and Antigonish Counties.

Drainage and Irrigation.—Several notably large drainage undertakings in Minnesota are being advertised for bids. Rosean County opens proposals Sept. 3 on a judicial ditch estimated to cost $315,487 and requiring 2,453,105 cu. yds. of excavation. Beltrami County is asking bids on a 165 mile ditch, requiring 1,656,560 cu. yds. of earth excavation, and estimated to cost $244,142. Winston Bros. Co., Minneapolis, Minn., at $41,930, were low bidders on Schedules 1 and 2 of Nelson Reservoir, South Canal for U. S. Reclamation Service.

Waterworks.—Bids are being asked for constructing several fair sized municipal water works. These cities include Craig, Col., Whitehall, Mont., Bellville, O., Farmersville, O., and Miller, Ind. The Lincoln, Steele, Fleming Co., New York City, at $424,670 were low bidders for new water supply system for Watervliet, N. Y. M. W. Wilkes, Atlanta, Ga., was awarded contract for water works and sewerage at Warrenton, N. C.

Sewage.—Whitehall, Mont., is asking bids for constructing sewer system; Thermopolis, Wyo., also is asking proposals for similar work. Chanute, Kan., opens bids Aug. 31 for sewage disposal plant. Watertown, S. D., awarded contract for sewer work to cost $86,260.

Rivers and Harbors.—New work advertised by U. S. Corps of Engineers includes the following: Dredging Murderkil and Mispillion rivers, Delaware; 425,000 cu. yds. levee work about 6 miles above Natchez, Miss.; furnishing and placing riprap and repairing concrete superstructure on breakwater, Buffalo, N. Y.; dredging and rock excavation in Jamaica river, Va.; furnishing and installing operating machinery, etc., at Dam No. 29, Ohio River. Other work advertised includes a harbor and dock wal for New York state and a 350,000 cu. yds. levee job in Salem Parish, La.

Buildings and Miscellaneous.—A considerable amount of school construction is being advertised at the present time. A number of government buildings also are ready for bids. The U. S. Bureau of Yards and Docks is calling for proposals on four oil fuel storage stations. Rensselaer Polytechnic Institute, Troy, N. Y., opens bids Aug. 27 on seven dormitories and a dining hall. The County Supervisors at White Plains, N. Y., are asking proposals on an $800,000 court house. The Supervising Architect, Treasury Department, Washington, D. C., is calling for bids for various buildings for the quarantine station at Tampa Bay, Florida.

It's Usually That Way.

Over 220 bids asked items were printed in our last issue. This was the largest number of bidding opportunities so far this year, and is a pretty good indication of the great improvement in the construction field that has come about in the last few weeks. Since the first of July there has been a steady increase in the amount of work advertised for proposals. The gains in municipal lines have been especially gratifying. Public utility developments, even, have been placed under contract, and as for the railroads more work was let in the last four weeks than was awarded during the whole first 6 months of the year. The outlook for a busy late summer and fall construction season was particularly good. And then, of course, something had to happen. The inexcusable carelessness of the White Star liner Arabic in trying to sink a perfectly good German torpedo opens up new complications in our relations with Germany. What the final results will be no one can tell. Perhaps a peaceable solution will be found. In any case the happening of last week is a pretty good indication of the uncertainties of the present times.

Uniform Legislation.

Uniform legislation affecting construction operations in all states would prove a boon to the contractor. As it is now there are almost as many different laws as there are states. This is considerable handicap to the man taking work in various sections of the country. A step for the betterment of these conditions, at least so far as they relate to building operations, has been taken. At a meeting at Louisville, Ky., early this month plans were formulated for a new national association made up of representatives from 40 organizations of builders, which will have large powers to act for its members as distinct from the National Association of Builders' Exchanges. One of the primary objects of the new organization will be to seek uniform legislation in all states regarding building operations.

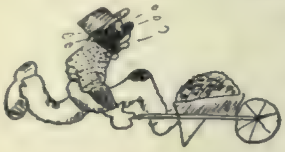
Corner Bead Dispute.

The corner bead—the sheet metal angle for strengthening plastering at the corners—is a small thing in itself, yet it has been the cause of much dissension in the building trades. In the Pittsburgh district building operations involving thousands of dollars have been tied up for some weeks because two unions could not agree as to which should have the honor of placing the beads. The Pittsburgh Plasterer Contractors had ordered the plasterers to put in the strengthening device. The American Federation of Labor held that this was work for the lathers. The dispute was submitted to a judge and he decided the lathers were proper persons to do the work. The unions can now return from their vacation and building construction can be resumed.

The Lighter Side of Engineering and Contracting

Sampling Eternal Fire and Damnation.

THE following is a story I heard while engaged on road construction in the Philippine Islands: A traveling salesman was in the dining room, trying to enjoy a dinner at the hotel in Iloilo, Philippines, when he espied some bottles of sauce upon another table. He called the proprietor and asked him if he would bring some of the sauce to him. The proprietor said he regretted that the sauces did not belong to the hotel, but they belonged to a missionary who had lately returned from China and India. The missionary happened to come in at that moment and told the traveling man to help himself. The traveling man took a liberal quantity of one sauce and another, ate a mouthful or two, choked, spluttered and showed other signs of distress. Then turning to the missionary he asked these questions: "I understand that you are a missionary?" "I am." "Then you preach everlasting fire and damnation?" "I do." "Well, my dear sir, allow me to congratulate you, for you are the first man I ever met who carried the samples."—R. C. S. W., Collinsville, Ill.



◆

A CERTAIN contractor has a habit of using somewhat emphatic language when anything goes wrong. His wife took him to task and finally persuaded him that the next time he had reason to bawl out his men he would say "God bless you" instead of the customary cuss words. A few days later he found one of his men loafing on the job and yelled to him: "Murphy, ye omadhaun, phaats the matter with ye. Get in there; pick up that shovel. God bless ye! —but—but ye know phat oi mane."

◆

"The Water Cure."

MIKE O'BRIEN, conducting a cornice works in a western city, secured the contract to install a galvanized iron tank at the State Insane Asylum. Specifications stipulated the tank should be 4 ft. high and 10 ft. in diameter, with a 6-in. outlet with necessary opening and closing valve. Thirty days after installation, Mike visited the institution to ascertain as to the suitability of the new facility. Upon approaching the superintendent of the asylum, he inquired for what purpose the tank served. The superintendent took O'Brien to the recreation grounds, where he observed one of the inmates vigorously carrying water, endeavoring to fill the tank. "You see, it's just this way, Mr. O'Brien," explained the superintendent, "when we are in doubt as to one's sanity, the 'Nut' is given the pail and informed if he will fill the tank, he will be discharged. However, we leave the outlet valve open; if he has sense enough to shut same he departs after filling the tank. That poor 'Nut'," smilingly added the superintendent, "has been trying to fill that tank ever since it was installed. —C. A. E., Los Angeles, Cal.

Street Improvement.

They took a little gravel,
And they took a little tar,
With various ingredients
Imported from afar.
They hammered it and rolled it,
And when they went away,
They said they had a pavement
That would last many a day.
But they came with picks and smote it,
To lay a water main;
And in time they called the workmen
To put it back again.
To run a railway cable
They took it up once more;
And, later put it back again,
Just where it was before.
They took it up for conduits
To run the telephone;
And then they put it back again,
As hard as any stone.
They took it up for wires
To feed the 'lectric light,
And then they put it back again,
Which was no more than right.
Oh, the pavement's full of furrows;
There are patches everywhere;
You'd like to ride upon it,
But it's seldom that you dare.
It's a very handsome pavement,
A credit to the town;
They're always digging of it up,
Or putting of it down.

◆

THE section foreman sent one of his men to the car for a tamping bar. The man failed to return and after a decent interval the foreman went to see what was the matter. He found the man fast asleep under a tree. Eyeing him with a stern smile the foreman said: "Slape on ye idle spalpeen—slape on, while ye slape ye've got a job, but whin ye wake up ye're out of wurrk!"

◆

Russian Strategy.

SOME years ago when the Southern Pacific was constructing its line on the West Coast of Mexico, experiments were made with Russian laborers shipped direct from Russia. The railroad having contracted a surplus of this class, turned them away. The United States government was constructing the Yuma Dam in Arizona at this time and suffered a shortage of laborers. A labor agent suggested the Russians be obtained. Fifty were contracted for as a test. They were brought into the United States from Mexico in bond. Some 30 Russians left in Mexico, becoming lonesome for their brothers over in the United States, quit and departed for the border. Immigration laws required each, before entering, to pay $2 head tax, pass a physical examination and have $35 United States money on his person. The leader was the only Russian fulfilling the monetary requirements. When the inspector inquired if he desired to enter, he replied in the negative. The following day he returned and entered. Unknown to the government his remaining fellow-countrymen were across the border in a few days. The leader had returned, loaning the $35 to the others, wherewith each, in turn, was worked across. In a few days there were additional Russian laborers available for the dam work. The contractor, using this class of labor, evidently benefited by non-requirement to pay a second bond on alien labor.
C. A. E., Los Angeles, Cal.

◆

JOHN SKEELS, the railroad contractor, a few years ago had a Scotch superintendent who had an uncommon liking for good "whusky." One day the chief engineer came over the work and met the Scotchman. Skeels asked his superintendent how he liked the boss? "Weel," replied the man, "I dinna like him much. He is too stingy. He started to pour me out a drink and told me to say 'when.' When my glass was two-thirds full, out o' politeness, I said stop, and d' ye ken he stoppit."

◆

A Voice from the Grave.

SEVERAL years ago while the Sixth Ave. Elevated R. R. in New York City was being built I was riding on the front platform of one of the old horse cars and heard the following: The car had stopped at the corner of 23rd St., and at the side of the track a gang of Irishmen were making an excavation for the foundation for one of the elevated columns. The driver of the car, thinking to get a "rise," called out, "Hey, Pat, what are you doing in the hole?" One of the laborers spit, looked at him and replied, "Shure, we're diggin' the graves av the strate car dhrivers." All present, except the driver, laughed.—W. W. S., Kenosha, Wis.

◆

Skinner Mulvey says: Whin a man gits married he halves his income and doubles his expenses. Johnny Connórs says if there is war he's goin' to enlist in the Salvation Army.

WATER SUPPLY FOR SAN DIEGO, CAL.

Proposed Purchase of System of Volcan Land & Water Co.

Cost of Completing Development Estimated at $2,871,950.

The city of San Diego, Cal., in order to secure a new water supply, has been considering purchasing the undeveloped system owned by the Volcan Land & Water Co. A study of this system has been made for the city by M. M. O'Shaughnessy and J. B. Lippincott, Consulting Engineers, and a report submitted to the City Council. In the report the value of the system in its present condition is placed at $2,880,625, including land and water rights. It is estimated that the cost of development to guarantee a minimum delivery of 10,000,000 gals. daily to the city would be $2,871,950. The cost of developing the entire system to a safe yield of 19,000,000 gals. daily would be approximately $6,500,000.

It is recommended that the following plan of development be followed: (A) The Pamo conduit (capacity 54 second feet) and the San Clemente reservoir should be constructed first so that a portion of the flood waters of the Santa Ysabel River could be diverted immediately to the city. (B) The Warner dam should be completed to such a height as to provide a depth of 90 ft. of water. (C) The conduit from the Warner reservoir (capacity 100 second feet) be built through a divide from the San Luis Rey River into the Pamo drainage.

It is stated the above development would guarantee the city the delivery of at least 10,000,000 gals. daily. The estimated cost is $2,871,950 and if built on a cash basis under efficient management, it is estimated that it will require two years for completion.

To procure the economic output of the system, ultimately the following construction is recommended: (D) Build the Pamo Dam to a full height of 170 ft., or if unforeseen difficulties should arise build this dam to a lesser height and complete the Sutherland dam to a height of 100 ft. (E) Construct a conduit to convey water from Warner reservoir power dam to Pamo reservoir with minimum evaporation losses. (F) Construct power plant on Warner conduit above Pamo.

The project as proposed by the Volcan Land & Water Company consisted essentially of the following: Construction of a dam at Warner Ranch on the San Luis Rey River. The water stored in this reservoir was to be diverted by means of a canal into the Santa Ysabel River upon which three reservoirs were proposed. The first is the Sutherland reservoir, the second (about five miles below) is the Pamo reservoir and the third (below Barnardo) is the Carroll reservoir.

The water from the Warner reservoir in passing into the Santa Ysabel drainage area could be distributed either to the Sutherland or Pamo reservoirs, from which the combined waters of Warner, Sutherland and Pamo are to be carried in a canal about 25 miles to the San Clemente regulating reservoir. This is about 13 miles from the center of San Diego and is merely required to carry sufficient storage to provide against any temporary interruptions to supply the reservoirs above.

From San Clemente the water would flow by gravity to University Heights reservoir in the northeasterly portion of the city. Regarding the Carroll reservoir development, the engineers in their report state that the cost of this development and delivery to city is so great that they do not believe it advisable at present to consider construction of this portion of the system.

It is recommended that the Warner dam be an earth fill structure constructed by the hydraulic process. The height of fill excluding the core wall trench would be about 105 ft. The dam would be 25 ft. wide at the top and practically 600 ft. thick at the bottom. The upstream slope would be 2½ to 1 and downstream slope 3 to 1. The foundation trench would be about 60 ft. wide at the bottom and would extend 20 ft. into solid rock. It would extend practically the entire length of the dam. The concrete core wall would be 3 ft. thick at the base and 1 ft. thick at the top, and would be built up to original ground surface. Test borings show that the underlying rock is badly broken so that it will be necessary to grout it. The outlet control is a reinforced concrete tower with gates and valves at four different elevations. The floods to be handled during the earlier period of construction would be discharged through a 13-ft. reinforced concrete pipe. The estimated cost of the Warner dam is as follows:

475,900 cu. yds. earth (allowing 10% shrinkage), at 27 cts.	$128,300
3,000 cu. yds. earth stripping on dam site, at 40 cts.	1,200
17,000 cu. yds. earth excavation core wall trench, at 25 cts.	4,400
26,000* cu. yds. rock and decomposed granite excavation in core wall trench, at $2.50	65,000
1,950 cu. yds. concrete in core wall, at $7.80	15,200
1,700 cu. yds. rock for crushing for concrete (rehandling from trench excavation), at 60 cts.	1,000
16,000 cu. yds. loose rock fill on downstream slope (rehandling from trench excavation), at 80 cts.	12,800
3,800 cu. yds. hand-laid riprap, at $2.80	10,600
4,200 cu. yds. concrete in flood control conduit (13 ft. diameter and 650 ft. long), at $19.40, including reinforcement	81,500
3,700 cu. yds. rock for crushing for concrete, at $1.75	9,100
Clearing reservoir site	5,000
Outlet tower, gates, pipes, etc. (including bridge)	17,800
Spillways†	13,500
100 grout holes, average deuth 90 ft.	11,300
Camp buildings, shed, shops, water supply, etc.	6,000
Camp maintenance and repairs	750
Plant	3,300
Local engineering and superintendence, 2%	7,700
Heavy plant, allowing 20% salvage value	20,000
Loss on labor transportation	1,500
Contractor's profit, 15%	62,400
Interest during construction at 4½%	21,500
Total cost of structure	$499,850

*Test borings indicate that probably 18,000 cu. yds. of this rock excavation can be used for loose rock fill on downstream slope and for crushing for concrete.

†Greater part of spillway excavation should be accomplished in obtaining earth for the dam proper. Figure given allows for finishing, trimming and lining, together with special concrete slab protection at ends.

The Warner canal which will convey water from the Warner reservoir will extend along the San Luis Rey River for a short distance and then by means of a tunnel through the divide will divert the water into the Santa Ysabel drainage basin, finally delivering it to the natural channel of Temescal Creek, from which it can be distributed to the Pamo or Sutherland reservoirs. The total length of canal, as proposed, is 6.6 miles, of which 6,200 ft. would be 6 ft. by 7 ft. concrete lined tunnel. The canal proper would be lined with 4 ins. of concrete and would have a 4-in. reinforced concrete slab roof for its entire length. The estimated cost is as follows:

22,250 lin. ft. of canal excavation (1 1/7 cu. yds. per foot), at 75 cts.	$ 16,700
Benching, at 60 cts.	13,300
4-in. concrete lining and 4-in. reinforced concrete roof (0.293 cu. yds. concrete per foot), at $8.10 per cu. yd.	52,800
850 ft. steel flume on trestle, at $7.10	6,000
Construction roads	4,000
County road changes	2,000
10,100 lin. ft. 6 ft. by 7 ft. concrete lined tunnel	211,100
Overhead charges, including engineering, contingencies, contractor's profit of 15%, extras, interest during construction at 4½ per cent	91,700
Total	$397,600

The Pamo dam would be an earth-fill structure, similar in all respects to the Warner dam. It would be constructed by the hydraulic process. The storm waters would be cared for by a 14½-ft. flood control conduit. The top width of dam would be 25 ft., bottom width 1,000 ft., length of crest 1,065 ft. About 1,961,800 cu. yds. of earth would be required in its construction. The estimated cost of the dam is as follows:

1,961,800 cu. yds. of earth (allowing 10% shrinkage), at 26 cts.	$509,900
10,000 cu. yds. earth stripping on dam site, at 40 cts.	4,000
120,000 cu. yds. excavation earth hardpan, decomposed granite, etc., in core wall trench, at 85 cts.	102,000
48,000* cu. yds. rock excavation in core wall trench, at $2.70	129,500
5,300 cu. yds. concrete in core wall, at $6.10	32,300
4,700 cu. yds. rock for crushing for concrete (rehandling from trench excavation), at 60 cts.	28,200
26,000 cu. yds. loose rock fill in downstream face (rehandling from trench excavation), at 80 cts.	20,800
9,700 cu. yds. riprap, hand laid (stone from trench excavation), at $1.35	13,100
8,500 cu. yds. reinforced concrete in flood control conduit (14½ ft. diameter, 1,100 ft. long), at $18.95	161,000
4,400 cu. yds. rock for crushing for concrete, at $1.75	7,800
Clearing reservoir site	3,500
Outlet control, gates, pipe, etc. (including bridge)	18,300
Spillways*	13,000
200 grout holes, average depth 60 ft.	15,000
Camp buildings, sheds, shops, etc.	7,000
Camp maintenance and repairs	3,500
Plant maintenance and repairs	4,000
Local engineering and superintendence, 2%	21,400
Heavy plant, allowing 20% for salvage value	25,000
Loss on labor transportation	1,800
Contractor's profit, 15%	168,300
Interest during construction at 4½%	72,500

*Greater part of spillway excavation will be accomplished in obtaining earth from dam proper. Figure given allows for finishing, trimming and lining, together with special concrete slab protection at ends.

The Pamo Canal would be used at first for conveying the Santa Ysabel flood waters and later the combined waters of Warner, Pamo and Sutherland reservoirs to the San Clemente regulating reservoir near San Diego. It would have a total length of about 25 miles and would consist mainly of three types of construction: Concrete lined and covered canal, steel flume, and concrete lined tunnel. The estimated cost is as follows:

47,951 ft. canal excavation (0.8 cu. yd. per foot), at 55 cts.	$ 26,400
Benching, at 50 cts. per foot	24,000
4-in. concrete lining and 4-in. reinforced concrete roof, at $5.80 per cu. yd.	66,700
37,080 ft. steel flume on bench, at $3.85	142,800
6,576 ft. steel flume on trestle, at $5.75.	37,800
24,386 ft. 5 ft. by 7½ ft. concrete tunnel, at $20	487,700
8,737 ft. low-head siphons, at $6.70	58,500
5,990 ft. high-head siphons, at $7.90	47,300
Total	$ 891,200
Overhead charges, including engineering and contingencies, contractor's profit at 15%, extras, interest during construction at 4½%	267,300
Grand total	$1,158,500

Studies of two separate types were made for the Sutherland dam. One of these was for an earth-fill structure; the other for a masonry arched structure with a gravity section. The earth fill type differs from the Warner and Pamo dams only in dimensions. It will have a height of fill, exclusive of trench, of 140 ft. The top width will be 25 ft., bottom width 700 ft. and the length on crest 900 ft. About 930,800 cu. yds. of earth would be required for this construction. The flood control conduit would be a reinforced concrete pipe, 12 ft. in diameter and 900 ft. long. The nature of the foundation and exposed bed rock at this site would seem to indicate that grouting would not be required. The estimated cost of the Sutherland dam of the hydraulic earth fill type is as follows:

930,800 cu. yds. of earth in dam (allowing 10% for shrinkage), at 26 cts.	$242,000
3,200 cu. yds. earth stripping on dam site, at 40 cts.	1,300
35,000 cu. yds. earth and decomposed granite excavation in core wall trench, at 75 cts.	26,100
33,000* cu. yds. rock excavation in core wall trench, at $2.70	89,100
3,200 cu. yds. concrete in core wall, at $6.30	20,100
2,900 cu. yds. rock for crushing for concrete (rehandling from trench excavation), at 60 cts.	1,700
18,000 cu. yds. rock for fill downstream face (rehandling from trench excavation), at 80 cts.	14,400
7,100 cu. yds. hand laid riprap, at $2.80	19,900
5,150 cu. yds. reinforced concrete in flood control conduit (12 ft. by 900 ft.), at $17.15	88,200
2,700 cu. yds. rock for crushing for concrete at $1.75	4,700
Clearing reservoir site	3,000
Outlet control, gates, pipes, etc.	16,300
Spillways†	10,500
Camp buildings, sheds, shops, etc.	6,000
Camp maintenance and repairs	3,600
Plant maintenance and repairs	4,200

2-mile road for hauling to dam site......	10,000
Local engineering and superintendence, 2%	11,200
Heavy plant, allowing 20% salvage value	20,000
Loss on labor transportation............	1,500
Contractor's profit, 15%..................	89,000
Interest during construction at 4½%....	38,400
Total	$721,200

*Probably 20,000 cu. yds. of this rock could be used for the loose rock fill on downstream slope and for crushing for concrete.

†The greater part of the spillway excavation should be accomplished in obtaining earth for dam proper. Figure given allows for finishing, trimming and lining, and special reinforced concrete slab protection at ends.

The site for the proposed masonry type of dam is about ⅜ mile below that for the earth dam. The height of the masonry dam from bed rock would be about 20 ft. greater than the earth dam. The structure would be built of cyclopean concrete, with about 20 per cent of the entire mass consisting of large rock plums. It is curved in plan, the radius of the crest being 400 ft. No special flood control preparations would be necessary for the structure, beyond the construction of the permanent outlet tunnel. This would be 5-ft. by 7½-ft. in size and 200 ft. long, driven through solid rock and lined with concrete if found necessary. The outlet control would be from a reinforced concrete tower. Spillways around the ends of the dam would be necessary. The estimated cost of the Sutherland dam of the masonry gravity arched type, is as follows:

92,500 cu. yds. 1:2½:5 concrete, at $6.30..	$582,700
23,000 cu. yds. rock plums, at $2.25......	51,700
48,000 cu. yds. rock for crushing for concrete, at $1.75...........................	84,000
7,400 cu. yds. rock stripping on foundation, etc., at $2.70........................	20,000
11,300 cu. yds. earth stripping on foundations, etc., at 25 cts.....................	2,800
Clearing reservoir site....................	3,000
Outlet tower, gates, pipes, etc...........	16,500
Outlet tunnel (5 ft. x 7½ ft. by 200 ft. long), at $20.............................	4,000
Bridge to outlet tower.....................	300
Spillways*	7,500
Camp buildings, sheds, shops, etc........	8,000
Camp maintenance and repairs	1,800
Plant maintenance and repairs..........	5,000
2 miles road for hauling to dam site.....	10,000
Local engineering and superintendence, 2%	15,900
Heavy plant, allowing 40% salvage value	22,500
Loss on labor transportation............	1,200
Contractor's profit, 15%..................	125,400
Interest during construction, at 4½%....	21,600
Total	$983,900

*Greater part of excavation for spillways should be accomplished in regular quarry work of obtaining rock for the dam.

The San Clemente dam would be a hydraulic earth-fill structure, 90 ft. high. The reservoir formed by this dam would be used merely to regulate the flow from the Pamo and Warner reservoirs. The dam differs in no particulars from the structures at Warner and Pamo. The total volume of earth required for its construction is 984,400 cu. yds. Here, as for the other dams, it would be necessary to provide ample spillways. However, the flood control conduit is not of so much importance, and a temporary flume probably could be used for the purpose. It is recommended that a pipe line be built from the reservoir to connect with the city distributing system. The estimated cost of this main is $125,000. The estimated cost of the San Clemente dam is $691,000.

IRRIGATION PROJECT FOR CENTRAL CALIFORNIA.

Proposed Development in Amador and Sacramento Counties.

Estimated Costs Range from $450,000 to $1,430,000.

A good-sized irrigation project is contemplated for lands in Amador and Sacramento Counties, California. Several thousand acres in San Joaquin County also may be covered in the ultimate development. The project as outlined takes in 12,000 acres on a foothill valley near Ione, and 23,000 acres in the vicinity of Galt. The possible addition from San Joaquin County is 25,000 acres lying east of Lodi. A preliminary investigation of the undertaking has been made by J. T. Whittlesey, Consulting Engineer, Claus Spreckles Bldg., San Francisco, Cal., and it is hoped to circulate petitions in the near future for the organization of a district.

The preliminary plans provide for a water supply from small streams in Amador County and a possible additional supply from the Mokelumne River. The reservoir site would be at Volcano, an old mining town. It is estimated that a 75-ft. dam would impound 19,000 acre feet of water, a 150-ft. dam 52,000 acre feet, and a 200-ft. dam 200,000 acre feet. For the distribution system the channel of Sutter Creek from Volcano to Ione could be used. It is recommended the main ditches be built with 3 ins. of concrete and that steel flumes be employed where it is not possible to use ditches.

Two plans are suggested for the project. As the first step in one of these it is proposed to utilize the runoff of the watershed tributary to the Volcano reservoir. By constructing a 125-ft. high dam 38,000 acre feet of storage would be provided. This would provide for 19,000 acres of land. A dam 75 ft. high could be built if it was desired to store up at the present time only a part of the Volcano watershed run-off. The latter construction would store water sufficient for irrigating 10,000 acres at Ione and would cost $450,000.

An increased supply could be obtained by making available an adjacent watershed of 40 square miles and by the construction of a ditch, flume and some short tunnels. This would furnish water for an irrigated area of 29,000 acres. The cost would be about $1,430,000. This would be the maximum development possible under the first plan and would be sufficient to irrigate the foothill area near Ione and the plains area near Galt.

The other plan provides for irrigation of the land near Lodi as well as that near Ione and Galt. Under the scheme a 125-ft. dam would be constructed to serve a district of 19,000 acres, as in the first plan. The additional supply would be obtained by driving a tunnel from the Mokelumne River to the Volcano reservoir. This would be about 5½ miles in length and with a diameter of 8 ft. would carry water enough to irrigate 52,000 acres. The estimated cost of this plan is $3,350,000. It is probable that the first plan will be adopted, and the Mokelumne tunnel scheme held in abeyance until some future time when the value of water for irrigation will justify the cost.

A $1,000,000 Esplanade Proposed for San Francisco.

An esplanade development to cost about $1,000,000 is proposed by the city of San Francisco, Cal. As outlined the improvements will extend along the ocean beach from the Cliff House southerly.

Plans have been completed by M. M. O'Shaughnessy, City Engineer, and as soon as his office and the Park Commission can agree on the inland lines for the protecting sea wall, the Board of Public Works will ask the Supervisors for authority to let contract for constructing the first section, for which an initial appropriation of $50,000 has been made. It is thought that 1,000 ft. can be constructed with this sum and when completed its necessity and usefulness will be so appreciated that the forthcoming appropriations will be larger in amount and an earlier completion of the entire project can be had.

The plans provide for a concrete sea wall to be sunk into the sand 11 ft. below low tide and which will be carried up on a slope 29 ft. long on a very flat angle to an elevation 15 ft. above the highest tide. At this point there will be a promenade 25 ft. wide. To the top of the wall the surface will be concave. At intervals of 100 ft. there will be landings 12 ft. wide with easy steps extending down to the beach and between the landings the slope of the wall will be stepped to form resting places.

The boulevard proper back of the 25-ft. balustrated walk will be 350 ft. wide, with foot paths for horseback riding and a smooth-paved surface for all kinds of vehicular traffic.

Contracts for Rapid Transit Construction, Philadelphia, Pa.

Bids were opened Aug. 16 by A. Merritt Taylor, Director of Transit of the city of Philadelphia, Pa., on the first contracts for the new rapid transit development of the city. One of these contracts provided for the construction of the City Hall section of the Broad St. subway. This will pass under the City Hall and the Market St. subway, and will involve some difficult underpinning work. The section is about 700 ft. long.

There were six bidders on the contract, five of them having their main offices in New York City. The other bidder, the Keystone State Construction Co., has its offices at 704 Pennsylvania Bldg., Philadelphia. The bidders, their lump-sum bid and their total bids, including the extras, were as follows:

	Lump sum bid.	Aggregate bid.
*Keystone State Construction Co.	$1,700,000	$1,737,320
The Foundation Co..........	1,720,815	1,763,870
Arthur McMullen Co........	2,250,000	2,286,060
Frederick L. Crawford, Inc., and Smith, Hauser & MacIsaac, Inc.	2,350,000	2,404,770
New York & New Jersey Construction Co.	2,449,000	2,486,980
Snare & Triest Co...........	2,758,000	2,787,240

*Awarded contract.

The other contract called for the erection of columnar supports along 26,000 ft. of the Frankford elevated line. On this work 10 bids were received, seven bidders being from Philadelphia and the remainder from New York City. The bidders, their lump sum bids and their total bids, including extras, were as follows:

	Lump sum bid.	Aggregate bid.
James D. Dorney*...........	$142,590	$149,235
Robert Lombardi*...........	149,000	155,150
Keystone State Construction Co.*	170,000	185,970
Edward Fay & Son*........	179,400	188,278
A. L. Guidone & Son†.......	190,000	202,334
Peoples & Rush*	227,000	235,240
Millard & Lupton Co.*......	260,000	273,150
New York & New Jersey Construction Co.†	282,200	290,450
American Paving & Construction Co.	307,000	315,640
Oscar Daniels Co.†.........	317,000	325,815

*Of Philadelphia. †Of New York City.

The City Council has appropriated $6,000,000 for these contracts and other contracts to be let later.

Status of Hetch Hetchy Water Supply of San Francisco.

Good progress is being made by the City Engineer's Department of San Francisco, Cal., in the development work in connection with the Hetch Hetchy water supply system.

Plans and specifications are about completed so that contracts can be let at an early date for the remaining 58 miles of railroad to connect the dam site to a point on the Sierra Ry., near Chinese Camp. Nine miles of this road already has been constructed and is now being used in conveying material to the place where initial work in the Hetch Hetchy will begin. The U. S. Government has approved of all the city's plans as to work, and in this respect matters are most satisfactory.

The Board of Public Works has requested the Supervisors to set aside $40,000 to provide funds for clearing the floor of the valley of timber and brush preparatory to flooding it with waters which will be held back by the diverting dam. M. M. O'Shaughnessy is City Engineer of San Francisco.

Double Tracking Contracts for Southern Ry.

The Southern Ry. is one of the few big trunk line companies of the country that have attempted any considerable amount of construction so far this season. A few weeks ago this company sold $3,500,000 bonds, the proceeds of which were to be used for double tracking on its main line between Washington and Atlanta, Ga.

Contracts for three sections of this work were awarded about three weeks ago. These covered 6 miles of line between Rock River and Concord, N. C., let to H. H. Thrasher, Knoxville, Tenn., and about 30 miles of line between Spartanburg Junction (Hayne) and Greenville, S. C., let to Cornell-Young Co., Macon, Ga., and the Morrow Construction Co., Atlanta, Ga., the latter company securing the section from Greer to Greenville, 13 miles in length. The aggregate cost of these three sections will be about $1,500,000, of which $260,000 is for the 6 miles between Concord and Rocky River. An idea of the work involved in this improvement is given by the statement that the Cornell-Young Co. contract includes 144,000 cu. yds. earth excavation, 110,100 cu. yds. solid rock excavation, 29,500 cu. yds. soft rock excavation, 26,500 cu. yds. loose rock excavation, 54,100 cu. yds. borrow and 8,500 cu. yds. concrete masonry.

It is understood that contracts for additional stretches of second track will be let in the near future. One of these sections lies between Greenville and Central and is about 26 miles in length. Bids on this are said to have been asked and it is probable the work will be let the first week in September. Another section that will come up for letting in the near future covers double tracking between Charlotte and Spartanburg. This will involve very heavy construction, particularly in the vicinity of Gaffney, S. C.

FUEL OIL STORAGE PLANTS.

Bids Asked on Four Stations for U. S. Navy.

Includes Pumps, Piping and Eight 2,100,000 Steel Tanks.

The U. S. Navy Department is to construct additional storage plants for fuel oil at various navy yards. Bids are now being asked for plants at Bremerton, Wash., Mare Island, Cal., San Diego, Cal., and Norfolk, Va.

Each plant will be capable of taking the most viscous commercial fuel oils from the tanker or barge pumps. The shore connection will lead through 6-in. flexible metal hose to the wharf pipe system and thence to the fuel oil heater on the end of the wharf approach, where the temperature is raised and the oil delivered to the pipe line leading through a heated insulated inclosure to the station pumps at the shore end of the approach. The pumps will deliver the oil to the tanks through the double line of oil pipes passing through a heated and insulated enclosure to valve chambers at the junction of each tank later with the main line. It will then go to the tank where it is discharged at the surface of the oil through a floating swivel outlet.

This outlet is a heater, the oil passing through the interior of the tubes, the steam being between the shell and the tube. In discharging the tanks the oil is heated under thermostatic control in the heater and flows thence by gravity through the same pipe lines that are used for filling the tank. It will be delivered by the station pumps through the pipe line on the wharf approach to the heater at the end of the approach where it will be cooled by sea water, pumped through the steam space of the heater and the oil delivered at a proper temperature to the piping system on the wharf.

Steam will be generated in an oil burning boiler plant at 200 lbs. per square inch pressure and will operate the main oil pumps and be exhausted into the fuel oil heating lines at 50 lbs. pressure. The cooling water for the approach heater will be supplied by a motor driven, vertical shaft, submerged centrifugal pump, located in the heater house at the end of the approach.

The "foam system" of fire extinguishing will be installed at each plant. At each pumping station two motor driven foam solution pumps will be installed. These will take their suction from the solution tanks located outside of the plant and will deliver to two pipe lines running to the tank.

The oil storage tanks will have a capacity of 2,100,000 gals. and will be enclosed in basins formed by earth embankment. The tanks will be about 100 ft. inside diameter and 32 ft. high from steel floor to top of side walls. They will be of steel throughout.

The more important items to be furnished include the following:

4 brick buildings for heating and pumping plants.
6 250-HP. oil burning water tube boilers.
3 300-HP. oil burning water tube boilers.
12 horizontal duplex fuel oil pumps.
8 motor-driven duplex foam solution pumps.
7 boiler feed pumps.
5 centrifugal sump pumps.
4 motor-driven centrifugal pumping units.
8 horizontal duplex fuel oil pumps with heater.
4 open type feed water heaters.
3 residue oil tanks, 11,000 gals. capacity.
4 4,000-gal. glass lined acid solution tanks.
4 4,000-gal. foam solution tanks.
4 1,000-gal. limewater tanks.
8 2,100,000-gal. fuel oil storage tanks.
16 swiveled floating special oil heaters.
3,100 ft. flexible metal hose.
40,050 ft. 5-in., 6-in., 8-in. and 10-in. screw pipe.
46,500 ft. screw and flange pipe smaller than 5-in.
4 chimneys.

The work also requires about 66,700 cu. yds. of excavation and 55,200 cu. yds. of back fill. There also will be about 3,200 cu. yds. of concrete construction.

Bids for furnishing and installing the piping, pumps, boilers, heaters, buildings and other work for the four stations will be received until 11 a. m., Oct. 16, by the Bureau of Yards and Docks, Navy Department, Washington, D. C.

A 5,260,000 Cubic Yard Government Dredging Job.

Bids were opened two weeks ago on one of the largest government dredging jobs that has come up for letting this year. The work involved dredging in the Delaware River on Bellevue and Cherry Island lighthouse ranges about 30 miles below Philadelphia, Pa. It was divided into three sections, Section F containing 1,555,000 cu. yds., Section G 1,875,000 cu. yds. and Section H 1,830,000 cu. yds. Seven concerns submitted proposals for the work; only two of them, however, submitted bids on the three sections. These were the American Dredging Co., Philadelphia, Pa., and the Eastern Dredging Co., Boston, Mass. The first mentioned firm was low bidder at 9¼ cts. on Sections F and H; its bid on Section G was 12.45 cts. The Maryland Dredging & Contracting Co., Baltimore, Md., bidding only on Section G, was low at 10.4 cts.

New Financial Plan for Seaboard Air Line Ry.

Under the new plan of financing for the Seaboard Air Line Ry., announced last week, the fullest development of the property will be possible. The Seaboard will be consolidated with the Carolina, Atlantic & Western R. R. The latter company is a consolidation of the North & South Carolina, Charleston Northern and South Carolina Western railroad, operating 416 miles of line. The Carolina, Atlantic & Western R. R. recently acquired the Georgetown & Western R. R., operating from Lanes to Georgetown, S. C., and from Andrews to the Pee Dee River, S. C., 70 miles. By the consolidation the Seaboard Air Ry. secures a low grade line from Hamlet, N. C., to Charleston. The new company will execute a mortgage authorizing an issue of $300,000,000 of bonds. Of the amount $22,893,000 of bonds have been issued and have been sold. Part of the proceeds of this sale will be used for the immediate construction of an extension from Charleston to Savannah, Ga., This will involve the building of 85 miles of railroad with a maximum grade of 0.3 of 1 per cent.

Water Works Picnic at Terre Haute.—For the past two years the employees of the Terre Haute, Indiana, Water Works Co. have held annual picnics on the pumping station grounds. The grounds are parked and form one of the city's beauty spots. The families of the employees attend these picnics and, if one may judge from a group picture of the picnicers, these outings are thoroughly enjoyed by all. As a good will builder among the employees these picnics possess an obvious business advantage quite apart from the recreation they afford.

PERSONALS

Mr. G. E. Byars, recently city engineer of Waco, Texas, has been appointed superintendent of buildings and grounds at the Agricultural and Mechanical College of Texas.

Mr. J. H. Lendi, formerly assistant to Mr. A. G. Carlson, mechanical engineer, Universal Portland Cement Co., has been given the title of electrical engineer in the engineering department of that company.

Mr. Carl Olson has been appointed city engineer and superintendent of water works for Rhinelander, Wis. Mr. Olson was formerly chemist and then engineer for a mining company. For a time he was geologist for the Wisconsin State Geological Survey on magnetic survey.

Mr. G. R. G. Conway, member of the Institute of Civil Engineers, and of the Canadian Society of Civil Engineers, who until recently was chief engineer of the British Columbia Electric Railway Co., Ltd., and the Vancouver Power Co., announces that he has opened offices at 409 Royal Bank building, Toronto, for consulting practice in civil and hydraulic engineering.

Mr. Arthur M. Torrey, for the past four years in charge of the soliciting department of Hildreth & Co., New York City, recently resigned that position to take charge of the engineering contract department of W. S. Barstow & Co., 50 Pine St., New York. This concern is engaged in engineering and construction work in various parts of the country and also controls the General Gas and the Eastern Power & Light corporations, operating some 40 public utilities in the eastern and middle western states.

Mr. George M. Lehman, chief engineer for the Lake Erie and Ohio River Canal Board, has been appointed by Governor Brumbaugh to represent the state of Pennsylvania at the Fifth National Drainage Congress to be held in San Francisco, Sept. 17 to 21, 1915. The coming Congress will make flood control a very prominent feature, and Mr. Lehman is strongly interested in that subject. At the meeting of the executive committee, held in Chicago last April, he was made fifth vice-president of the Congress and member of the committee on finance.

Mr. Joseph E. Love has been appointed engineer for the South Dakota Board of Railroad Commissioners, Pierre, S. D. Mr. Love attended both the George Washington University and the University of Wisconsin, but received his degree in electrical engineering from Northwestern University, where he attended during 1912-13. He was employed as laboratory assistant for the U. S. Bureau of Standards for one year during his college course. In 1911-12 he was engineer on breakwater construction for the Edward Gillen Dock, Dredge & Construction Co. For three years he was draftsman in the engineering department of the Chicago, Milwaukee & St. Paul. Since January of this year Mr. Love has been structural engineer for that railroad at Butte, Mont.

Mr. William A. Del Mar has resigned from the engineering staff of the New York Central & Hudson River Railroad to accept the position of assistant electrical engineer of the Interborough Rapid Transit Co. of New York City. His work will be on the new "dual system" subways, problems of operation, etc. Mr. Del Mar began his professional experiences in the testing department of the General Electric Co. in 1901. The next two years he was draftsman and inspector for the Manhattan Railway Co. at New York. Since 1904 he has been assistant engineer for the New York Central. Mr. Del Mar has taken an active interest in electrical standardization, as is shown by a list of the numerous committees with which he has been connected, and whose specifications have in several cases been widely adopted. He is also the author of "Electric Power Conductors," and of other technical treatises.

Mr. Edgar L. Tenny has opened an office as consulting engineer at 1642 Monadnock building, Chicago, and will specialize in bridges, buildings, foundations and derricks. Mr. Tenny has been with the Illinois Steel Co. for four years past, in the designing and estimating department on steel and concrete structures. During that time he made a specialty of derrick design, and purposes to continue specializing in that field in his consulting work. About two and one-half years prior to that he was bridge designer with the Chicago Northwestern Ry. Co. He was with the Indiana Steel Co. at the time of building the Gary, Ind., plant and served as an apprentice at Schenectady with the General Electric Co. in shops and testing department. Mr. Tenny graduated from the Iowa State College in 1904.

Mr. Walter F. Faber, civil engineer, is president of the newly organized Faber Engineering & Construction Co., which has recently opened offices at 410 Bessemer building, Pittsburgh, Pa. The firm will specialize in the designing and superintending of fireproof construction, and especially in sewage disposal plants. Mr. Faber was chief engineer for the Jones & Laughlin Steel Co. from 1908 to 1911, and as such superintended the construction of the town site and large plant at Woodlawn, Pa. During the following two years he was in charge of construction for the U. S. Government at Lock and Dam No. 7, Ohio River, located at Midland, Pa. Since 1913 he has been superintendent of construction for James L. Stuart on the new Rosenbaum building, the William Penn Hotel and the W. G. Johnston building, all in Pittsburgh, Pa.

Mr. Gardner S. Williams, consulting engineer, Cornwell Building, Ann Arbor, Mich., has opened an office in Chicago for consultation, designing and supervision of construction in hydraulics, hydro-electric development, water power and water supply. Associated with him are Mr. G. E. Ackerman, member American Society of Mechanical Engineers; Mr. K. K. Holland, Mr. A. E. Greene and Mr. L. E. Ayres, associate members American Society of Civil Engineers. Mr. Williams is a member of the American Institute of Consulting Engineers, the American Society of Civil Engineers, the Western Society of Engineers, the New England Water Works Association and the American Water Works Association. He is a graduate of the University of Michigan, civil engineering class of 1889. He has since held positions as follows: Engineer on construction of water works at Bismarck, N. D., Greenville, Mich., and Owosso, Mich.; civil engineer for the Board of Water Commissioners at Detroit; engineer in charge of hydraulic laboratory at Cornell; professor of civil, hydraulic and sanitary engineering at the University of Michigan, and member of International Waterways Commission in 1903-5. In 1911 he opened his consulting engineering offices in Ann Arbor and has become widely known in his field. The address of the Chicago office is 1018 Corn Exchange Bank Building, 134 South La Salle street.

CONTRACTORS.

The Ross Construction Co., Sacramento, Cal., which was recently awarded the contract for a large bridge at Red Bluff, Cal., has been in the engineering and contracting field for the past fifteen years. The company last year constructed the American River, Luten design bridge, at Sacramento, Cal., $120,000, and in 1913 built the Stoney Creek bridge, also Luten design, at Orland, Cal., $115,000. In addition it has built numerous other concrete and steel bridges, levees, wharves and foundations throughout California. The bridge at Red Bluff will comprise thirty-two 80-ft. concrete arch spans, with 21-ft. roadway and 4-ft. sidewalk. The contract price is $109,000. The firm is composed of Mr. Charles R. Ross and Mr. George G. Pollock.

CIVIL SERVICE NEWS

The New York State Civil Service Commission announces examinations as follows:

Laboratory Assistant in Bacteriology, State Department of Health, $720 to $1,200 per annum; open to non-residents and non-citizens. Required: Completed course in bacteriology and at least eight months' practical experience in laboratory work. Application must be in by Sept. 8. Examination, Sept. 18.

Expert Appraiser, Bureau of Special Franchises, State Tax Department, $3,000 per annum, Sept. 18.

Inspector of Masonry, $3.50 to $5 per day. Two years' practical experience as engineer, foreman or inspector on public works or other engineering construction, or five years' experience as mason; Sept. 18.

NEW CATALOGUES

Road Ripper.—Paper, 10x6¾ ins., 4 pp., The Austin-Western Road Machinery Co., Chicago.

Describes the Austin Road-Ripper, a scarifier attachment for use with the Austin Mammoth Graders. Illustrated.

Lubrication of Pneumatic Tools.—Paper, 6x9 ins., 8 pp., Chicago Pneumatic Tool Co., Chicago.

Bulletin No. 130 discusses the necessity of cleaning and lubricating pneumatic tools and the qualification of Airoilene oil for that purpose. Also shows Chicago automatic oilers.

Motor Trucks.—Circular. The Gramm-Bernstein Co., Lima, Ohio.

Describes Gramm motor trucks and shows the special features, such as transmission, interlocking device, worm drive, rear axles, multiple disc clutch, Ross steering gear, etc. Shows trucks used for various purposes.

Reinforcement.—Paper, 4x8½ ins., 16 pp., The Shop-Fabricated Reinforcement Co., Cleveland, Ohio.

Booklet No. 1, introducing shop-fabricated reinforcement or S.-F. R., and its special feature, the "Rivet Grip." Describes the material and its adaptations in detail with sketches and photographs, and suggests specifications.

Centrifugal Pumps.—Paper, 6x9 ins., 64 pp., Lea-Courtenay Co., Newark, N. J.

Catalogue H-2, describing the various types and sizes of Lea-Courtenay centrifugal pumps. Discusses the necessity of an efficient testing plant, inspection of parts, and details of pump design and construction. Gives tables of horsepower, speed, dimensions, etc.; illustrated.

Explosives.—Paper, 6x9 ins., 186 pp., E. I. Du Pont De Nemours Powder Co., Wilmington, Del.

Farmers' Handbook, giving instructions in the use of explosives for clearing and cultivating land, ditching and subsoiling, blasting telephone pole holes, road building, sinking wells and numerous other similar operations. Illustrated.

Steam Pumps.—Paper, 6x9 ins., 6 bulletins. Gardner-Governor Co., Quincy, Ill.

Circular P-9, 4 pp., describes the "Gardner Booster," a mud pump for rotary drilling in oil fields; illustrated. Circular P-3, 8 pp., describing Gardner Duplex Steam Pumps, boiler feeders and general service; illustrated. Circular P-5, 4 pp., Gardner compound duplex packed piston pumps; illustrated. Circular P-4, 8 pp., Gardner low service, tank, brewery and fire duplex steam pumps; illustrated. Circular P-10, 4 pp., Gardner feed pump and receiver; illustrated.

Service to Industry.—Paper, 6x9 ins.; 12 pp. Mellon Institute of Industrial Research, University of Pittsburgh.

Under the above title this booklet tells of the object, history, home, system, scope and success of the Mellon Institute, showing views of the apparatus, laboratories, machine shops, etc., with which it is equipped.

Hauling Equipment.—Paper, 6x9 ins., 30 pp. Orenstein-Arthur Koppel Co., Koppel, Pa.

Catalogue No. 911, describing Koppel hauling equipment for road building, including industrial railways and cars of various kinds. Describes construction of Wayne county, Michigan roads, Illinois highway work, shows "Koppel Movies," illustrating the various steps in road construction, shows the equipment, and gives tables of materials and definitions of road terms.

Jacks.—Paper, 6x9 ins., 24 pp., Templeton, Kenly & Co., Ltd., 1020 South Central Ave., Chicago.

"Bulletin Catalogue" No. 115 describing Simplex Jacks for steam and electric railroads, industrial, automobile, telephone and ordnance purposes. Cuts, specifications, data on capacity, lift, height, weight and price, and description of operation and uses for which it is designed are given for each of the numerous types.

Rod Benders.—Paper, 3½x6 ins., 6 pp. Folder. Electric Welding Co., Pittsburgh, Pa.

Pamphlet B., describing and illustrating the Efficiency Rod Bender, and giving lists of prices, agents and users.

INDUSTRIAL NOTES

J. O. Hobby, Jr., has been appointed treasurer of the American Locomotive Co.

Mr. C. D. McArthur, after more than a year's absence, has again assumed the office of chief engineer of the Blaw Steel Construction Co., of Pittsburgh, Pa. Mr. McArthur will be in personal charge of the Blaw Engineering Service Department, and all form problems requiring special design will be under his direct supervision.

The corporate name of the Marion-Osgood Co., of Marion O., manufacturers of steam shovels, dipper dredges, ballast unloaders and kindred machinery, has been changed to The Osgood Co. This change of the firm's name has been made in order to conform to the trade name "Osgood" which for some time has appeared on the company's shovels and dredges and other excavating machinery.

The Burd High Compression Ring Co., Rockford, Ill., manufacturers of Burd high compression piston rings, has appointed Mr. O. P. Hand as director of publicity. Mr. Hand comes to Rockford after 14 years' experience as advertising manager for the Minneapolis Iron Stove Co., a large manufacturing and jobbing concern of that city, and an extended connection as editor of a prominent trade journal.

The Mesta Machine Co., Pittsburgh, Pa., has just received an order from James B. Ladd, consulting engineer, Philadelphia, Pa., for a 1500 H. P. mill engine for the Broken Hill Proprietaries Co., Ltd., New Castle, N. S. W., Australia. The engine is for rolling mill service and is of heavy-duty tandem-compound Corliss valve type. This engine when installed will make the fourth unit that the Mesta Machine Co. has built for the Broken Hill Proprietaries Co.

CATALOGUE REVIEWS

Lumina.—Paper, 8½x11 ins., 48 pp., Detroit Steel Products Co., Detroit, Mich.

"Lumina," a new catalogue, just off the press, deals with export sash, Lumina solid steel windows, doors and partitions. The book contains up-to-date information on steel window problems, drawings showing construction details, tables of overall dimensions and photographs of installations.

Lumina sections, standard Lumina ventilators, standard types of Lumina sash, explanation and drawings of construction details, Lumina worm and gear operator, Lumina continuous monitor sash, Lumina steel channel doors, Lumina steel tube doors, fire escape doors, and partitions, are some of the chapter headings. All of these subjects are extensively illustrated.

Some typical installations are shown in the latter part of the book.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Testing the Qualifications of Applicants for the Position of Water Superintendent.

The questions asked the candidates for the position of water works superintendent at Kalamazoo are published in this issue. These are of interest, broadly speaking, as showing the trend to choose superintendents because of their knowledge of water works matters rather than for political considerations. Similar examinations have, of course, been held elsewhere in the secondary cities, notably, in recent weeks, at Niagara Falls, N. Y., and Fall River, Mass. However, the number of superintendents so chosen is believed to be, comparatively speaking, very small.

The Kalamazoo questions make interesting reading. Are they too easy or too difficult? Probably opinion will vary on this point. Certain it is that they are numerous, but the answers are quickly given and plenty of time was allowed the applicants to write out their answers.

One thing is clear enough and that is that a man would have to possess a fairly good general knowledge of water works matters to pass this examination. The examination would speedily eliminate those with little or no knowledge of the business, and, if honestly conducted, would debar such men from securing appointments no matter what their usefulness as political lieutenants.

We are of the opinion that all superintendents should be chosen on a civil service basis. To those who are competent the examinations would prove a very simple matter. This would protect such men and would tend to prolong their terms of office, especially since much weight should be assigned to training and experience.

In arguing for civil service regulation of water works operation we are taking for granted that the examinations will be honestly conducted and that the questions will be consistent with the knowledge requisite to satisfactory service in this field. Of course civil service is sometimes debauched, but where the disposition to do this exists bad conditions will flourish no matter what the details of the local governmental processes. Politicians' systems for "beating the civil service" are usually easily exposed. The wronged employe has no difficulty in getting a large and influential audience.

On Outlining Water Works Papers.

A few months ago the Committee on Statistics of Water Purification Plants of the New England Water Works Association virtually outlined the ideal description of a water purification plant. Twenty-one items were listed for the guidance of those who prepare for publication descriptions of filter plants. These items were quoted in an article published in this journal at the time the report was submitted, but they are here repeated to illustrate the broader subject of outlining other types of water works articles. The items follow:

1. City or town, and population at last census.
2. Name of owner.
3. Name of designer.
4. Date when plant was put into service.
5. Total cost, with statement as to what is included.
6. Source of supply.
7. Rated capacity.
8. Method of purification.
9. Total capacity of subsiding or coagulating basins.
10. Total capacity of filtered water basin.
11. What chemicals are used.
12. Where chemicals are applied.
13. How applications of chemicals are made.
14. Number of filter units.
15. Net area of filter surface.
16. Depths of filtering materials.
17. Sizes of filtering materials.
18. For slow filters,—arrangements for cleaning sand surface, sand handling, sand washing.
19. For mechanical filters,—method of cleaning filter beds.
20. Number of subsiding or coagulating basins.
21. How the rate of filtration is controlled.

These items indicate such evidently proper matters for inclusion in a description of a water purification plant that one would naturally take for granted that they would be covered in such descriptions. However, the committee found in going over the published descriptions of filter plants that a number of important facts were commonly omitted. So numerous are these omissions that the committee found it impossible to make compilations of even the most general data which would be adequate. Accordingly, to regulate such matters better in future, the quoted schedule of desirable data was prepared.

Many of these matters are so simple that the writer of a description is all the more likely to omit mention of them. Because they are so well known to him he is likely to forget that they are not equally well known to others.

The schedule is a formula in which the person acquainted with local conditions substitutes the local values of the variables. Obviously the utility of the formula consists largely in its aid to the memory—in reminding authors to include many simple matters which otherwise they might overlook in their attention to matters of exceptional interest. Of course, additional details should be given in virtually all cases, though these are likely to vary in their nature from place to place.

We think it likely that the principle of outlining articles, here illustrated, might advantageously be extended to other interests in the water works field. In technical literature, as in other commodities, the purchaser has a right to specify the character of the article he desires, in general terms at least. This would seem to be a proper function of water works and other engineering society committees when opportunity offers.

Such outlines are particularly helpful to inexperienced writers of papers for presentation before societies. The use of the formula will not operate as a check on originality in writing. In fact, its use is likely, by suggestion, to conduce to originality and to broaden the scope of the description.

The Bureau of Standards' Studies of Concrete Disintegration by Alkali.

Do alkaline soils and waters disintegrate concrete? This question has been debated actively by American engineers for at least a dozen years. The conclusions from their debates are that some concrete is disintegrated by alkali and other concrete is not, and that the concretes which best resist disintegration are those that are dense in structure and rich in cement. These conclusions are not greatly modified by the evidence of tests whose progress results are just now made public by the Bureau of Standards. Later, when the series of tests planned have furnished their evidence complete, we may expect conclusions of some quantitative value. Progress must necessarily be slow in any investigation of this sort and a year is not a tenth of the full time needed for definitive conclusions, but a year has told one truth which is that concrete not of the very best quality will go to pieces in certain concentrated alkali soils. This fact cannot longer be successfully disputed.

A brief outline of the plan of tests of the Bureau of Standards is as follows: Hand-made and machine made drain tile of various proportions of materials and various consistencies of mixtures have been molded by regulation methods and laid in soils having alkali salts of various characters and in various degrees of concentration. These tile have been laid in such soil in quantities which permit a few tile being removed each year until the last tile removed have been buried for ten years. As each year's quota of tile is exhumed other new tile are substituted. At the end of a decade, therefore, unusually complete evidence of alkali action on the tile will be available. Meanwhile concrete blocks will have been buried and consecutively removed to give evidence of resistance of mass concrete work. The two types of specimens fairly represent the two general forms in which concrete is used for irrigation works, namely mass concrete structures and thin walled concrete conduits.

The results of the first year's tests are naturally slender. They, however, indicate: (1) That drain tile of cement must be well made of good materials and rich dense mixtures if they are to endure in the most concentrated alkali soils; (2) that well made tile of 1 cement 3 aggregate will endure one year in concentrated alkali soil; (3) that well made tile of leaner mixture than 1 cement and 3 aggregate will not endure in concentrated alkali soil and it is possible that subsequent results will show that such leaner mixtures will not endure in soil having an appreciable amount of alkali; (4) that no other general conclusions may wisely be drawn from the tests made until results of succeeding years are obtained.

Can We Increase the Volume of Engineering Construction in Winter?

Winter in all northern latitudes is the slack season of engineering construction. The "construction season" closes with the first inclement weather of the fall. Until spring, man, plant and capital are idle or merely mark time. There are exceptions to general practice and they are important to note because they make clear the fact that it is habit and custom that have as much to do with the slackening of engineering operations in winter as does the inclemency of the weather. These in a few words are the conclusions of a committee of the Oregon Society of Engineers, which has been investigating winter unemployment in engineering construction. On the whole, the committee says finally, winter work is quite as economical for the taxpayer as that done in the summer season.

In making this claim of economy the conditions in the mind of the committee were those of the mild winter climate of the north

Pacific coast. It is proper to allow for these conditions but there are many northern latitudes where similar or not much more severe winter climate prevails and where winter work is equally feasible. Except in the most severe northern climate construction work is not prohibited by storm and frost for a season of three or four months. There are, in fact, not many days when the weather makes construction operations impossible. Cold makes these operations physically more difficult without doubt, and normally increased difficulties mean increased cost. Other things being equal, a yard of concrete cannot be placed or a yard of earth cannot be excavated with as little labor in cold weather as it can be done in warm weather. Does, however, a yard of concrete or of excavation necessarily cost more in cold than in warm weather?

The Oregon Society committee presents reasons for a negative answer to this question. In winter good labor is more plentiful since many high class men ordinarily busy in summer are looking for work. The contractor by winter work holds his organization together, doing profitable work instead of killing time. Finally, capital and plant are both producing instead of lying idle. These are economic advantages that help to counterbalance extra cost due to any greater difficulty of cold weather construction. For the community there are the further economic advantages of not having a large number of men idle during several months and of not having capital tied up so long in construction operations.

There is no rigid rule that may be used wisely to govern the time of all construction in all places. Winter construction is not always wise nor is it always wise to take for granted as fact that winter work is invariably to be avoided.

Diversified Experience and Systematic Study After Graduation.

A short time ago there appeared at the office of a well known Chicago contractor a young engineer in search of a job. This young man was a graduate of an engineering school and had been engaged in engineering work for three years. As there was little construction work in progress the contractor was unable to use another engineer—in fact at the time he was more in need of construction work than additional men. He was impressed with the young man's earnestness and evident ability, however, and asked him to call again in two or three weeks in case he was still out of work. In about two weeks the young engineer again presented himself and renewed his request for work. There still was no need for another man in the contractor's organization, but the latter had become interested in the engineer's case and questioned him concerning the disposition of his time since his former visit. The young man replied as follows: "After leaving your office I tried for two days to find a job in the kind of work in which I had spent most of my time since graduation. I was unsuccessful, however, and became convinced that I was merely wasting my time in tramping about the city so I went over to the John Crerar library (a technical library) and have spent most of the remaining time in studying the details of other branches of engineering."

The above incident was brought to our attention by the contractor himself, who in telling of it stated that his experience with young engineering graduates had been unsatisfactory, due mainly to the fact that each man seemed to be possessed with the idea that he was a specialist in a particular branch of engineering work and was not interested in general engineering work. The contractor commended this young applicant upon his good sense in seeking to acquire knowledge in other branches of engineering and in not being afraid to act as his own teacher. He ended by stating that the young engineer referred to had gained his engineering education in a foreign technical school.

We believe that the above incident may well be given serious attention by recent graduates of and teachers in the engineering schools of this country. We venture to assert that the average graduate of technical schools—situated as was this young man—would not have spent his time to as good advantage. Rather he would have considered himself sufficiently well equipped by his training in college and would not have seriously assumed the task of further educating himself. Those who teach in our engineering schools—or rather those who direct the teaching, but who unfortunately are unable to give much time actually to teaching—are partly to blame for not impressing upon their students the need for continued, systematic study after graduation—study in which the graduate must be both teacher and student. It may also be well for engineering teachers to bear in mind that early specialization in any branch of engineering work may prove of decided disadvantage to the engineering graduate later on. The young engineer who specializes early in a single branch of engineering, and neglects to master general engineering principles and practice, will be fortunate if he ever is in a position to reap the reward of his efforts. The man who hopes to achieve great success as an engineer must obtain a sufficiently varied experience to enable him to appreciate the problems of those with whom he must deal; he must also realize early in his career the need for continued, systematic study after graduation.

The Miracle of Nation-Wide Telephone Service.

Although published statements have been made that nation-wide telephone service will be accomplished before long, we had not seen an authoritative, definite announcement of the fact until we read Mr. John J. Carty's testimony in a recent telephone case (June 15, 1915), before the Railroad Commission of Wisconsin. Coming from the chief engineer of the American Telephone and Telegraph Co., the following quotation should be of interest:

> Before much more than a year is out it will be possible to talk from Milwaukee to every city and point of consequence in every single state in the Union, no matter how far away that point may be.

This will be a truly marvelous accomplishment, yet the general public has become so accustomed to witnessing unprecedented performances in the world of electricity that even a nation-wide telephone service is likely to attract scant attention. We must, in fact, look to the utter failure of similar attempts at long distance telephony in Europe if we would appreciate the thing that Mr. Carty and his staff of engineers have accomplished. There has been no single brilliant invention to which may be attributed their entire success in making it possible to talk from New York to San Francisco. As to this we can do no better than to quote Mr. Carty again:

> Certain European scientists had attempted to accomplish the problem of long distance telephony and their method of solution was to make changes in the instruments at the subscriber's station. When I was at the Congress in Paris there were several of the ablest men there who were working hard on that problem. The general staff [i. e., the engineering staff of the American Telephone and Telegraph Co.] studied it and decided that no amount of work or time put in in that way would ever be successful. We determined that while we must have the best of [transmitting and receiving] instruments we can get, all things considered, and while we have got them, that the solution was to be obtained by paying attention to all the details, and everything pertaining to the line and the intermediate apparatus and the switchboard and to improving telephone repeaters and relays. European scientists attacked the problem from one point of view and we from the other. Now our efforts have been crowned with complete success, but the European methods of attack have not [succeeded] and will not.

One of the remarkable features of this achievement in long distance telephoning is the ability to use existing telephone instruments and existing exchange plans. Thus, without increasing the investment, except as to long distance or toll lines, the entire telephone service of America will soon be so broadened that Arizona may converse with Maine.

When sitting in New York a person takes up a telephone receiver and there flows into his sound-funnel a stream of perfectly intelligible words whose fountain is in San Francisco, there comes realization that a miracle of engineering achievement has been wrought. Three hours of the sun's travel apart are two men. The voice of one starts delicate airwaves that move a thin diaphragm of iron; delicate electric waves are generated, flash three thousand miles and impart an identical motion to another diaphragm, which speaks into the listening ear. The telephone has always been a marvel, but its greatness grows with the distance of its effectiveness.

In the face of these accomplishments in telephone development in America, there are well-meaning politicians who urge government ownership of the telephone system, and point to Europe as an example of what America should do! Of all the ironies! They ask us to take pattern from Europe, which itself has patterned all it has in telephony upon the model furnished in America, and yet remains hopelessly outclassed as to quality and extent of telephone service. Politics, thou art a clown!

Eye Control of Consistency of Concrete Mixtures.

There is no better regulation of consistency of concrete mixture than the human eye if the vision be skilled and is conscientiously applied. Because skill and conscientious application are not common in men plentifully available for mixer operations, the automatic measuring tank has become a requirement of equipment of the concrete mixer. On the average it gives better results than the human eye. There has been talk recently of returning to the open mixer and the mixer operator's skilled judgment to control consistency. It is pointed and with reason that no prescription of number of turns and speed of turning and of a constant for wetting can equal the results possible with a skilled exercise of human judgment. The weakness of this reason is that it is an extension of the particular to the general. For certain concrete specifications the cost of skilled operations and of time required for such control is warranted, but it is not warranted for concrete work generally. The mechanical mixer, with automatic charging drivers and prescribed methods of operation, strikes a better average of concrete cost and quality than does any other means, for all but a few scattered purposes for which concrete is employed.

The Importance of Articles Giving Specific Data on Small Engineering Projects.

In a recent issue of Engineering and Contracting we published an article on the design, construction and unit costs of a reinforced concrete bridge, the article being the contribution of the superintendent in charge of construction. Certain introductory statements of the author are pertinent and an elaboration of them may be helpful. To quote:

> So much has properly appeared in the engineering journals regarding big contracts and great feats of engineering that one may feel few are interested in the difficulties of the "lesser lights." He of limited experience and financial resource often lacks confidence in the possible merits of his achievements; and perhaps justly so, for, even though the problems confronting him are, within the limits of his skill and plant, apparently insurmountable at times, they are of little magnitude and less importance to the public and to the big contractor. However, there possibly are small contractors who are displaying ability quite as keen as the larger ones. The following recital of facts, without claim to originality, ingenuity, or commensurate success in solving problems, is presented in the hope that some other "little fellow" may be somewhat guided or warned.

As indicative of accomplishment and of progress, the big feats of engineering and the big contracts have a proper place in our engineering literature, but it will be conceded that descriptions of such projects—necessarily incomplete—may be of little except news value to the average engineer or contractor. Large projects often require highly specialized knowledge and skill, but the financial backing of such projects is generally such as to insure the employment of men recognized for special skill along certain lines. The professional standing of such men is generally sufficient assurance that the investor's money will not be wasted. On the medium-sized and small job, however, we have no such assurance that the work will be handled satisfactorily, and our chief protection lies in the general education of the engineers and contractors engaged in this class of work, coupled with a better appreciation by them for the importance of their work.

We agree with the author of the statements quoted that small contractors often display ability fully as keen as the larger ones, as necessity often compels them to exercise the highest type of skill and ingenuity to complete a project with the inadequate equipment and backing at their disposal. It is difficult, however, to induce such men to speak or write of their successes and failures, due mainly to the mistaken idea that their problems are not those of the average man and to the tendency to under-rate the importance of certain work simply because of their familiarity with it. What is most needed in engineering literature are more articles which state facts and conditions as they actually exist, and a lesser number of those which include only that which is novel or is flattering to the author. The article referred to is worthy of mention because it is intended to be merely a "recital of facts, without claim to originality, ingenuity or commensurate success in solving problems." Its author is to be commended for his frankness in admitting mistakes of judgment and for expressing his honest opinion as to the value of certain methods of doing work and of certain kinds of equipment.

WATER WORKS

The Valuation of Water Works Properties.

V. Appraisal of Water Right Values.

By Halbert P. Gillette.

In the preceding article of this series the appraisal of reservoir site values was discussed. Closely related thereto is the appraisal of water right values. Three years ago two papers of mine on water right valuation were published in ENGINEERING AND CONTRACTING, appearing in the issues of April 17 and Dec. 4, 1912. The first of those papers discussed the question of the value of water rights where the water is used to supply a city or town with water for domestic, industrial and fire purposes. The second of the papers related to the value of water used for power purposes.

Whatever the use to which water is put the general methods of estimating the value of the water rights are the same. I am speaking now of commercial or exchange value—the price that a willing buyer would pay a willing seller for a thing rather than resort to the purchase of an alternative thing.

So little understood are the principles of economics by most people, that it is not surprising to find many who are at a loss how to value a thing upon which there is no market quotation. Water rights are not commonly quoted for sale, except in irrigation districts, so, in the absence of market quotations, it seems to many to be impossible to do more than guess at the value of water rights. However, as stated in the preceding article of this series, a criterion of the value of a given thing is the cost of securing the next best alternative that will perform the same function. The only limitation in the application of the alternative plant method of valuation may be stated thus: The market price of the product of the plant must be such that its net earnings give a normal rate of return on the cost of the alternative plant. Average prospective net earnings capitalized at the normal rate of return give the value of a productive property. It is conceivable, of course, that an alternative plant might cost so much that its product could not be marketed at a price that would yield a normal return on the cost. Obviously, then, the value of the plant could not equal its cost. But, within this limit, the alternative plant method of valuation is strictly applicable.

It follows, then, that if the gross earnings are not affected by the substitution of an alternative for any part of a plant, the correct criterion of the value of a part of a plant is found by the rule given below in italics.

In the fourth article of this series a mistake was made in wording the general rule to be used in applying the alternative plant method, although the illustrative problem was correctly solved.

Correctly stated, the rule for applying the alternative plant method of valuation is as follows:

Assuming gross-income to be unchanged by substituting an alternative part in a plant, the value of any part is the first cost of its most economic alternative plus the capitalized difference in their respective average annual operating expenses.

Expressed algebraically this rule is:

$$v = C + \frac{E-e}{R}.$$

It will be seen that this formula is the same as that given in the second article of this series (June 2) for estimating accrued depreciation, to which reference should be made. See also ENGINEERING AND CONTRACTING, July 14, for discussion of the depreciation formula.

We are concerned now with the application of this general rule to the appraisal of water rights. Certain water rights are owned, leased or otherwise controlled by a water company. Their value is in question. The appraiser must arrive at the value by considering the most economic alternative sources of water. Suppose the water company has a watershed from which it secures a water supply that is impounded near the city and is delivered by gravity. Two alternatives may present themselves: (1) Another but more distant watershed from which a gravity supply is obtainable, and (2) a nearby river from which the water must be pumped and filtered.

An estimate is made of the first cost and operating expense of each of these two alternatives, and of the corresponding operating expense of that part of the existing plant that would be displaced were either of the alternatives used.

The following example will illustrate the solution of such a problem. Let the first cost of the alternative gravity system be estimated to be as follows:

Watershed rights, 10,000 acres at $10 per acre	$100,000
Pipe line right of way, 16 miles	16,000
Headworks, supply pipe line and reservoir	460,000
Total	$576,000
Overhead charges and contingencies 30%	172,800
Total first cost	$748,800

Let the yearly operating expense, including maintenance, depreciation and taxes, be $23,000 on this alternative water supply system. Let the corresponding first cost of the existing supply system be:

Headworks, pipe line and reservoir	$400,000
Overhead charges and contingencies, 25%	100,000
Total first cost	$500,000

Let the yearly operating expense be $15,000.

Then, if a normal return rate is 8 per cent, the value of the existing supply system *including* its water rights and lands associated therewith is $\$748,000 + (\$23,000 - \$15,000) \div 8\% = \$848,000$. Since this includes the $500,000 first cost of the existing supply system, it follows that the water rights (and lands associated therewith) of the existing system are worth $\$848,000 - \$500,000 = \$348,000$.

Four important points are to be noted: (1) The estimated cost of acquiring watershed rights must be included in the first cost of the alternative water supply system but must be excluded from the first cost of the existing water supply system.

(2) The interest rate used in capitalizing the difference in operating expenses—8 per cent assumed in this case—must be a normal return rate on such an investment. It must not be a bare interest rate on well secured loans. The question as to what is a normal or fair return rate will be discussed in the tenth article of this series. If functional depreciation it not provided for in the operating expenses it should be provided for by increasing the normal return rate, and this is preferable where the water right values themselves are depreciable.

(3) Estimated allowances for contingencies should ordinarily be considerably higher for a plant not built than for one in existence, particularly where engineering and accounting records of the existing plant are fairly complete.

(4) If water is brought from a great distance a larger distributing reservoir is needed in or near the city than if the supply line is short. Breaks in a long line are more likely to occur, and the fire risk correspondingly increased if the distributing reservoir is small.

Where an alternative supply system involves pumping and filtration or other treatment of the water, the annual expenses when capitalized may become very great, and will correspondingly increase the value of the water rights of an existing pure, gravity supply.

Questions of metering the water may also enter the problem. It is commonly economic to meter a water supply that is either filtered or pumped, but it is frequently not economic to meter a gravity supply where the supply pipe lines are short, reservoir inexpensive and the water abundant.

Water right values may depreciate, either through the ultimate contamination of the water which necessitates filtering or other treatment, or through increase of the water consumption beyond the capacity of the existing water supply. The latter condition can be predicted with a considerable degree of accuracy, but in making such a prediction three factors should not be overlooked: (1) The possible reduction in water consumption through the use of meters. (2) Possible increase in the existing supply by damming existing streams and by diverting other streams. (3) The continued use of the existing supply even when a new supply system is eventually built. In brief, the appraiser should carry in mind the history of the growth of other water supply systems under similar economic conditions.

Under certain rather limited conditions the value of water rights for city purposes is to be measured by the value of water used for other purposes, such as irrigation or power. In several instances I have found that the market price of water for irrigation served to establish the value of water used for city purposes.

Occasionally, also, a water company may have recently purchased or leased water rights or water sheds. Such purchases or leases throw light on the question of water right values, but are not always conclusive in themselves.

Where water sheds have been acquired by purchase, the price paid has usually been several fold the value of the land for agricultural or other purposes. If three-fold, there is said to be a public utility factor or multiple of three. If satisfactory evidence can be secured with which to establish what the average utility multiple would be in a given case, this method may be used as a criterion of the value of water rights. Thus, if $300 an acre has been paid for watershed land worth only $100 an acre for farm purposes, it is evident that $200 an acre represents the cost of acquiring the water rights. In the absence of records of land purchases under conditions similar to those confronting the appraiser, it is usually not satisfactory to value water rights by the real estate method.

OBJECTIONS TO THE ALTERNATIVE METHOD OF APPRAISAL.

When a public service commission or court is called upon to decide the value of water rights, the inclination is either to reject all claims for such values or to allow merely a nominal value. The reasoning commonly used in rejecting water right values in a rate case is this: The city has granted the water company a franchise to sell water. Courts will not permit franchise values, which arise from capitalized profits, to be included in the rate-making base. Yet to allow a water right value is equivalent to allowing a franchise value, for in effect it permits the capitalization of profits that are securable only by virtue of the franchise.

Those who reason thus fail to realize where the very same sort of reasoning would carry them were it applied to any land owned by the company. Indeed the fundamental fallacy in their reasoning arises from the false assumption that by accepting a franchise a company tacitly dedicates all increment in the value of its lands to the public. Water rights are land entities, like coal, natural gas, etc. Hence it was inevitable that the Supreme Court would hold that water rights acquired by a company must be valued for rate making purposes, even as they have always been valued when condemned for public use. It is equally inevitable that a "capitalized profit method" must be used to appraise water rights, since, in the final analysis, land and land entities used to produce goods or services can be valued only by capitalizing the net revenues derivable from them. The "alternative plant method" above outlined is a capitalized gain method, but it does not result in capitalizing all the existing profits from an entire plant as does the appraisal of a franchise value by the capitalization method. It results in appraising water rights by precisely the same process that a parcel of land used for right of way may be correctly appraised.

CITATIONS OF COURT DECISIONS.

Whenever water rights have been acquired by condemnation by the public, payment has been made for the rights; but it has been urged by public utility commissions that. since rate-making cases differ from condemnation proceedings, water right values should not be included in the total value except at what the water rights had actually cost the companies. About a year ago (Apr. 27, 1914) the Supreme Court of the United States settled this question definitely. The Circuit Court of the United States for the Northern District of California had held that water right values should not be considered in making a rate for water used in irrigation. The U. S. Supreme Court reversed the decision, saying:

> Whether the [water] right was paid for, as the plaintiff says, or not, it has been confirmed by prescription and is now beyond attack. * * * Recurring to the fact that in every instance only a few specified indivduals get the right to a supply, and that it clearly appears from the latest statement of the Supreme Court of California, Palmer v. Railroad Commission, Jan. 20, 1914, that the water when appropriated is private property, it is unreasonable to suppose that the constitutional declaration meant to compel a gift of the former owner to the users and that in dealings with water appropriated for sale, it meant that there should be nothing to sell. (San Joaquin and Kings River Co. v. County of Stanislaus, Vol. 34, Sup. Ct. Rep. 653).

The Palmer case referred to in this decision is the case of Palmer v. Railroad Commission of California, 138 Pac. Rep. 9,997, from page 1001 of which I quote:

> The proposition that the waters of a non-navigable stream are in their nature private property and not property primarily devoted to public use is not only established by authority; it is demonstrable from well established principles of the law of real property. * * * This was decided as early as Hill v. Newman, 5 Cal. 446, 63 Am. Dec. 140. * * *
>
> These rights were, and still are, strictly proprietary and in their nature private. * * * They are no more public than is the land to which they belonged and of which they formed a part.

Acting under these decisions the California Railroad Commission has allowed values for water rights in several condemnation and rate cases, e. g. the case of the City of Glendale (Vol. 4, p. 1019, Opinions R. C. C.); the case of the San Jose Water Co. (Vol. 4, p. 1109, Opinions R. C. C.).

It will be noted that the U. S. Supreme Court decision above quoted overrules such older decisions as the following:

> When the water is appropriated for distribution and sale it is devoted to a public use and the community by paying the rate fixed for supplying it, is entitled to use it, without paying extra for a so-called water right. The right to appropriate the water in the first place, as well as the franchises to distribute it, are granted by the state and the water company will not be allowed to charge the public extra for this privilege. (San Diego Land and Town Co. v. City of Nat. City, 74 Fed. 79, 86.)

So also does the U. S. Supreme Court decision appear to negative any such reasoning as the following:

> It [the water company] is bound to take advantage of practicable natural facilities. If there is more than one source of supply, other things being equal, the community is entitled to have the least expensive one used. So long as the company enjoys practically exclusive franchises, so long it must afford the community the benefit of the conditions which nature has provided for them. For instance, if water can profitably be served from a nearer source of supply at a certain rate, the company ought not to be allowed to charge a higher rate, based on the expense of bringing it from a further and more expensive source. (Brunswick & T. Water Dist. v. Maine Water Co., 59 Atl. 537.)

It is interesting to note the uniformity with which courts have ruled that water power rights have value for taxation purposes. The following decisions are illustrative:

> In the appraisal of a water-power, as of other property, all the facts and circumstances affecting its value are competent to be considered. The assessors may consider the cost of equal power derived from other sources, that is, its comparative economy. (Winnipiseogee Lake Mfg. Co. v. Town of Gilford, 10 Atl. 849.)
>
> Is land upon which there is a valuable unimproved water privilege, where no power is being developed, to be assessed only for the value of the land, without the privilege? We think not. We think that, insofar as this land was made more valuable by the stream and fall, so far these were properly to be considered in the valuation of the land. (Saco Water Power Co. v. Buxton, 56 Atl. 914.)

This association of water rights value, with land value is repeatedly emphasized in court decisions. For example it is stated in the case of Manufacturing Co. v. Gilford, 6 N. H. 337 (see also 10 Atl. 849) that water power, or rights in a reservoir of water, are an interest in the land upon and by which they are created. Also in Kimberly & Clark Co. v. Hewitt, 44 N. W. 303, it is declared that water power, used or unused, is included within the meaning of the word "land."

In the Spring Valley Water Works case 192 Fed. 137, Judge Farrington allowed $2,100,000 as the value of the water rights.

The law as to acquiring ownership of water rights varies in different states, but, once the ownership has been acquired by a water company, there is no longer any doubt that the full value of the water rights must be given to the company either in condemnation proceedings or in a rate case.

Questions Asked in Examination of Applicants for Position of Water Works Superintendent at Kalamazoo, Mich.

(Staff Article.)

In 1914 a civil service amendment to the city charter was adopted in Kalamazoo, Mich. Under this enactment all city employes have been placed on a merit basis and are removed from political bias and influence. The step was taken, of course, to insure business efficiency in all municipal departments.

In the spring of the present year there was held a civil service examination of the six applicants for the position of water works superintendent. The questions asked are here given:

GENERAL SUBJECTS.

1. Give the date of your birth.
2. Where did you receive your grade school education?
3. Have you attended high school? How long and where?
4. What other academic education have you had?
5. Have you had any shop experience? State where, how long and what you did in the shop.
6. What experience have you had with pumping machinery? Where? What did you do and how long employed?
7. What experience have you had in laying water pipes? Where? What did you do and how long were you employed?
8. State any experience you have had which you think would qualify you as a water works superintendent.

PRACTICAL QUESTIONS.

1. What are the principal sources from which cities obtain their water supply?
2. How would you examine water to see that it was satisfactory for a city water supply?
3. How is water treated to remove mud?
4. How is water treated to remove vegetable matter?
5. How is water treated to remove bacteria?
6. How is mineral matter removed from water?
7. How far can water be lifted on the suction side of a pump?
8. How would you find a leak in the pump suction?
9. Explain the difference between a condensing and a non-condensing pump.
10. What does the condenser do?
11. What is the difference between a simple and a compound pump?
12. How would you inspect a boiler to see if it is fit for service?
13. If the level of the water in the reservoir of a water works plant is 175 ft. above the pumping engine, what is the approximate pressure at the station?
14. How is the amount of water pumped by a pumping engine controlled?
15. Explain the action of a turbine pump.
16. Why are water tube boilers usually used instead of return tubular boilers when the pressure in the boilers exceeds 125 lbs. on the gage?
17. Where pipes are buried in the ground why are cast iron pipes used in almost all cases?
18. Which would be the stronger, a cast iron pipe 12 ins. in diameter and with ½-in. thickness or a pipe 8 ins. in diameter with the same thickness of metal, and why?
19. What are the most common defects in cast iron pipes?
20. When cast iron pipes are manufactured why are they cast on end with the bell end down?
21. Explain how a lead joint is made on hub and spigot pipe.
22. What determines the depth below ground that a service pipe should be laid?
23. What is the largest size corporation cock tap you would allow in a 6-in. main, and why?
24. What would you do in question 23 if a very large tap were required?
25. Suppose in a certain portion of a city containing about 3,000 residents it is found at times of heavy demand that no water will flow in the second story. On investigation it is found that this section is being supplied by 5,000 ft.

of 6-in. main. What would you expect would be the difficulty?

26. In purchasing coal for a pumping station what are the principal points to be considered.

27. If in installing a pump it is found that the flanges on the pipe are not parallel with the flanges on the pump so that the 16-in. flange on one side is open ⅛ in. and on the other side opposite it is open 3/16 in. what would you do to close the joint?

28. In hiring a man to work for you as engineer or fireman what would you consider as the most important qualities he should have?

29. An important 12-in. main has a piece 12x3 ins. broken out of the center of a length of pipe. How would you repair it quickly?

30. What are the advantages in using meters in a water works system?

31. What would you consider the proper per capita limits in water consumption for a city of 40,000 people?

32. How would you proceed to find out if an excessive amount of water were being used in any section of a city?

The population of Kalamazoo was 39,437 in 1910. The superintendent's salary is $1,500 a year. The superintendent's official title is Chief Engineer and Superintendent of Water Works. He has charge of the operating end except for the handling of the meter and plumbing subdivisions of the department. The latter are handled directly by the Water Commissioner who also has charge of the financial end of the management.

As a result of the examination Mr. Wilbur F. Reed was appointed superintendent. Mr. George Houston is Water Commissioner.

The Kalamazoo Civil Service Rules are published in the volume of annual reports of the city for the year ending with April, 1915. Mr. A. E. Hughes is secretary of the Civil Service Commission, and we are indebted to him for the list of questions here given.

Design Features and Cost of Gravity Water Works at Mellen, Wis.

Contributed by W. G. Kirchoffer, Consulting Sanitary and Hydraulic Engineer, Madison, Wis.

The city of Mellen, Wis., has perhaps the most novel and unusual water supply of any city in the State of Wisconsin. Mellen is situated on the "Soo" road about 25 miles south of Lake Superior in a small valley adjacent to the range of hills which extends into Michigan, from which so much iron is obtained. The population of the city was 1,850 in 1910.

OLD RIVER SUPPLY.

For a number of years, Mellen has had a public water supply from the Bad river, but it was not fit for domestic use. Recently, the Peoples Water, Light & Power Co. was incorporated, took over the property of the old company, and constructed a new water supply and storage system with additional and larger mains.

NEW SPRING SUPPLY.

About two miles to the south of the city, in the above mentioned range of hills, are a number of springs, the combined flow of which approximated 250,000 gals. per day. These springs were found to have an elevation of 181 ft. above the business section of the city, and 140 ft. above the highest residential portion. It was, therefore, decided to use the springs as a supply of water. The works for utilizing this supply are here illustrated and described.

Gravity Pipe Line.—The distance from the southern city limits to the springs is 8,990 ft. To lay a pipe line for this distance of a diameter sufficiently large for a fire stream supply and to allow properly for the loss of head would have cost the company more than it was necessary or advisable to spend. It was, therefore, decided to lay a 6-in. pipe from a dam, where the spring could be collected, to the city, and to construct a reinforced concrete standpipe on a hill just inside the city limits so that the top of the standpipe would be slightly above the surface of the water in the reservoir at the springs. From this point to the northern limit of the business section a 10-in. main was laid. By this arrangement the standpipe furnished practically the same pressure as the dam at the springs did but had the added advantage of being near the city with a large main for the delivery of water in case of fire. These mains were also connected to the pipe line from the dam so that water could be taken from the reservoir supply should the standpipe be empty.

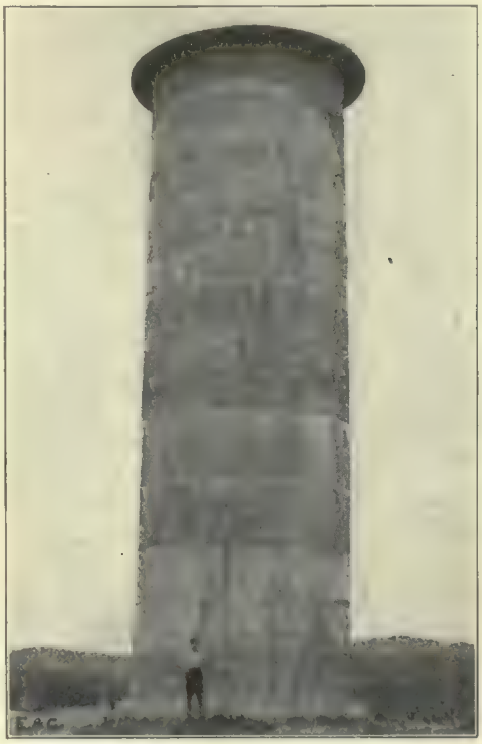
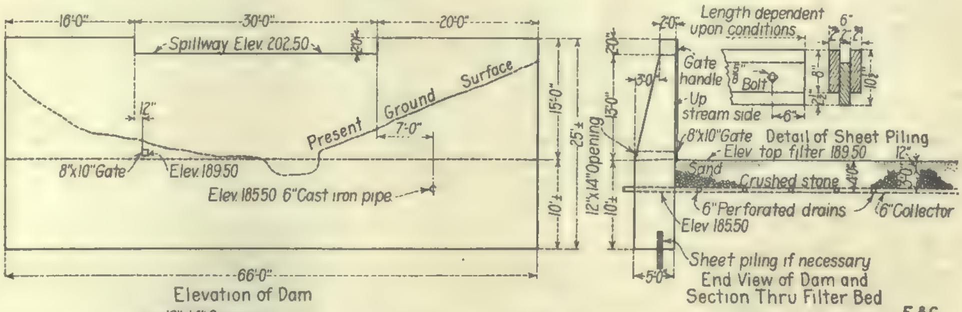
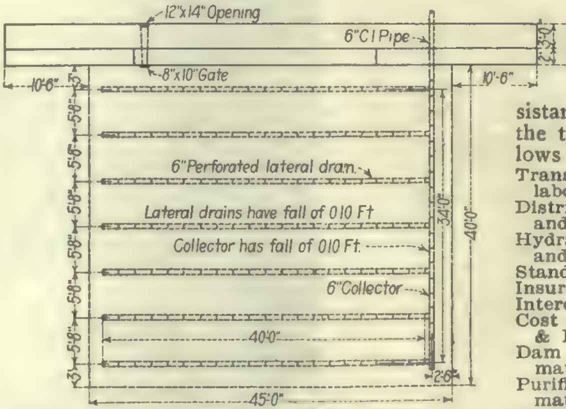


Fig. 1. View of Reinforced Concrete Standpipe, Mellen, Wis.



Elevation of Dam

End View of Dam and Section Thru Filter Bed


12"x14" Opening
6" C I Pipe
5'0"
8"x10" Gate
10'6"
10'-6"
5'-8"
6" Perforated lateral drain
Lateral drains have fall of 0.10 Ft.
Collector has fall of 0.10 Ft.
6" Collector
34'0"
40'0"
40'0"
2'6"
45'0"

Plan of Dam and Filter

Fig. 2. Design Details of Dam and Filter Bed of Mellen, Wis., Water Works.

Concrete Dam.—To collect the springs and to provide a storage of water, a concrete dam was constructed in a small valley to which these springs are tributary. A view of the dam is shown in Fig. 4. To cut off all possible underflow, a row of sheet piling was driven to a depth about 12 ft. below the bottom of the dam. The flow of some of the smaller springs not in the reservoir created by the dam was collected by means of 6-in. vitrified pipe lines. The dam is constructed of concrete and is 66 ft. long by 15 ft. high above the bottom of the spring brook. The spillway is 20 ft. wide at the crest of the dam and 50 ft. long. Before the dam was completed, the reservoir site and side slopes were stripped of all trees, shrubs and vegetable matter. The design details of the dam are shown in Fig. 2.

Filter.—As a precaution against a possible contamination of the water and the entrance of leaves and sticks, a filter was constructed in the bottom of the reservoir consisting of underdrains, 3 ft. of crushed rock and 12 ins. of sand. For details of this filter see Fig. 2. The underdrains were connected directly with the pipe line leading to the city so that there was no possible chance of contamination after the water was once filtered.

Standpipe.—The standpipe above mentioned is 16 ft. in internal diameter by 55 ft. high. It is located on a hill 128 ft. above the city. The walls of the standpipe are uniformly 12 ins. thick and are reinforced with ¾, ⅝ and ½ in. round rods. The design details of the standpipe are shown in Fig. 3 and the finished structure is shown in Fig. 1.

The concrete was mixed in the proportion of 1:2:4, gravel from the adjoining hills being used for the work. The walls of the standpipe were waterproofed with ½-in. plaster coat of 1:1 cement mortar, a cement wash and two coats of Hydrex Preservative paint. However, in spite of all this precaution some leaks did develop in the lower joints.

Fire Pressure.—The head of water from the dam and standpipe produces a hydrant pressure throughout the city from 61 lbs. on the hills in the residence section to 76 lbs. in the valleys in the business section. As an extra precaution against fire, the mains were connected to the fire pumps of one of the saw mills so that river water could be used in emergency cases.

COST OF WATER WORKS.

All of this work was done by day labor under the direction of the writer and his assistants. The detailed cost of the work at the time it was put in operation was as follows:

Transmission mains, dam to city limits, labor and material	$ 6,454.72
Distribution mains, inside city, labor and material	15,690.83
Hydrants (26), 21 in position, cost, labor and material	806.55
Standpipe land, Dunn purchase	150.00
Insurance, during construction	353.08
Interest, during construction	330.00
Cost of plant purchased (Mellen Water & Light Co. purchase)	4,100.00
Dam and reservoir in woods, labor and material	3,883.25
Purification system, filter at dam, material	1,077.88
Standpipe, reservoir in city	2,396.36
Meters, cost and installing same	1,265.35
Engineering and superintendence during construction	2,415.75
Services, connections between mains and consumers' premises	660.73
Stationery and printing during construction	75.49
Miscellaneous equipment and tools	826.84
Total cost	$40,488.83

QUANTITY AND QUALITY OF WATER SUPPLY.

The water is comparatively soft and is a very fine drinking water. No evidences of contamination have been noticed in the three years that the plant has been in operation.

The cost of operation is a minimum as the only expense is that for the secretary who reads the meters, keeps the books, collects the rentals and makes what small repairs are necessary. The quantity has always been sufficient except for a short period one dry summer when the water from a lake lying above the reservoir was turned into it by ditching.

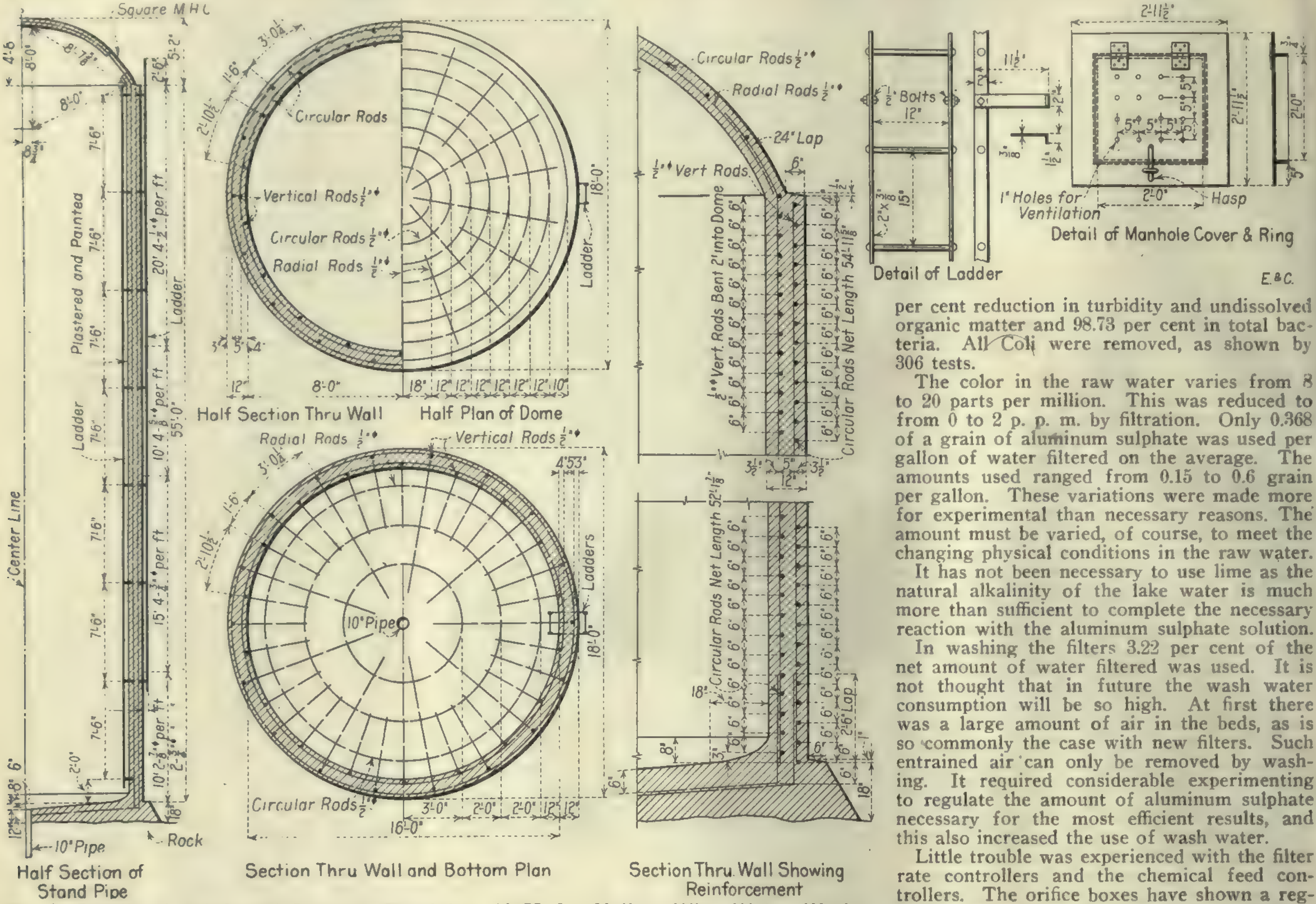


Fig. 3. Details of Reinforced Concrete Standpipe, 16x55 ft., Mellen, Wis., Water Works.

Cost and Efficiency Data on Water Purification at Erie, Pa., During Early Months of Operation.

(Staff Article.)

The water purification process at Erie, Pa., consists of sedimentation, coagulation and filtration. The sedimentation basin, which was put in operation in the fall of 1911, has a capacity of about 1½ days' supply. The filter plant, which was placed in operation on June 28, 1914, has twelve rapid sand filter units, each having a capacity of 2,000,000 gals. per 24 hours when operated at the rate of 125,000,000 gals. per acre per day. The sedimentation basin was not in operation at all times. When it was in operation it removed over 50 per cent of the turbidity and all the quick falling sediment from the raw Lake Erie water. While the settling basin is in operation, a saving of $8 per day is made in the operation of the filter plant. This saving is due to the lessened amount of aluminum sulphate and filter wash water required when the quantity of solid material in the raw water is reduced by sedimentation.

STERILIZATION.

During the first six months of 1914, before the filter plant was placed in operation, the supply was sterilized with calcium hypochlorite. The amount of hypo used averaged 7.06 lbs. per 1,000,000 gals. The average reduction in total bacteria due to sterilization was 97.01 per cent. All B. Coli were removed as shown by 411 tests of the tap water made during the six months. The operation of the sterilization plant required the services of a chemist and three attendants. The attendants each had an 8-hour watch. The cost of sterilization, exclusive of steam, electricity and water used was 69 cts. per 1,000,000 gals. As soon as filtration was begun the old sterilization plant was discontinued and an average of 4.85 lbs. of calcium hypochlorite per 1,000,000 gals. have been added to the filtered water immediately after filtration.

Fig. 4. View of Dam and Spillway at Springs, Mellen, Wisconsin, Water Supply Works.

FILTRATION.

The average daily quantity of water filtered during the second six months of 1914 was 16,675,200 gals. Daily analyses showed a 100 per cent reduction in turbidity and undissolved organic matter and 98.73 per cent in total bacteria. All Coli were removed, as shown by 306 tests.

The color in the raw water varies from 8 to 20 parts per million. This was reduced to from 0 to 2 p. p. m. by filtration. Only 0.368 of a grain of aluminum sulphate was used per gallon of water filtered on the average. The amounts used ranged from 0.15 to 0.6 grain per gallon. These variations were made more for experimental than necessary reasons. The amount must be varied, of course, to meet the changing physical conditions in the raw water.

It has not been necessary to use lime as the natural alkalinity of the lake water is much more than sufficient to complete the necessary reaction with the aluminum sulphate solution.

In washing the filters 3.22 per cent of the net amount of water filtered was used. It is not thought that in future the wash water consumption will be so high. At first there was a large amount of air in the beds, as is so commonly the case with new filters. Such entrained air can only be removed by washing. It required considerable experimenting to regulate the amount of aluminum sulphate necessary for the most efficient results, and this also increased the use of wash water.

Little trouble was experienced with the filter rate controllers and the chemical feed controllers. The orifice boxes have shown a regulation to 0.006 of a grain to the gallon of water.

The filter plant is operated by five men besides the superintendent. There are three 8-hour shifts and one filter operator is employed on each shift to take charge of the general operation. There is also a laboratory assistant who acts as a general assistant throughout the plant. A janitor completes the working force. The entire plant is in charge of the superintendent of filtration, Mr. J. S.

Dunwoody, who is also the chemist and bacteriologist. Mr. Edward W. Humphreys is superintendent of water works.

These notes are based on Mr. Dunwoody's annual report for 1914.

Comparison of Actual Cost of Laying 6-in. Cast Iron Water Pipe in 12 and 16 ft. Lengths at Council Bluffs, Iowa.

(Staff Article.)

In order to determine the relative cost of laying 6-in. cast iron water mains in 12 and 16 ft. lengths at Council Bluffs, Iowa, streets were selected where the soil conditions and depth of cover were similar and a time keeper was kept on the work continually to keep an accurate cost account of each class of work. The work was done by day labor in April, 1915. The weather conditions were favorable.

The mains were laid with 5 to 5½ ft. of cover. From the fact that these streets were soon to be paved great care was taken to tamp thoroughly every shovel of back filling, thus increasing the cost of this item above normal.

TABLE I.—ITEMIZED COMPARATIVE COST OF LAYING 6-IN. CAST IRON BELL AND SPIGOT WATER PIPE IN 12 AND 16-FT. LENGTHS, AT COUNCIL BLUFFS, IOWA.

	6-in. C. I. main on ground			Cost		Excav. and backfill. at 20c per hour.		Pipe laying costs							
Street No.	Length of pipe sections, ft.	No. of lengths and feet.	Weight, in lbs.	Per ton.	Amount.	Per ft.	Amount.	B. H. at 25c per hour.	Caulking at 25c per hr.	Lead at 4c per lb.	Laying jute fuel, etc.	Total cost.	Cost per 1,000 ft.	Average cost per 1,000 ft.	Difference in cost per 1,000 ft.
1	16	103 1,648	57,470	$23.95	$688.20	16⅓c	$269.09	$14.78	$11.02	$38.54	$44.37	$1,066.00	$646.85	$646.85	......
2	12	97 1,164	42,104	22.95	483.14	16¼c	189.18	13.49	10.03	38.41	30.65,	764.90	657.13	666.93	$20.08
3	12	94 1,128	42,341	22,95	485.86	15⅞c	175.80	15.09	9.90	40.00	36.70	763.35	676.73		

Table I gives the detailed cost of doing the work, including the foreman's wage at $90 a month, and the timekeeper at $2 per day. Common labor was paid 20 cts. an hour, and the caulkers and bell hole diggers 25 cts. an hour.

The 16 ft. lengths were laid on street No. 1 and the 12 ft. lengths on streets Nos. 2 and 3. Time was kept on each class of work as carefully as possible with a view to making an accurate comparison of detailed cost. It will be noted that the saving in using the 16 ft. lengths was $20.08 per 1,000 ft. of main.

The work was done under the direction of Mr. S. L. Etnyre, Superintendent of the Council Bluffs City Water Works, to whom we are indebted for this information.

An Effective Water Works Publicity Measure at Terre Haute.

(Staff Abstract.)

One of the most effective publicity measures employed by the Terre Haute Water Works Co. was the sending out, to a selected list of prospective water takers, of a circular entitled: An Important Trial. This document purports to be the record in the case of The People vs. Mr. City Well and Mr. Privy Vault. Mr. City Well personifies the shallow well owned by the householder. Such wells supply the chief competition encountered by public water systems. The other defendant needs no introduction.

The case is called and the presiding judge directs the Prosecuting Attorney to state what he expects to prove and to introduce his witnesses. The following is a record of the subsequent proceedings in the case:

Prosecuting Attorney:—Your honor! We expect to prove that the defendants are guilty of making a large number of people sick and causing the death of others. That the defendants are jointly responsible for contaminated water, which when consumed by the people causes ill health and even death. We expect to prove that the defendant, Mr. Privy Vault, is responsible for typhoid in connection with the house fly; that the house fly carries contagion from the vault into the houses and onto the food.

First let us hear the testimony of Mr. H. E. Jordan, Bacteriological Chemist of Indianapolis.

Mr. H. E. Jordan:—One of the most striking instances of the agency of flies in the spread of typhoid fever occurred during the Spanish-American war, at Chickamauga Park. The method of sewage disposal at this place was simply the use of open pits and the sprinkling, at certain hours of the day, with lime. It was a noticeable fact that during the middle hours of morning and afternoon, these sewage pits were filled with flies, and at the meal time the food on the tables in the mess-tents was covered with flies that had white feet. There is not in recent history recorded so severe an epidemic of typhoid as occurred among the soldiers of the American army at this camp, and the report of the experts regarding this is to the effect that the water supply could not in any way be held responsible for the disease, but that the flies, acting as carrying agents from slops to food, were directly responsible for the greater majority of the typhoid cases.

Prosecuting Attorney:—Dr. Eugene Buehler, Secretary of Indianapolis Board of Health.

Dr. Buehler:—I regret exceedingly that it is possible to say anything about the wells of Indianapolis, for had we our way, there would be no wells. Last year 922 wells were examined and 428 were condemned. We examine only such wells as are reported to us for examination or from premises which have been reported for typhoid fever or other sickness. There can be no doubt that many of the wells now in use are polluted and should be closed.

Prosecuting Attorney:—Dr. H. E. Barnard, Chemist to Indiana State Board of Health.

Dr. H. E. Barnard:—We may accept it as a fact that filth within 100 ft. of a well will influence the character of the water. But this is not the whole truth, for the original source of filth may be much farther away and have gradually defiled the soil in the direction of the well until it extended within its influence. Cess-pool filth has been known to permeate through the soil for a distance of 200 yds. and poison wells.

In a small village the supply of water from wells may have been of unexceptional quality for an indefinite time, but the place grows, population becomes more dense, the ground water is drawn upon in excess of the supply, the drainage area of the well is increased, and the water becomes less pure both from this cause and from the increased amount of sewage returned to the soil. Wells should be abandoned as a source of water supply for household use whenever there are more than two houses to an acre of land.

Many men guard the honor of their family well as sacredly as the honor of their name, and refuse to believe that a water which has been used for generations can be other than pure. However praiseworthy this attitude be, it is wholly wrong. Only sickness will teach what sanitary science has failed to do. The blind faith in the purity of well water is one of the chief reasons why typhoid fever so constantly ravages the country districts. We have heard time and again the statement, "My well water is the best in the county," and have found by analysis that it was little superior to raw sewage; clear and cool perhaps, but nevertheless reeking with the putrefactive bacteria of the privy vault and the filthy hog pen.

When the people realize the economic cost of water-borne disease, when they understand that one death from typhoid fever costs the community more than pure water, when the city dweller can be made to appreciate the fact that the cesspool in the back yard becomes inevitably a source of water supply for his well, and when the country dweller learns that water from a surface well is dangerous, we may expect not only proper legislation, but consistent compliance on the part of citizens that will eradicate the scourge now imposed upon us.

Prosecuting Attorney:—Our next witness is C. A. Jennings, Consulting Sanitary Expert and Superintendent of Filtration, Union Stock Yards, Chicago, Ill.

Mr. Jennings:—Most well and spring waters are clear and cool, which unfortunately is the layman's criterion of purity in water. A water might be highly contaminated with disease germs, and yet be clear and practically colorless. Many owners of wells and springs make grave mistakes, each thinking that, regardless of conditions, his water, because clear and cool and a well or spring water besides, is not possibly liable to contamination. Surface drainage and seepage from cesspools and privies, even when located at some distance, often contaminate wells and springs and so cause much sickness and even death.

Prosecuting Attorney:—The next witness is State Sanitary Engineer of Illinois, Mr. Paul Hansen.

Mr. Paul Hansen:—One of the greatest menaces to the health of a community is the use of private wells. Ordinary soil will for a long time produce a remarkable degree of purification in the water which reaches the wells from surface sources, but in time the soil becomes so saturated with filth that sooner or later purification will no longer be complete. In connection with its investigation of public water supplies the Ohio State Board of Health has analyzed samples of water from numerous typical private wells in built-up communities, and with but few exceptions these have been found dangerously contaminated. The old-fashioned privy vaults act as centers for the dissemination of disease germs by flies, more especially typhoid fever, and, as already noted, pollute the soil and endanger nearby wells.

Prosecuting Attorney:—Dr. Edward Bartow, Director of Illinois Water Survey and Secretary of the Illinois Section of the American Water Works Association.

Dr. Edward Bartow:—An investigation of the typhoid fever rate in Illinois shows that the rate in the southern 51 counties is more than 30 per 100,000, while in the northern 51 counties the rate is 12 or less. In trying to account for this situation we find that 10.8 per cent of the towns of more than 1,000 inhabitants in the northern part of the state are without a general water supply, whereas 32.8 per cent of the towns in the southern half are without a general water supply and must therefore rely on the city wells. Without a water supply there are necessarily privy vaults and cesspools because of the lack of a sewerage system. From these statistics we cannot but conclude that Mr. City Well and Mr. Privy Vault are in a great measure responsible for the high typhoid fever rate.

Prosecuting Attorney:—Our next witness will be Dr. J. N. Hurty, Secretary of the Indiana State Board of Health, a man of national reputation, who has done as much as any other man in the United States towards bringing about better sanitary conditions.

Dr. J. N. Hurty:—When we learn to dispose of all our excrement all of the time in a sanitary way, then typhoid fever will not be known. At the present time all houses, except those connected with sewers or septic tanks, have a privy with a vault which receives the voided excrement. In the same yard a well almost always exists. Both well and vault may be dug to the same water vein or water-bearing gravel, and eventually the seepage from the vault gets into the well. As this seepage always contains poisons those who drink the well water are poisoned more or less, according to their strength to resist. Flies also may carry this vile matter to us. The symptoms of poisoning from privy vaults are languor, coated tongue, headache, indigestion, diarrhoea and a lot of bad feelings which pass under the general name of malaise, malaria or biliousness.

Mr. Privy Vault and Mr. City Well are a pair of bad citizens. To my certain knowledge they delight in causing disease and death. Both are deliberate murderers. Mr. Privy Vault deliberately pollutes the air and the ground. Mr. City Well sucks up the pollution that Mr. Privy Vault soaks into the ground, and hands it to the people. He pretends to supply refreshing drink and thus deceives his victims into taking typhoid and other poisons. Both of these bad citizens must be banished.

Prosecuting Attorney:—We will now hear the evidence of Mr. H. E. Brown.

Mr. H. E. Brown:—We used well water for years, and thought it was good because it was clear and cool until we had three cases of typhoid fever. The cost of this siege of sickness was in the neighborhood of $1,000. We filled up the well and privy. No more well water for us.

Prosecuting Attorney:—Your honor, these are all the witnesses we have at present, although we can, if necessary, secure many, many more who will corroborate the testimony already given.

The Judge:—Mr. Attorney for the Defendants, call your witnesses.

Attorney for the Defendants:—Your honor, we had expected to have some witnesses to show the small cost of well water, but they have failed to appear, and, under all the circumstances, I will submit the case without evidence.

Prosecuting Attorney:—Your honor, I believe we have made a strong case against the defendants; that we have shown that even if the first cost of well water may be low the ultimate or final cost is very great. I leave the case in your hands.

The Judge:—The verdict of this court is that the defendants are guilty as charged and that they shall be banished as suggested by Dr. Hurty.

Cost of Motor-Trucking by Chicago Water Works in 1914.

(Staff Abstract.)

The subject of hauling received a great deal of study during 1914, by the officials of the Chicago water works, in connection with the installation and use of the automobile trucks purchased by the department in 1913. The trucks purchased for regular hauling include one 5-ton and three 2-ton Pierce-Arrow trucks. A transportation section was organized in the Division of Water Pipe Extension, with a head motor truck driver in charge.

The cost of hauling averaged about 13 cts. per ton mile with the 5-ton truck and varied from 14 cts. to 32 cts. per ton mile with the 2-ton trucks, depending on the conditions and the efficiency with which they were used. There has been an increase in efficiency and a lowering of costs from the first by the use of these trucks. Details are given in Table I.

The hauling under contract by teams in 1914 was done at an average cost of 26.9 cts. per ton mile. The hauling by teams hired by the day was still higher.

The use of motor trucks and the general study of transportation have shown that the motor trucks are economical and efficient when properly handled, that hauling of certain materials by contract is advisable, and that teams hired by the day are not efficient.

The motor trucks were used for the hauling required by all the divisions of the Bureau of Engineering as well as for other bureaus and departments, and the cost of the service was billed. The cost of operating the trucks was reported on monthly. Table I gives a summary of the monthly reports. The high ton-mile cost on Truck No. 3 for November and December was due to the character of service which consisted of small loads, long hauls and an excess of loading time. The same is true of No. 2 truck for December.

The motor trucks were used to good advantage in connection with testing water mains. All mains laid by contract and all feeder mains are tested under 100 lbs. pressure. This pressure is produced by means of a pump driven by a gasoline engine. This outfit is hauled to the various points where new mains are to be tested. During most of the year this hauling was done by teams and it was impossible, on account of the long hauls, to make more than one test a day. Later in the year, at a cost of $10 a day, an auto truck was used for this purpose and three or four tests of mains were made each day.

TABLE I.—COST OF OPERATING MOTOR TRUCKS IN CHICAGO BUREAU OF ENGINEERING IN 1914.

	Mileage.	Ton miles.	Operating expense.	Cost per day.	Cost per ton mile.
5-ton Truck No. 1—					
July	824	1,931	259.28	9.97	.134
August	838	1,914	257.05	9.88	.134
September	723	1,744	237.96	9.91	.136
October	902	2,045	267.39	10.28	.13
November	1,014	2,299	300.78	13.07	.13
December	950	2,339	293.52	12.33	.125
2-Ton Truck No. 2—					
July	911	926	210.16	8.40	.227
August	934	1,017	209.89	8.40	.205
September	800	948	197.69	8.98	.201
October	1,091	1,044	225.79	8.36	.216
November	1,111	1,256	189.54	7.90	.15
December	559	536	159.69	11.41	.31
2-Ton Truck No. 3—					
July	721	770	192.74	9.13	.25
August	930	908	208.78	8.70	.23
September	725	631	191.94	9.14	.30
October	1,038	864	218.97	8.11	.25
November	1,039	470	162.32	7.06	.345
December	778	651	254.79	10.62	.40
2-Ton Truck No. 4—					
July	816	478	201.34	9.15	.42
August	973	792	221.04	9.21	.27
September	948	778	211.69	9.62	.272
October	891	769	217.99	9.08	.283
November	1,097	1,155	187.19	8.14	.16
December	974	983	182.56	7.02	.186

To test the worth of motor truck haulage in the water works construction division a 5-ton truck was employed for 16 days in hauling excavated rock from the shore shaft excavation of the new Wilson Avenue Intake Tunnel. During this period 367 loads, aggregating 1,280 cu. yds., were hauled away at a cost of 28 cts. per ton-mile.

These data are taken from the 1914 report of the City Engineer of Chicago.

An Interesting Example of Direct Competition Between Publicly and Privately Owned Water Works Plants in Tarentum, Pa.

Contributed by Leo Hudson, Cunsulting Hydraulic and Sanitary Engineer, Pittsburgh, Pa.

An unusual condition exists in the Borough of Tarentum, Pa., in that there are two water works systems supplying water in the borough—one system owned and operated by the borough and the other owned and operated by a private company known as the Allegheny Valley Water Co., previously known as the Tarentum Water Co.—and these two plants have overlapping systems and are in direct competition.

The water furnished by the company has always been unsatisfactory in both quantity and quality. For this unsatisfactory water a high rate was charged by the company. The officials of the borough were unable to get any satisfactory action from the company, and so on Sept. 13, 1907, the Borough of Tarentum filed a bill in equity in the court of common pleas of Allegheny County, praying the court to require the water company to furnish an adequate supply of pure water for public and private uses. The company thereupon agreed to filter its water supply and furnish an adequate supply of pure water for public and and private uses. The rates then charged by the company were raised and the company started to build a filter plant.

Upon the completion of the filter plant the water furnished was not satisfactory and at times the raw river water was served direct by bypassing the filters. The protection against fire was not bettered and several disastrous fires occurred, the water supply being inadequate. Other efforts were made by the officials of the borough to get the company to correct the conditions, but these efforts were unsuccessful.

By reason of the unsatisfactory conditions the council of the Borough of Tarentum passed an ordinance April 27, 1908, signifying its desire to increase the indebtedness of the borough in the sum of $100,000 for the purpose of constructing a municipal water plant, and directed that a public election be held within the borough on June 16, 1908, for the purpose of procuring the assent of the electors thereof, which election was duly held and the assent of the electors was given thereto by an overwhelming vote in favor of said proposition.

The Tarentum Water Co. and its successors, the Allegheny Valley Water Co., then filed a bill in equity to restrain the Borough of Tarentum from constructing its proposed water works, and after three years of litigation the decree of the court of common pleas of Allegheny County dismissed the bill of the company and affirmed the right of the borough to construct a municipal water works. This decision was appealed and the right of the Borough of Tarentum to build its own plant was finally determined by the highest court in the land.

As a result of this litigation the council of the Borough on Aug. 5, 1911, passed an ordinance authorizing an increase in the indebtedness of the borough and an issue of bonds in the sum of $100,000 for the purpose of constructing a municipal water works.

Plans were prepared and a thorough investigation was made to select a source of supply. At first it was thought that a ground supply could be obtained from wells, but this source was finally abandoned and the supply was taken from the Allegheny River. The plans were finally perfected and submitted to the Pennsylvania State Department of Health and a permit was issued by that department on Sept. 24, 1913. The water was pumped into the distributing system on May 19, 1914, and the municipal plant has been in constant operation since the date it was started.

Since the municipal plant was completed it has been supplying water of 99.98 per cent purity, and an abundant quantity with a highly satisfactory pressure.

Upon the completion of the plant the borough council established a rate for water which was practically the same as the one charged by the company. This equal rate was established because the citizens were willing to pay the rate imposed if they could only get a satisfactory water.

Upon the serving of water and the establishing of rates by the borough the bondholders of the water company petitioned the Pennsylvania Public Utilities Commission, representing:

> that the officials of the Borough of Tarentum are now and have been for some time past engaged in the construction of a water plant and are threatening to furnish water at unreasonably and ruinously low rates for the purpose of injuring, destroying and bankrupting the said Allegheny Valley Water Co * * * that your petitioners are informed and believe that said officials have not complied with the public service law in that they have not obtained the requisite consent, nor filed the required

schedule of rates; that they are also informed and believe that the water the said officials of Tarentum propose to furnish to its inhabitants is neither pure nor healthful. Filed April 23, 1914.

This case was submitted before the commission and testimony taken Sept. 1, 1914.

The prayer of the petitioners was that the commission restrain and enjoin said Tarentum Borough and its officials from further continuing to construct said plant and that they be restrained and enjoined from so using said proposed plant as unreasonably and unfairly to depress rates, thereby injuring and destroying the security of the bondholders.

The answer of the borough was in substance as given in the historical sketch above and under authority of a permit secured from the Board of Health of the Commonwealth of Pennsylvania the borough had completed its municipal plant and is now prepared to furnish a sufficient supply of pure water, and that the Allegheny Valley Water Co. has never furnished an adequate supply of pure water, and that the borough by authority of law had in process of construction its municipal water plant for the rendering and furnishing of water to its citizens prior to the passage and approval of the public service company law of July 26, 1913. P. L. 1374.

The answer denied that the borough threatened to furnish water at unreasonably low rates, and that the water was dangerous.

In rendering decision, April 9, 1915, the Public Service Commission of Pennsylvania, by Hon. Samuel W. Pennypacker, chairman, stated:

Whatever may be the conclusion reached in this case, the determination of the question involves great hardship.

The Allegheny Valley Water Co. has an established plant and has with its predecessor, the Tarentum Water Co., for many years been supplying the Borough of Tarentum with water. It has issued bonds secured upon its plant to the amount of $500,000. No matter what may have been the purpose of the borough the effect of the erection of a water plant by it will be to lessen the value of these securities. It appears from the evidence taken that much the larger number of persons supplied with water by the Allegheny Valley Water Co. are inhabitants of Tarentum. On the other hand the borough has completed a water plant and has issued bonds to the amount of $100,000. To prevent the operation of this plant would also have the effect of destroying property and lessening securities. The commission is unable to see any way by which the relief prayed for in the petition can be granted. The evidence fails to show that the water supplied by the respondent is impure as alleged. Both plants draw their water from the Allegheny River. In that river above both of them there are discharges of sewage. Both depend for purification upon filter plants. The system adopted by the borough has had the approval of the State Board of Health.

The evidence also fails to present anything which would enable the commission to find that the rates established or to be established by the respondent are "unreasonably and ruinously low."

It appears from the testimony of Leo Hudson, the borough consulting engineer, which was not contradicted, that the filter plant of the borough was completed and the water turned into the system April 19, 1914. The petition in this case was filed April 23, 1914, four days afterwards. The proceedings were begun too late to enable the commission to enjoin the construction of the plant, as prayed for, even if it should have the power. * * *

Then on April 9, 1915, the prayer of the complainants was refused and the petition dismissed.

The schedule of rates established by the borough, which are substantially the same as the company rates, is as follows:

SCHEDULE OF RATES OF MUNICIPAL WATER WORKS AT TARENTUM.

By meter:

First 7,500 gals, 30 cts. per 1,000 gals.

First 2,000 gals. in excess of 7,500 gals., 25 cts. per 1,000 gals.

Second 2,000 gals. in excess of 7,500 gals., 20 cts. per 1,000 gals.

Third 2,000 gals. in excess of 7,500 gals., 15 cts. per 1,000 gals.

All water in excess of 13,500 gals, 10 cts. per 1,000 gals.

Special meter rates for building purposes:

Water used in erection of framed building, 15 cts. per 1,000 gals.

Water used in erection of brick or stone building, 15 cts. per 1,000 gals.

Water used in erection of cement works, 10 cts. per 1,000 gals.

Flat rate, without meter:

One spigot per quarter, $2.50.
One spigot and toilet, per quarter, $3.35.
One spigot, pave wash and toilet, per quarter, $3.50.
One spigot and complete bath, per quarter, $5.
Pave wash, per year, $4.
Private stable, per year, $4.
Livery stable, per quarter, $4.50.

Flat rate for building purposes:

For each single dwelling house, $3.
For each double dwelling house, $6.

Fire service:

Private use, per year, $45 (4-in.).
Private use, per year, $25 (2-in.).

Sprinkler service:

Five cents per annum for each sprinkler head, with a minimum of $60 per year for 4-in. connection to main and $100 per year for 6-in. connection to main.

A discount of 10 per cent is allowed if paid in advance.

When the borough plant was started in operation it was estimated that the company had about 1,000 connections. It is estimated at this time (Aug. 5, 1915) that it has about 350 connections. Connections were made to the borough plant at the following rate:

April 19, 1914	0
July 19, 1914	301
Oct. 19, 1914	570
Jan. 19, 1915	587
April 19, 1915	624
Aug. 5, 1915 (to date)	698

About 650 of the borough consumers were those which left the water company. The remainder of the borough customers are new customers. The borough allows itself $45 per year for each hydrant as a fire protection charge. Of course the company has lost this source of revenue.

A report has just been made showing the expenditures and receipts to date in the borough plant. They are as follows:

RECEIPTS.

Water	$7,834.17
Meters	2,224.93
Fittings	146.09
Rent	110.00
Miscellaneous	104.28
Total	$10,419.47

DISBURSEMENTS.

Salaries	$ 1,112.44
Court expenses	300.00
Labor at plant	2,623.57
Supplies	3,372.61
Connections	5,912.41
Total	$13,321.03

Next year these connections will not have to be made, and it is estimated that about $1,215 will be saved on the other items. On the given number of connections a revenue equal to the above will be received and this will put the receipts $4,225.85 above the disbursements. The interest on the bonds will amount to $4,000, and it is expected that the plant will show a profit at the end of the second year.

From an economic standpoint it is, of course, unfortunate that the conditions in Tarentum necessitated the construction of a second plant and the destruction of an existing plant, but there existed a larger economic question which had to be counted in lives and sickness and the loss of property by fire. If this latter saving could have been made without destroying the value of the company's plant the problem would have been solved. But the company refused to meet the situation, and for its bad faith in rendering the public the service it agreed to render it lost its investment. The people of Tarentum wanted to pay a fair return upon the investment necessary to render the proper service, but they wanted the service. It was in this failure in rendering anything like the proper service that the company has only itself to blame for its distress.

Water Works Rules and Regulations in Connecticut.—The Connecticut Public Utilities Commission on June 30, 1915, issued a set of rules, regulations and standards for water companies operating in that state. The general provisions refer to facilities for testing, records of tests and history of meters, tests of meters before installation, tests of meters by request of customers, adjustment of bills for meter errors, meter dials and form of bills, deposits minimum charges, etc., interruptions of service and complaints. The special provisions pertain to the purity of the domestic supply, adequacy of pressuure and the making of pressure surveys, meter testing equipment, pre-installation and periodic tests of meters, and meter accuracy.

SEWERAGE AND SANITATION

Six Types of Construction Camp Garbage and Refuse Incinerators.

(Staff Abstract.)

The following rules are laid down by the Commission of Immigration and Housing of California for the disposal of garbage and refuse in construction camps:

1. Kitchen garbage and refuse should be kept in fly-proof containers, preferably metal, until permanently disposed of. Such containers should be emptied at least once in two days.
2. Fly-tight receptacles should be provided, convenient to the sleeping quarters, for the collection of waste such as paper, cast-off clothing, etc.
3. All garbage should be disposed of either by incineration, by burying, or by feeding to hogs. Hogs should not be allowed within a quarter of a mile of camp. Garbage should not be fed to chickens as they will not consume it all, thus affording fly breeding and feeding places.
4. Incinerators for the burning of garbage and waste can be easily and cheaply constructed.

Six types of construction camp incinerators are illustrated and described herewith.

Chimney Type.—Figure 1 shows a chimney type incinerator for a camp of 2,000 persons. This can be built of rock, cobblestones or old brick by unskilled labor. In California such an incinerator can be built at an estimated cost, for labor and material, of the brick type for $137 and of concrete type for $144. For a permanent camp the incinerator should be built of either concrete or brick and lined with fire brick.

The bill of material for the chimney type of incinerator is as follows when constructed of brick: 800 fire brick, 2,500 common brick, 1,800 lbs. grate bars or old rails, 36 cu. ft. excavation. When built of concrete: 24 cu. ft. excavation, 128 cu. ft. concrete, 120 lbs. reinforcing steel, 800 fire brick, 1,800 lbs. grate bars or old rails. The bill of platform material is as follows: 4 pieces 4x4 in. by 7 ft. wooden posts, 2 pieces 4x4 in. by 6 ft. wooden girders, 115 lin. ft. 2x6 in., wooden joists and braces, 30 lin. ft. 2x12 in. plank flooring, 20 lin. ft. 2x12 in. stair stringers, 30 lin. ft. 2x12 in. stair treads, 44 lin. ft. 2x4 in. braces and supports, 9 lin. ft. 2x3 in. sized hand rail, 4⅝ by 5 in. bolts, 10 lbs. 20d nails.

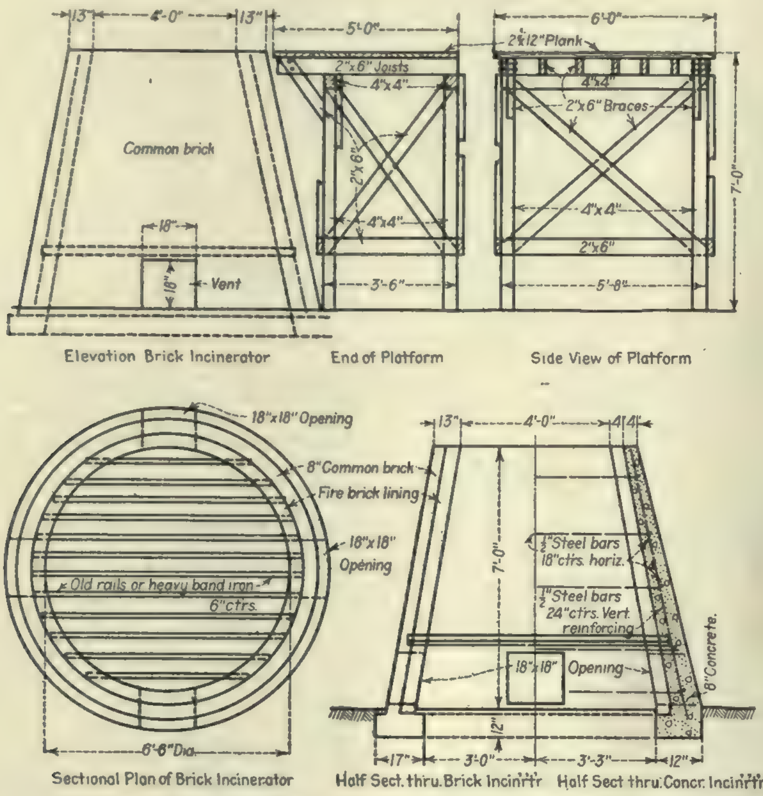


Fig. 1. Details of Construction Camp Incinerator of the Chimney Type.

Stack Type.—Figure 2 shows a stack type of incinerator for a camp of 150 people. The pan shown is 8 ins. in depth and is used to evaporate liquid slops, while the solid garbage is placed on top of the fuel. By treating the liquid thus separately, a great deal of fuel is saved.

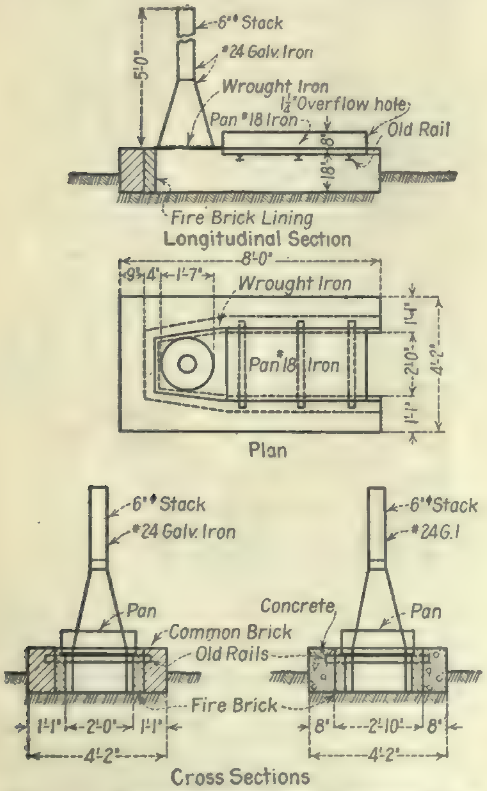


Fig. 2. Details of a Camp Incinerator of the Stack Type.

The bill of material, using brick, is as follows: 144 fire brick, 330 common brick, 20 cu. ft. excavation, 225 lbs. of old rail or grate bars, 22 sq. ft. of No. 24 galvanized iron for stack. When using concrete: 20 cu. ft. concrete, 144 fire brick, 20 cu. ft. excavation, 225 lbs. old rails or grate bars, 22 sq. ft. No. 24 galvanized iron for stack, 1 piece wrought iron plate 26x26 ins., 21 sq. ft. sheet metal for pan.

The estimated cost of this type of incinerator for labor and material is as follows for California conditions: brick type $36.50, concrete type $34.

Barrel Type.—Figure 3 shows a barrel type of incinerator suitable for a camp of 125 persons which can be built at the following cost:

1 common flour or sugar barrel	$0.50
Placing clay	3.00
Old rails or scrap iron	0.50
Incidentals	2.00
Total	$6.00

Barrel and Trench Type.—Figure 4 shows a barrel and trench type of incinerator suitable for a camp of 115 persons. This incinerator can be constructed in the following manner. Dig two trenches 10 ft. long and 10 or 12 ins. wide, bisecting each other. At the point of bisection the trenches should be from 15 to 18 ins. deep, gradually shallowing from this point to their origin. Over the place of bisection place four boards to support an ordinary sugar or flour barrel. Around the barrel pile sods of earth and pack tightly up to the top of the barrel. If sods are not obtainable use clay. Make a fire in the trench under the barrel and when the barrel is burned out a hard cone of earth or clay is left.

In operating this type of incinerator one trench opening near the cone is left uncovered, according to the direction of the wind, and the other three are plugged with soil. Thus a flue is formed through the one opening and the top of the cone. The ashes should be raked out at the end of each day's use and a fresh fire started in the morning. Fuel and garbage are fed to the fire through the top of the cone.

The estimated cost of this incinerator is as follows:

1 cu. yd. excavation	$1.00
1 common sugar or flour barrel	0.50
Placing clay or sod	4.00
Incidentals	.50
Total	$6.00

Rock Pile Type.—Figure 5 shows a rock pile incinerator which can be installed very cheaply if rock is available on the ground. This incinerator is suitable for a camp of about 2,500 persons. Construct as follows:

At some convenient point dig a circular pit 3 ft. in depth and 15 ft. in diameter. Cover the bottom with loose stones to a depth of 14 to 16 ins. On this build a circular wall to a height of 1 ft. above the original ground line and pack tightly the excavated earth around the wall so as to provide a sloping approach, thereby preventing surface water from gaining access to the pit. Build a pyramid of large stones 4 or 5 ft. high in the center to provide a central draft. The head of the bottom stones evaportes the liquid slops while the solids are soon consumed as fuel for the fire. Precautions should be taken to empty the garbage into the crematory and not around it.

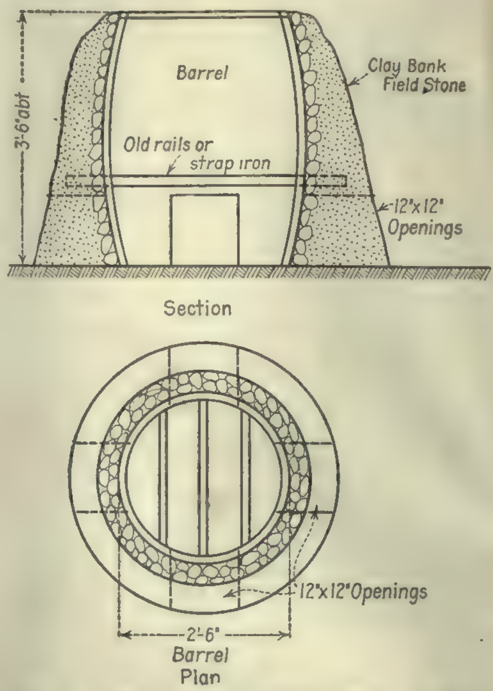


Fig. 3. Detail of Camp Incinerator of Barrel Type.

The estimated cost of the rock pile incinerator is as follows:

22 cu. yds. excavation	$22.00
Placing rock in place	15.00
Gathering and hauling stone	9.00
Cement	4.00
Total	$50.00

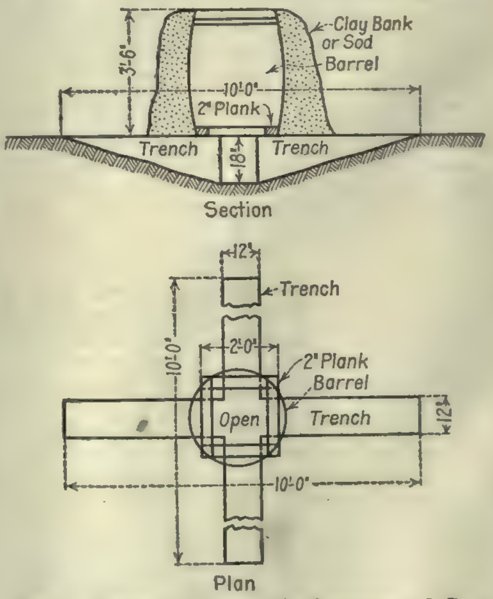


Fig. 4. Detail of Camp Incinerator of Barrel and Trench Type.

Pit Incinerator.—Figure 6 shows a pit incinerator suitable for a camp of 250 people which is constructed as follows:

Dig a pit 5x2½ ft. by 6 ins. deep at one end and 12 ins. deep at the other. Bank the excavated earth around the pit and fill it with stones on which to build the fire. When the stones have become heated, liquid refuse is poured into the pit at the shallow end where it gradually evaporates. Solid garbage is burned on the fire.

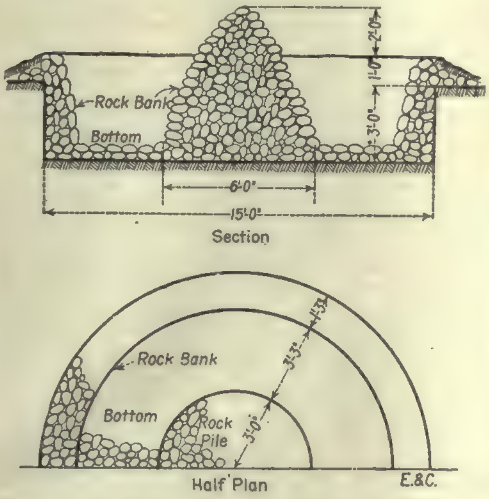


Fig. 5. Detail of Camp Incinerator of Rock Pile Type.

The estimated cost of the pit incinerator is as follows:

Excavation	$1.00
Placing field stone	1.50
Incidentals	.50
Total	$3.00

ACKNOWLEDGMENT.

This information is abstracted from an advisory pamphlet on Camp Sanitation and Housing issued by the Commission of Immigration and Housing of California, San Francisco.

Method of Keeping Sewer and Other Records in Frankfort, Ind.

(Staff Abstract.)

One of the most important, but usually most neglected parts of the routine work of the city engineer in the small city is the keeping of office records. It is a difficult thing, as a rule, to convince the members of the common council of the importance of keeping a complete record of everything. Usually the records have been neglected so long that the members of the council view the necessary expenditure to bring them up to date as a needless waste of money. Then often the engineer, when he contemplates the vast amount of work necessary to start a set of records and complete them, is overwhelmed and gives up the idea. His predecessors in office had been too careless or too lazy to keep up the records and he feels that he is not bound by any rules to do another man's work.

Possibly the greatest cause, for the two mentioned above, for neglecting the records is that when the engineer should be compiling his records, he is busily engaged in outside work endeavoring to piece out his salary. Salaries somewhere nearer in proportion to the duties and responsibilities placed upon the engineer would remove the incentive to seek outside work and thus give him more time for routine office work.

It is my intention to discuss briefly a system of office records that has been devised for my office at Frankfort and which we are now trying to perfect. The most important requirement of a system of office records is that they be elastic to take care of the future growth. This requisite is met by means of card indexes, loose-leaf binders and sectional cabinets. Filing space can be provided as needed and arranged to suit the demands.

FILING CARDS.

The most important thing in the records is a good index to enable one to find any desired information in the quickest possible time. This must be extremely elastic. In indexing our office, we adopted the card index, using 3x5 in. cards and one-third cut guides. We adopted the street subdivision and I believe it to be the best for city work, as 95 per cent of the data in the engineer's office relates to streets. Each street has a guide behind which are filed all index cards referring to that street.

The data referring to alleys gave us considerable trouble, but finally we hit upon the scheme of referring all north and south alleys to the first street east of them and all east and west alleys to the street south. I might remark that nearly all streets in Frankfort run east and west and north and south. The alley cards are filed behind a guide marked "Alleys" and are further subdivided by means of an alphabetical set of guides. Behind each letter are filed all cards of alleys that are referred to streets the first letter of which is that letter. For miscellaneous data, subject guides were used, such as ordinances, corporations, pavements, sewers, etc. The index was further subdivided by the use of colored index cards. All data relating to improvement of streets or alleys are placed on buff cards, those relating to sewers on salmon, those relating to openings, vacations, etc., on green, those relating to grades and grade lines on cherry, those relating to property on blue, and unclassified data on white cards. Any particular subject or improvement is placed on one card with sufficient notes to make it easily found and on this card are given the file numbers of all data relating to this subject.

DRAWING FILES.

All maps, plans, profiles, etc., are filed in a large cabinet containing several drawers, to each of which is assigned a capital letter. Each drawer is subdivided, where necessary, into compartments, to which are assigned lower-case letters. The drawings, etc., are assigned consecutive numbers in each compartment. This gives a file number consisting of a capital letter, a lower-case letter and a number. All these are filed flat unless the size prohibits.

DOCUMENT FILES.

Resolutions, specifications, etc., relating to improvements are also filed in this cabinet. All such data of any particular piece of work are placed in a folder to which is assigned a file number consisting of drawer capital letter, two figures to show the year, and a decimal. The decimal begins at one each year and runs consecutively through the year. On the outside of each folder is an abstract of each step in the proceeding, showing reference to the record of the council proceedings, where full proceedings can be found. These folders were made from heavy bill-poster paper purchased at a local printing office. As the assessment rolls are referred to most frequently in the future, they were placed in another drawer and were given the same file number as the folder for the improvement to which they refer, except, of course, a different drawer letter was used.

SEWER RECORDS.

The most important record drawing is the sewer record. The present record consists of a bound book of profile-plan paper, but we have started work on a new record, which will be in a loose-leaf binder. On this record are shown the plan, profile, abutting tracts of land, location of each house connection, all appurtenances, character of soil, etc. In Frankfort no house can be connected to a sewer until the engineer issues a permit. These permits show the plumber making the connection, who is under bond, the person for whom the connection is made, and what it is proposed to connect. These permits are numbered consecutively and as each connection is made, the permit number is shown on the sewer record and the permit filed away.

RECORD MAPS.

Record maps are made up on small scale plats of the entire city and are mounted on rollers which are hung on the wall. These maps are seven in number. First is a sanitary sewer map on which are shown all sewer lines in service, with the sizes, kind, grades, year built, etc. Second, a storm sewer map, with the same data as above. Third, a water works and heating line map, on which, in red, are shown the mains of the Frankfort Water Works Co., with all appurtenances, size and kind of mains, year laid, etc. In green are shown the mains of the Frankfort Heating Co., with similar data as above. Fourth, a gas, telephone and other sub-surface structure map, with complete data, different colored ink being used to distinguish them. Fifth, a street improvement map, showing the kind of curb, walk and pavement on each street and alley. Sixth, a property map, to which I will refer later; and seventh, a monument and bench-mark map, of which I also say more later.

In connection with the above record maps is kept a tabulated list of all appurtenances, such as manholes, lampholes, flush tanks, fire hydrants, etc. All these are numbered consecutively in the order they are built, and on the tabulated list are shown all dimensions, date built, references as to location, etc.

Copies of all ordinances relating to the department are filed in a loose-leaf ordinance record. In a similar manner, additions, with their dedications, are filed.

All monuments are numbered consecutively, and a tabulated list is kept on which are shown sufficient notes and ties to enable accurate relocation. Bench-marks are also numbered and the record shows the datum plane, elevation, location and by whom set.

A copy of the ordinances establishing grades is filed in a grade ordinance book, in connection with which are grade sheets drawn to scale.

PROPERTY RECORD.

In most of our cities the engineering department is also the assessment bureau. Possibly in other counties in the state the records in the county auditor's office are in such shape that a person can find property owners at a faster rate than about ten per hour, but not so in Clinton county. Last winter we started work on a property record and now have it nearly complete. For this work 5x8 in. cards were used, on the face of which appear the addition (if platted ground), block and lot number, owner's name, a brief description and reference to the deed record in the county recorder's office. On the back are shown all special assessments made against the property. These cards are filed in a card index cabinet behind guides showing the addition. The filing of the unplatted tracts of ground presented a rather difficult problem, which was solved by the use of large-scale standard maps in connection with the property record map. The entire city was divided into 37 divisions of such size that when platted on a scale of 1 in. to 100 ft. the standard maps were about 16 by 25 ins. Each division was numbered and each tract within the division was given a letter. This method resulted in giving the same ease in locating an unplatted tract as is usually expected for platted tracts. These cards are filed behind guides numbered to correspond to the divisions. The deeds are

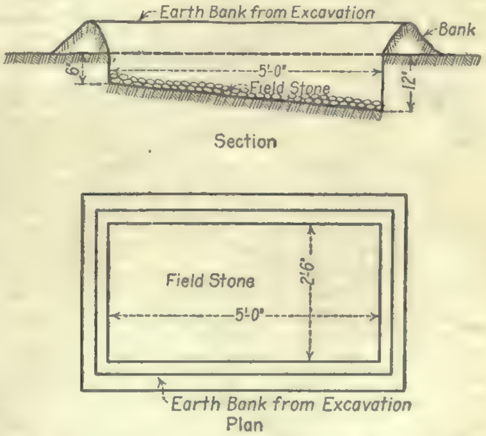


Fig. 6. Detail of Camp Incinerator of Pit Type.

copied on 3x5 in. cards and filed behind guides numbered to correspond to the deed record in a card index transfer case. This method of filing the deeds was used only after experimenting with bound books and loose-leaf binders. The keeping of this record requires about one hour per week and has proven itself to be one of the most useful records in the office.

This briefly covers what records we are at present endeavoring to keep up and they seem to cover our local conditions very well. I feel that the necessity of complete, well-kept records in the engineer's office cannot be overestimated. The first thing is to start a system early and the second is to keep everlastingly at it. Do not let it get ahead of you. If you do not find a system of records in your office, take off your coat and wade in.

ACKNOWLEDGMENT.

This discussion is from a paper by Mr. R. H. Boynton, City Engineer of Frankfort, Ind., before the Indiana Municipal League.

Essential Features in the Design and Operation of Refuse Disposal Plants.

(Staff Abstract.)

The essential features to be considered in the design of plants for the disposal of garbage or offal are sanitation, freedom from nuisance, and economy. To obtain desired results all three essential features must be considered, with first attention given to sanitation and freedom from nuisance. The following outline gives the principal items to be considered in design and operation:

1. Site should be accessible for the delivery of material depending on local conditions, and work to be done.
2. Buildings should be permanently constructed and designed from the standpoint of equipment to be used, and the installation of same.
3. All material should be rapidly handled and equipment used in transporting and handling should so far as possible be housed, so as not to expose the material in unloading and delivering to the reduction equipment.
4. The gases carrying odors should be condensed or scrubbed sufficiently to take up all soluble gases, and the insoluble gases deodorized.
5. All odors given off in process of disposal due to exposure or being unconfined, should be removed by mechanical means and deodorized.
6. The equipment used should be selected so as to require the minimum amount of gas carrying odors to be treated, and at the same time produce gases of a nature lending themselves to deodorizing treatment.
7. All parts and equipment should be duplicated where necessary to insure satisfactory and continuous service.
8. The plant should be designed to permit frequent hosing and cleanliness with minimum amount of attention.
9. Special attention should be given to the selection of equipment, in regard to depreciation and maintenance.
10. All material so far as possible should be enclosed during the process of disposal and the recovery of by-products.

To eliminate the nuisance caused by odors given off from rendering or reduction plants the following essential features must be considered:

1. The type of equipment used should be such as to produce a minimum amount of gas-carrying odors.
2. The equipment and apparatus used should be designed and installed so as to confine all odorous gases.
3. Proper and sufficient means must be provided to deodorize the gases produced.
4. The equipment and apparatus installed must be operated properly and efficiently.

Proper attention from a sanitary or free-from-nuisance standpoint cannot be expected when sufficient control is not obtained by the municipality, as to the manner in which the work is to be conducted. When contracts are awarded in competition for short terms it usually results in the plants being constructed with less attention being paid to details and permanent construction. It is an evident fact that when contracts are obtained it is necessary to charge off the larger part of the first cost of the plant during the life of the contract, and that the cost of operation will be increased when it is necessary to consider sanitation and freedom from nuisance as the first object. It is only natural to expect the commercial side to be foremost, unless proper control is exercised by the municipality, whether the work is conducted by contract or by the municipality.

ACKNOWLEDGMENT.

This outline of essential requirements is quoted from a report by Irwin S. Osborn to the New York Disposal Corporation, which has the present contract for disposing of New York City's garbage.

ROADS AND STREETS

Costs and Methods on the Construction of a Large Concrete Sidewalk, Harrisburg, Pa.

Contributed by Joel D. Justin, Principal Engineer, Board of Public Works.

Nothing could be simpler than the construction of a good concrete sidewalk. Still there is no class of concrete work which is more often done in an unsatisfactory manner. The spalling and disintegration of concrete sidewalks is observable everywhere, and produces in the mind of the layman an unfavorable opinion of concrete work in general. When a property owner desires a concrete sidewalk, he obtains prices from several sidewalk contractors, specifying, generally, merely the length and width of the sidewalk. The cheapest man generally gets the work. Probably not one per cent of this class of work gets any supervision. Under such circumstances, competition forces a large proportion of inferior work.

In connection with the construction of a series of reinforced concrete retaining walls along the river front, the City of Harrisburg has just completed a concrete sidewalk 10,600 ft. long and 12 ft. 3 ins. wide.

The sidewalk which was built under rigid inspection, was constructed in alternate blocks 6 ft. 1½ ins. square and 6 ins. thick, with 1 part of cement, 2½ parts of sand and 4½ parts run of crushed limestone, maximum size 1 in. The mixture was made so dry that considerable heavy ramming was necessary to bring moisture to the surface. This concrete was then deposited in a block compartment and screeded and thoroughly tamped. The top coat mixed 1 part cement to 1½ part quartz sand, was mixed so dry that it is necessary to squeeze a ball of the mortar in the hand to bring moisture to the surface. The top coat is then spread over the concrete base and screeded and rammed into place, either with tampers or by striking heavily with the flat of the shovel. The surface is then finished off hard and smooth with floats and metal trowels.

It is essential that both concrete base and top coat should be placed fairly dry, as if either is wet, there is formed a minute layer of laitance between the base and the top coat. This causes a dividing plane, which frequently explains the peeling off of the top coat of sidewalk work as generally constructed.

TABLE. I.

		Totals Per Day.	Per Cu. Yd.	Per Sq. Yd.
Supplying Mixer—				
Cement, 1 man @ $1.50	$1.50			
Stone, 6 men @ $1.50 per 10-hr. day	9.00			
Sand, 2 men @ $1.50 per 10-hr. day	3.00	$13.50	$0.194	$0.032
Mixer Running—				
1 engineer @ $2.50	2.50			
1 fireman @ $2.00	2.00	4.50	0.065	0.011
Transporting Concrete—				
2 men on cars at mixer @ $1.50	3.00			
3 men on train @ $1.50	4.50			
1 horse @ $2.00	2.00	9.00	0.130	0.022
Placing and Ramming Concrete—				
4 men placing, ramming, screeding @ $1.50	6.00	6.00	0.086	0.014
Mixing Top Coat—				
5 men mixing @ $1.50	7.50	7.50	0.108	0.018
Transporting Top Coat—				
3 men wheeling @ $1.50	4.50	4.50	0.065	0.011
Placing and Screeding Top Coat—				
4 men @ $1.75	7.00	7.00	0.101	0.017
Finishing Top Coat—				
1 man @ $3.00.				
1 man @ 2.00.				
1 man @ 2.00	7.00	7.00	0.101	0.017
Setting Templets—				
1 foreman @ $3.00	3.00			
3 carpenters @ $2.00	6.00			
2 helpers @ $1.75	3.50	12.50	0.180	0.030
Finished Grading—				
1 foreman @ $2.00	2.00			
8 men @ $1.50	12.00	14.00	0.201	0.034
Total Labor Cost		$85.50	$1.23	$0.205
Coal mixer @ $3.10 ton		.78	0.011	0.009
Use of mixer, tracks and cars			.0444	0.024
Grand Total (aside from overhead)		$87.28	$1.26	$0.210
			Per Cu. Yd.	Per Sq. Yd.
Cost of Materials—				
1.4 tons stone @ 90 cts.			$1.26	$0.210
.7 ton sand @ $1.50			.91	.152
1.8 bbls. cement @ $1.10			1.98	0.330
Cost materials			$4.15	$0.692
Total labor, mixer-coal			1.26	0.210
Total cost			$5.41	$0.902

6 sq. yds. = 1 cu. yd. (6 ins. thick).

The writer has placed over one hundred thousand square yards of top coated concrete in the manner here outlined, where weather conditions are exceptionally severe and none of it has come off. He is firmly convinced that the method secures a perfect bond between the concrete and the top coat. Blocks placed in this manner have been broken up and removed and it was found impossible to separate the top coat from the base, the fracture in every case occuring elsewhere.

The sidewalk was located at the foot of a bank varying in height from 12 to 15 ft. A two bag batch steam driven mixer of the Milwaukee Paver type was stationed on the bank and moved from place to place under its own steam as the work progressed. Set ups were from two to three thousand feet apart. Sand, stone and cement were delivered by team on an asphalt street within 20 to 75 ft. of the mixer. The cost of cement delivered on the job was $1.10 per barrel net, including deduction for lost and stolen bags. Crushed stone cost 90 cts. per ton delivered on the job and sand $1.30 per ton.

After mixing, the concrete was dumped through a chute into Koppel cars, running on a narrow gage track beside the sidewalk. From the cars, the concrete was dumped directly into place. The top coat was mixed on the sidewalk and transported in wheelbarrows to the points required.

Each block 6 ft., 1½ ins. square and 6 ins. thick contained 0.695 cu. yds., requiring 1.25 bbls. of cement, 0.822 bbls. of this being in the concrete base and 0.428 bbls. in the top coat. The average was thus 1.8 bbls. per cubic yard including the top coat.

An itemized statement of the organization and cost per unit is given in Table I. The average output per 10-hour day was 100 blocks or 69.5 cu. yds. or 417 sq. yds.

It should be noted that no allowance has been made for overhead or depreciation. All other charges are included.

The work was done as an item of a large contract by the Stucker Brothers Construction Company of Harrisburg. The work was under the supervision of the Board of Public Works, of which James H. Fuertes of New York is Consulting Engineer, and the writer Principal Engineer.

The Economics of Pavement Repairing.

(Staff Abstract.)

To determine the economical limit of repairs two variables must be considered, and the limit will occur at the minimum of their sum. If a pavement surface is used for 20 years, one-twentieth of its cost may be taken as its annual depreciation; but if in use but 10 years, then one-tenth the cost is the annual depreciation. For any particular class of pavements there may be prepared a table of depreciation by dividing the cost of renewable surface by numbers representing the age of the pavement. For the cost of repairs, if at the end of 10 years 10 cts. per yard has been expended for repairs, the average rate has been 1 ct. per year. If at the end of 20 years 60 cts. per yard has been expended, then the average repair rate has been 3 cts. per yard per year.

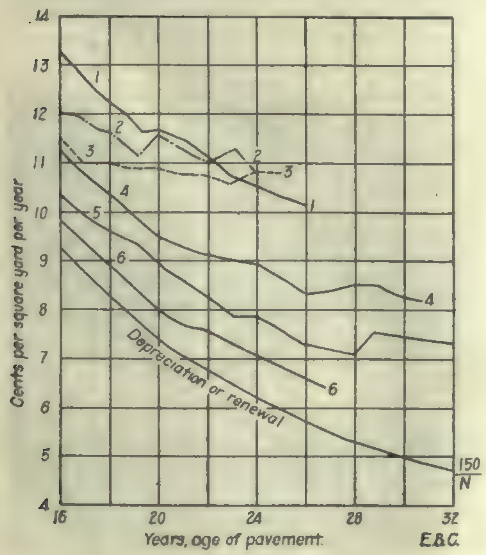


Fig. 1.

For an application of this method the tabulation Table I is made.

In the tabulation the cost of renewable surface is assumed at $1.50 a square yard. This amount is divided by the consecutive numbers representing age of pavement (column 1), and gives the annual allowance for depreciation as shown in column 5. The actual expenditures made annually for repairs per square yard are given in column 2. In column 3 are shown the totals of such repair cost to the given year, and in column 4 the average cost of repairs per year to that date (column 3 divided by column 1). Column 6 (the sums of columns 4 and 5) shows the cost of depreciation plus cost of repairs, and in this is to be found the minimum or limit of repairs. This example shows that the cost of providing the pavement over a term of years, depreciation plus repairs, had been a decreasing one except in the 28th year, where a large repair expenditure had raised the annual cost, but that a lower cost was reached thereafter.

An immediate use of such a tabulation is found in determination of the allowable repairs for any year. An inspection at once shows, with an annual cost of 9.5 cts. per yard per year at the 20th year, that if 9.5 cts. be expended in the 21st year the annual cost rate will remain the same. As the repairs in the 21st year were less than 9.5 cts. (5.8 cts.) the average annual cost was reduced to 9.3 cts. Had it exceeded 9.5 cts. the average annual cost would have been increased. From the above considerations the following rule is formulated:

TABLE I.

Age.	Annual cost of repairs.	Total.	Average annual cost of repairs.	Annual allowance for renewal.	Annual cost of pavement.
1 to 7	....	3.0	....	....	....
8	2.7	5.7	0.7	18.8	19.5
9	0.8	6.5	0.7	16.7	17.4
10	12.9	19.4	1.9	15.0	16.9
11	4.9	24.3	2.2	13.6	15.8
12	0.6	24.9	2.1	12.5	14.6
13	2.1	27.0	2.1	11.5	13.6
14	2.2	29.2	2.1	10.7	12.8
15	1.4	30.6	2.0	10.0	12.0
16	0.9	31.5	2.0	9.4	11.4
17	2.9	34.4	2.0	8.8	10.8
18	3.0	37.4	2.1	8.3	10.4
19	0.3	37.7	2.0	7.9	9.9
20	3.1	40.8	2.0	7.5	9.5
21	5.8	46.6	2.2	7.1	9.3
22	3.5	50.1	2.3	6.8	9.1
23	9.6	59.7	2.6	6.5	9.1
24	5.9	65.6	2.7	6.3	9.0
25	4.2	69.8	2.8	6.0	8.8
26	....	69.8	2.7	5.8	8.5
27	8.3	78.1	2.9	5.6	8.5
28	12.5	90.6	3.2	5.4	8.6
29	6.9	97.5	3.4	5.2	8.6
30	5.0	102.5	3.4	5.0	8.4
31	5.2	107.7	3.5	4.8	8.3

The allowable repairs for a succeeding year should not exceed the sum of the total cost of repairs to date, plus the cost of the wearing surface, divided by the age of pavement, and when the necessary repairs would exceed such amount the street should be resurfaced. This rule, like the celebrated artist's paints, should be applied with brains. It is believed to be sound, simple, easy of application, and a valuable aid to an engineer's broad judgment.

To fairly discuss the rule some applications are given. These are from maintenance records of sheet asphalt pavements in Buffalo, N. Y., where detailed records of yearly costs are available for nearly 700 contracts. In Fig. 1 are shown annual cost (repairs plus depreciation) for six streets with fairly uniform repairs. There is also plotted for reference the curve of depreciation (cost—150 cts.—divided by age), all figures in cents per square yard. Figure 2 shows the same record for three streets in which the rule of minimum cost has been violated and repairs continued. These streets may be described briefly as follows:

(1) 17,235 sq. yds., heavy traffic, about 5,000 tons per day, now in good condition except somewhat uneven.

(2) 5,800 sq. yds., heavy traffic street. Condemned in 24th year.

(3) 19,100 sq. yds., medium traffic street. General conditions warrant an early condemnation.

(4) 22,500 sq. yds., medium traffic. Condemned in 31st year and repaved in 32d year. This street is used for further study in Fig. 3.

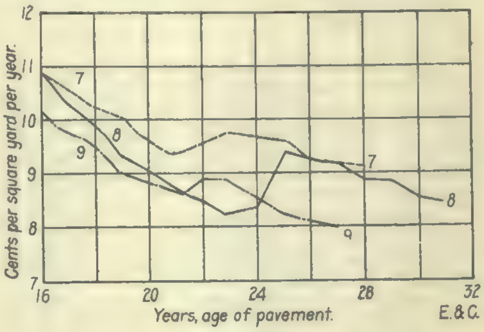


Fig. 2.

(5) 8,900 sq. yds., residence street. Laid on a bituminous base. Surface worn very thin, but bituminous base prevents deep holes.

(6) 5,800 sq. yds., short residence street of exceptionally low repair costs, 0.8 ct. per yard per year for 27 years; apparently destined for long life.

(7) 7,000 sq. yds., residence street in fairly serviceable condition. In its 22d and 23d years 27.6 cts. per yard was expended for repairs.

(8) 13,400 sq. yds., medium traffic street. One of several streets laid same year on which guarantee was voluntarily extended 3 years. In its 24th and 25th years 48.6 cts. per square yard was expended for repairs. Now in fair condition.

(9) 18,200 sq. yds., medium traffic residence street, now in fair condition. In 22d and 23d years 20.9 cts. per square yard was expended for repairs.

Some irregularities in these lines are due to known insufficiency of repairs or entire omission for one year.

In applying this rule several points should be borne in mind:

(a) Repairs due to settlements or other local causes may warrant a high rate when such repairs may place the whole surface in a satisfactory condition.

(b) Known deficiencies of repairs for a period followed by such as replace deficiency must be given due consideration.

(c) Due regard for general condition of whole surface. Occasionally pavements exhibit some traits of the celebrated "one horse shay."

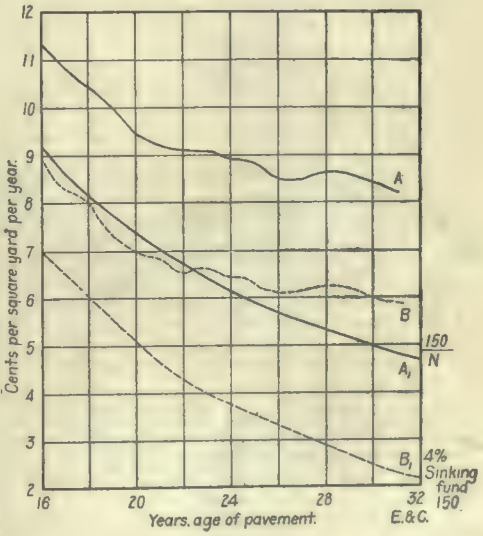


Fig. 3.

(d) If a pavement is plainly of quality below the average of its kind, its annual costs, while decreasing, may be so much above the reasonable expectations for its successor that the rule should be drawn tightly or perhaps forced; while with the reverse condition some leniency may be felt for one which is giving better than average service. This is illustrated by No. 5 above.

The impossibility of making such uniform repairs as to create a smooth curve of annual cost demands a careful study of the line, and a smoothed or average curve of cost may well be sketched and studied in making final decision.

This rule has been applied in Buffalo for about three years, at first as a check upon the opinions of those long in charge of such work, and later as a guide in the formation of such opinions, and it has been found to be most sound and to conform to judgment based on extended experience.

The argument for the use of a sinking fund curve instead of a straight depreciation, while theoretically warranted, has little practical merit.

In Fig. 3 is shown line A_1, straight depreciation or cost divided by age; line B_2 is the sinking fund curve at 4 per cent compound interest to produce $1.50 at the given age. They depart from the parallel by only about 0.1 ct. between 20 and 30-year ages—an immaterial amount. Above these lines have been plotted, as lines A and B, the record of street No. 4 of Fig. 1, based respectively on straight and sinking fund depreciation; they show no appreciable difference in character to warrant use of the more complicated sinking fund provision.

Another element may well enter into this problem. In the above discussion no allowance has been made for deteriorated condition of a roadway during its determined life. Generally an old surface will be uneven and less desirable even if intact and serviceable, and at times some weight should be given to such condition. It is possible in the rule herein suggested to make allowance for a deteriorated useful value of a wearing surface and also give weight to losses occasioned through interruption of traffic in resurfacing by decreasing or increasing the assumed value of the wearing surface.

No attempt has been made to discuss the various theories which have been advanced for this purpose, as such would of necessity be somewhat controversial. The pure theory of limitations of repairs may well have more extended and public discussion than is generally accorded to it. It is the essense of sound engineering and of vast financial import.—Extract from an article by Geo. H. Norton, in "Cornell Civil Engineer."

Increased Radius of Curb at Street Corners.

(Contributed.)

At most street intersections the radius of the curb at the street corner is such that a motorist desiring to turn the corner finds it impossible to describe an arc of turn that will enable him to maintain a moderate rate of speed and still keep his machine on the proper side of the pavement while turning into the cross street. The radius of the curb curve is usually but little over a foot, hence the driver cannot commence to turn until he has practically passed the corner. Increasing the radius of the corner curve up to say, 12 or 14 ft., will permit most types of cars to turn a corner at the same distance from the curb as when driving down the street.

Changes such as suggested by the accompanying sketch have been made at several street intersections in Chicago, notably at Lincoln Parkway and Diversey Boulevard, and at Devon and Evanston Avenues.

How materially the possibilities of making the desired turn within the proper confines are facilitated will be seen by referring to the sketch, Fig. 1. The double dotted lines show the curb at the usual street corner, while the double solid lines back of these illustrate what has been accomplished at the two localities mentioned—the change at Lincoln Parkway and Diversey Boulevard being shown in Fig. 2.

Without such construction, a driver following the line A in the direction noted by the arrow, and turning into the intersecting street, would have to cross its center line and could not pass two cars coming toward him as indicated by the arrows B. Increasing the radius of the curve, as shown by the solid lines, permits the driver to follow the arc of the curb and thus keep to the right of the center line of the street, where he properly belongs. This is clearly illustrated by the line C.

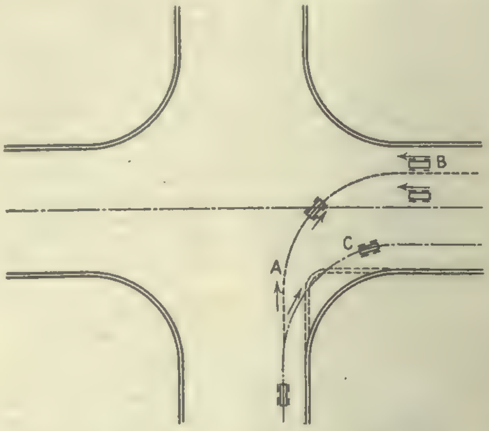


Fig. 1. Sketch Showing Ordinary and Large Radius Curb Corners.

Such an improvement is particularly desirable on boulevards or where other streets intersect with boulevards. It is likewise desirable at intersections of narrow streets. This subject deserves the attention of engineers in charge of street improvements, and the practice suggested should be universally adopted, if for no other reason than to increase safety.

Suggested Methods, Organization and Equipment for Concrete Road Construction.

(Staff Abstract.)

When it is considered that ordinarily from one-third to one-half of the total cost of constructing a concrete pavement is for the labor employed in doing the work after the materials are delivered, the importance of efficient organization, proper equipment and economical methods becomes readily apparent. Failure to give these features proper consideration may easily result in adding from 10 to 20 per cent to the cost of a concrete pavement, and has no doubt frequently caused road contractors to sustain a net loss on projects of this kind, where profits might have been made.

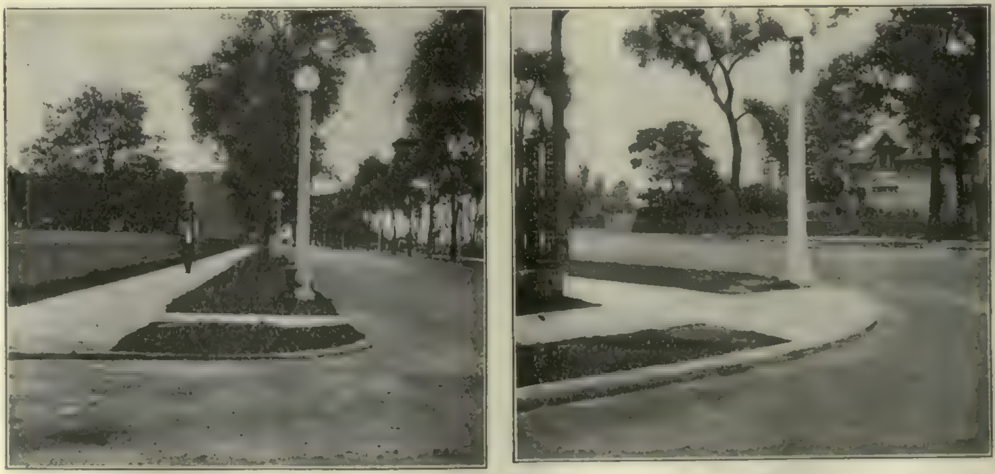


Fig. 2. Comparison of Ordinary and Long Radius Curb Corner at Lincoln Parkway and Diversey Boulevard, Chicago.

For the guidance of contractors in planning and executing their work, the points which are of most importance are, first, the proper order and progress of the work; second, the economic handling of materials; and third, the amount of capital necessary to carry on such work economically.

ORDER AND PROGRESS OF WORK.

In constructing a concrete pavement it is especially desirable that the work of mixing and placing the concrete be as nearly continuous as practicable after it is once begun. Where the mixer is permitted to stand idle for even a few days the force of laborers employed in operating it will usually become more or less disorganized, and an appreciable amount of loss and unsatisfactory work will generally result when the mixing is resumed. On this account the order and progress of the work should ordinarily be planned with the primary view to keeping the mixer going full time every working day that the weather will permit. This means that ample provision should be made for completing the drainage structures, the grading, and the preparation of the subgrade well ahead of the mixer, as well as for supplying the mixer with all necessary materials.

The drainage structures should preferably be completed in advance of the grading in order to obviate the necessity for moving embankment material the second time. Where the concrete materials are to be hauled out by means of an industrial railway, however, it is usually impracticable to extend the railway ahead of the grading, and the saving effected in hauling the materials for the drainage structures on the industrial railway may justify permitting the grading to proceed ahead of the drainage structures.

Rather than construct a concrete culvert sufficiently far in advance for the subgrade to be prepared before the mixer arrives, it may sometimes be economical to leave out a section of the pavement over the culvert. But the extra expense involved in going back and putting in a section of this kind after the work of laying the pavement has progressed a considerable distance ahead is usually considerable and is often underestimated by contractors. This method of doing the work also involves a delay in opening the road, and as a rule is very objectionable on that account.

The work of preparing the subgrade and setting the forms should preferably proceed sufficiently far in advance of the mixer to allow for two or three days' run. The prepared subgrade, if properly drained, dries out much more rapidly after rains than the rough grade, and thus it is possible to resume the placing of concrete much earlier than when the roadbed has not been shaped and rolled. A soaking rain will usually cause the prepared subgrade to heave slightly and make rerolling necessary, but ordinarily this is a very small item.

OPERATING THE CONCRETE MIXER.

In general it is economical to employ a mixer of the street-paving type for mixing and placing the concrete, though in some cases it has proved satisfactory to do the mixing in stationary mixers and haul the concrete out to its place in the road. This latter method is applicable to relatively only a very few sets of conditions, however, and will therefore not be discussed in detail.

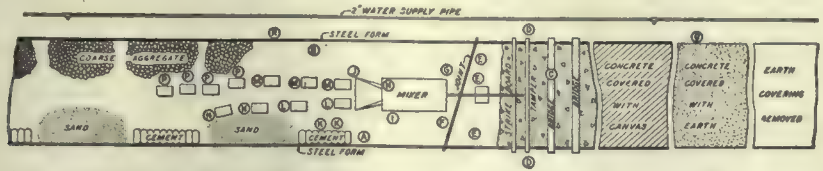


Fig. 1. Diagram Showing Distribution of Force, Using 2-bag Mixer.

A, foreman; B, subforeman; C, finisher; D, 2 laborers striking and tamping; E, 3 laborers placing concrete and assisting in striking; F, mixer tender; G, laborer cleaning subgrade and setting joints; H, mixer engineer; I, fireman, also sprinkles subgrade; J, laborer assisting wheelers and cement handlers; K, 2 laborers handling cement; L, laborers wheeling sand; M, 3 laborers wheeling coarse aggregate; N, 2 laborers loading sand; P, 4 laborers loading coarse aggregate; Q, laborer sprinkling pavement; R, water boy. Total, 2 foremen and 25 laborers. ▭ indicates wheelbarrow.

There are two sizes of street-paving mixers commonly used in concrete road construction. The smaller is capable of mixing a batch, of the proportions usually required, containing two bags of cement, and the larger will mix a batch containing three bags of cement. The larger size is economical where materials can be rapidly obtained and where the amount of work to be done is sufficient to warrant providing equipment for handling the materials necessary to keep the larger mixer running up to its capacity. Where the materials can be economically obtained only at a slow rate, or where the expense of providing facilities for handling large quantities of materials would be excessive, the smaller size of mixer is more economical to use. When efficiently operated, either size of mixer should ordinarily mix from 400 to 450 batches of concrete in a working day.

Organizing a force of laborers to operate a paving mixer efficiently requires considerable skill in handling men. The best results are generally obtained when a mixer is fully manned and each laborer is assigned definite work to perform.

The diagrams, Figures 1 and 2, illustrate mixer organizations for the two sizes of mixers in general use, which were worked out by a contractor of considerable experience. Laborers for preparing the subgrade, setting the forms, and for covering the concrete with earth should be provided in addition to those called for in the diagrams.

HANDLING MATERIALS.

One of the most difficult problems which has to be solved in connection with concrete road construction is that of determining the proper methods to employ in handling and delivering the materials for the concrete. The different kinds of material required must be delivered to the mixer in definite proportions at the same time, and it is evident that the location of the several sources from which the materials are obtained, with respect to each other and to the road, will have a very great influence in determining the most economical transportation methods.

Consider, for example, a project on which is used a concrete mixer of the street-paving type which mixes a batch containing three sacks of cement. If the work is to progress normally, the quantities of the different materials required each day will be approximately as follows:

Cement, barrels	320
Sand, cu. yds.	70
Coarse aggregate, cu. yds.	140
Water, gals.	8,800

In addition to the above, if the mixer runs continuously, about 10,000 gals. of water will be required each day for keeping wet that part of the pavement which will have been laid during the two preceding weeks, and for sprinkling the subgrade before the concrete is placed. This makes the total weight of water which may be required each day about 75 tons, and the total weight of all the materials combined about 420 tons per day.

The importance of the water supply is not always appreciated by contractors and engineers, and the provision made for delivering water on the work has sometimes been entirely inadequate. Another frequent error is that of overestimating the amount of water which a chosen stream is capable of supplying. In general, the most practicable method of delivering the water is to pump it through a pipe line laid along the road. The pipe should be at least 2 ins. in diameter, and for the mixer under consideration the pump should be capable of furnishing about 25,000 gals. of water in 10 hours to any point on the pipe line. Ordinarily at least 10,000 ft. of pipe will be required if the concrete is to be sprinkled for two weeks after it is laid.

The proper method of handling the cement is sometimes considerably affected by the requirements which the specifications provide regarding tests. Some specifications require that the cement shall be held until the results of the 28-day test are reported, while others permit its use as soon as it has satisfactorily passed such tests as may be made within seven days. If any tests of consequence are required and the sampling is not done until the cement arrives at the nearest railroad station, it will be necessary either to unload and store it or pay demurrage charges. This difficulty may be overcome to some extent by placing an inspector at the cement plant to collect and forward samples to the testing laboratory as soon as the cars are loaded. The testing may then be begun while the cars are en route.

Another plan sometimes employed to lessen the demurrage and avoid rehandling is to purchase bin-tested cement and have the cars loaded under the supervision of an inspector. When this is done, the cement may be used as soon as it arrives on the work, but the custom of cement manufacturers to make a slight additional charge for bin-tested cement may entirely offset the economical advantages gained by its use.

No matter what the arrangements for testing the cement may be, provision should usually be made for storing near the work sufficient cement to keep the mixer going for four or five days, in case that shipments are delayed, as frequently happens.

In general, the most satisfactory method of hauling the materials for the concrete is by means of an industrial railway constructed along one shoulder of the road, though this method is not always the most economical. Teams, traction engines with trailers, and motor trucks with or without trailers have each been frequently used for this purpose, and are no doubt each economically best adapted to certain sets of conditions. But all these are objectionable from a construction standpoint on account of the damage which they usually do to the subgrade.

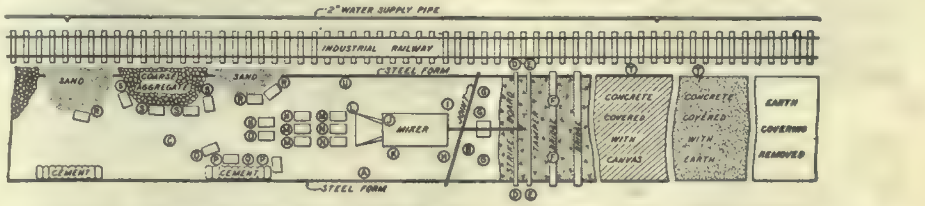


Fig. 2. Diagram Showing Distribution of Force, Using 3-bag Mixer.

A, foreman; B, subforeman on placing concrete; C, subforeman on charging mixer; D, 2 laborers striking; E, 2 laborers tamping; F, 2 finishers; G, 3 laborers placing concrete; H, mixer tender; I, laborer cleaning subgrade and setting joints; J, mixer engineer; K, fireman, also sprinkles subgrade; L, laborer assisting wheelers; M, 3 laborers wheeling sand; N, 4 laborers wheeling coarse aggregate; O, 2 laborers wheeling cement; P, 2 laborers handling cement; Q, laborer opening bags; R, 3 laborers loading sand; S, 4 laborers loading coarse aggregate; T, 2 laborers sprinkling pavement; U, water boy. Total, 3 foremen and 36 laborers. ▭ indicates wheelbarrow.

Among the advantages possessed by an industrial railway for hauling the concrete materials are:

(1) Materials may be delivered without disturbing the subgrade.

(2) The railway may be readily operated along the shoulder of a newly laid pavement, which makes it practicable to prosecute the work at any desired point.

(3) Hauling is affected comparatively little by weather conditions.

(4) Where there is sufficient work to keep an industrial railway outfit busy, it is usually economical, especially where the size of the projects is such that the railway can be operated continuously throughout a season on the same project. The purchase of an industrial railway outfit, however, usually involves a greater outlay of capital than is desirable for a single project.

From a purely economical standpoint the choice of means for hauling the materials would probably be made about as follows:

First. Where the maximum haul does not exceed 3 miles and the amount of concrete to be laid does not exceed about 5,000 cu. yds., team haul would probably be economical.

Second. If the amount of concrete to be laid exceeds about 5,000 cu. yds., or if the maximum haul exceeds about 3 miles, and the materials are hauled in from the same direction, an industrial railway, tractors, or motor trucks may be economically used.

Third. Where the materials are hauled in from each end of the road, or where it is desired to operate more than one mixer at the same time, the industrial railway is usually more practical and economical.

Where the sand and coarse aggregate are shipped in by rail, the work of unloading the railroad cars and loading the wagons or cars in which the materials are to be hauled out to the work can usually be most economically done by means of machinery especially adapted to this kind of work. In order to avoid paying demurrage, and to have the materials on hand when they are needed, it is nearly always necessary to handle a considerable part of the materials the second time. Hence it may be desirable to have two sets of unloading and loading machinery in cases where the stock piles and bins are located out on the work instead of at the siding where the materials are delivered.

The kind of unloading and loading device to employ depends to a very great extent on the quantities of materials to be handled and the other conditions to be met. If the stock piles and bins are adjacent to the siding where the materials are delivered, and a considerable quantity of work is to be done, a locomotive crane may frequently be used to advantage, while, if the stock piles and bins are out on the work, it may be economical to handle the material at the siding with scrapers or similar devices and install an elevating device at the bins where the materials are stored. In other cases the extent of the work may not be sufficient to warrant any machinery whatever for handling the materials, in which event the handling may be rather expensive.

CAPITAL REQUIRED.

The amount of capital required to carry on concrete road construction successfully depends almost wholly on the size of the project and the circumstances under which the work is to be done. Where a considerable quantity of work is to be done in the same community it may be possible to keep a very elaborate equipment busy, even though the individual projects are comparatively small. On the other hand, it may be poor economy to provide more than the smallest practicable equipment for a rather large project in a community where few other concrete roads are likely to be constructed.

The equipment necessary for handling and hauling the materials frequently represents a much greater outlay of capital than all other expenditures combined, but, as has already been pointed out in discussing the handling of materials, the conditions affecting this feature of the work are subject to great variation. A general discussion as to the cost of this part of the equipment, therefore, would usually be of small value in connection with any particular project and will not be undertaken.

The equipment necessary for doing the rough grading in connection with concrete road work is not essentially different from that required for grading other types of roads. Since the amount of capital necessary to provide grading equipment to suit various sets of conditions is familiar knowledge to practically all road engineers and contractors, this feature will not be discussed here.

The capital required to provide equipment for preparing the subgrade and mixing and placing the concrete depends on the rate at which it is purposed to carry on the work. The lists given below show the approximate cost of outfits using either a 2-bag or a 3-bag mixer.

OUTFIT NO. 1 (2-BAG MIXER).

1 rooter plow	$ 50
1 road grader	300
1 heavy 4-horse plow	30
Shovels, picks, and other small tools	75
1 10-ton macadam-type road roller	2,500
1,800 ft. of steel forms, complete with stakes, etc.	200
1 pump and engine capable of delivering at least 1,500 gals. of water per hour	175
10,000 ft. of 2-in. wrought-iron water pipe, with valves every 200 ft.	950
400 ft. of rubber hose, with couplings	80
12 wheelbarrows	60
1 concrete mixer, with skip and distributing device	1,600
Strike board, tamper, mortar hoes, sledges, etc.	100
Total	$6,120

OUTFIT NO. 2 (3-BAG MIXER).

1 rooter plow	$ 50
1 road grader	300
1 heavy 4-horse plow	30
Shovels, picks, and other small tools	100
1 10-ton macadam-type road roller	2,500
3,000 ft. of steel forms, complete with stakes, etc.	325
1 pump and engine capable of delivering at least 2,500 gals. of water per hour	300
10,000 ft. of 2-in. wrought-iron water pipe, with valves every 200 ft.	950
600 ft. of rubber hose, with couplings	120
20 wheelbarrows	100
1 concrete mixer, with skip and distributing device	2,000
Strike board, tamper, mortar hoes, sledges, etc.	100
Total	$6,875

Ordinarily the method of paying for the work should enable the contractor to meet most of his bills for labor and materials after the first one or two estimates, so that the total amount of capital required for carrying on the work need not greatly exceed the cost of the equipment. For the average small project, where no very elaborate equipment is required to handle the materials, it seems that a total working capital of about $10,000 should be sufficient.

ACKNOWLEDGMENT.

Extract from Bulletin No. 249, U. S. Department of Agriculture, Office of Public Roads, by C. H. Moorefield and J. T. Voshell.

County Must Pay for Engineering Mistakes.—The United States Circuit Court of Appeals has reversed the action of the lower court and ordered a trial of the suit brought by the American Pipe and Construction Co. of Pennsylvania to recover $891,952 from the county of Westchester. This amount, it was alleged in the complaint, was the aggregate of extra expenses incurred by the Mack Paving and Construction Co. in building the Bronx Valley sewer, due to mistakes in the engineering plans. The District Court dismissed the suit, holding that the whole of Westchester County was not obligated to stand the expense of the sewer improvement which benefited only a part of the county. In reversing the ruling of the lower court, Judge Rogers said that the expense of the sewer improvement must rest on the whole of Westchester County because there is no other political subdivision upon which it can rest. Judge Rogers, in conclusion, said the sewer was built for the benefit of Westchester County and will be maintained by it, and the Bronx Valley Sewer Commission being only an agent, the county is responsible for its debts.

BRIDGES

New Bridge of the Chicago, Burlington & Quincy R. R. Over the Missouri River at Kansas City, Mo.

(Staff Article.)

Contracts have been let by the Chicago; Burlington & Quincy R. R. for the replacement of the old Hannibal bridge across the Missouri River at Kansas City, Mo., with a new bridge located adjacent to the old structure. The new bridge will form a square crossing of the river, while the present structure makes an angle of about 15° with the perpendicular to the harbor lines. The south end of the new bridge will coincide with the south end of the old structure.

The new bridge will be a double-track structure and will consist of a 75-ft. girder approach span at the north end, two 330-ft. fixed spans, a 450-ft. swing span across the main channel, and girder approach spans at the south end, one of which, a 120-ft. span, will lie inside of the south harbor line. The truss spans will be of the pin-connected Pratt type with sub-divided panels. Each span, including the girder spans, will have two decks, the lower deck being used for railway traffic and the upper one for highway traffic. The top of the highway deck will be 24.87 ft. above the base of rail of the lower deck, while the vertical clearance of the bridge above standard high water will be 26.25 ft. The swing span provides a clear channel of 200 ft. on each side of the pivot pier. Figure 1 is an elevation of the bridge illustrating the general design features.

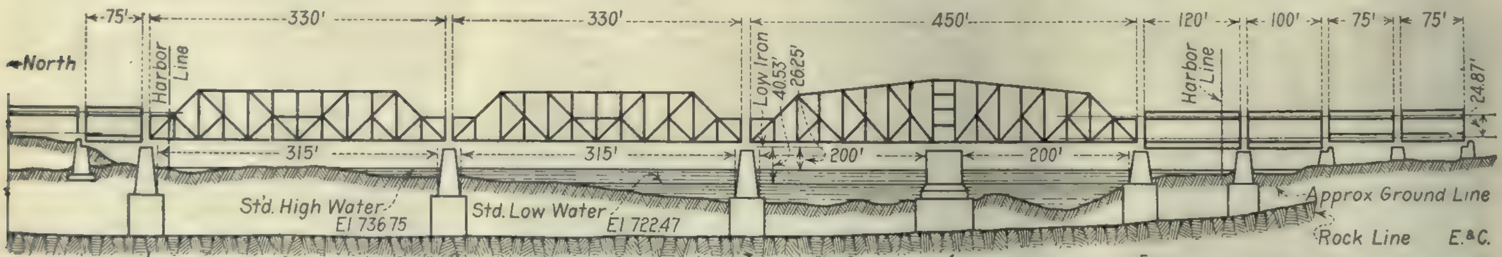


Fig. 1. General Elevation of New Bridge of Chicago, Burlington & Quincy R. R. Over Missouri River at Kansas City, Mo.

The highway deck will be approached from the south by a viaduct having a 6½ per cent grade, which will connect with Broadway; another viaduct, also on a 6½ per cent grade, will form an approach at the north end of the structure.

The trusses are designed for a live load consisting of two Cooper's E-90 engines, followed by a uniform load of 7,500 lbs. per foot on one track and a uniform load of 7,500 lbs. per foot on the other track, except the floor system, sub-diagonals and hangers which are designed for two Cooper's E-90 engines on each track. The allowable unit tensile stresses are: 35,000 lbs. per square inch for nickel steel eye-bars, 25,000 lbs. per square inch for the silicon steel which is to be used in the main members of the trusses, and 18,000 lbs. per square inch for the medium steel to be used in all other parts of the bridge.

The piers for the truss spans and for the girders of the south approach will be carried to bedrock, which lies at depths varying from 70 to 130 ft. below the base of rail. These piers will be sunk by the pneumatic process. By referring to Fig. 1 it will be noted that the rock surface dips rapidly toward the south.

PERSONNEL.

The design and construction of the bridge are under the direction of C. H. Cartlidge, bridge engineer of the Chicago, Burlington & Quincy R. R., to whom we are indebted for the foregoing data. The steelwork—about 5,500 tons—will be furnished by the American Bridge Co., and the substructure will be built by the Union Bridge & Construction Co., of Kansas City, Mo.

Erection Progress on the Quebec Bridge.

(Staff Article.)

In previous issues we have published data on the design and construction of the Quebec Bridge. To indicate the progress which is being made on the erection of this bridge, Figs. 1, 2 and 3 are shown. Fig. 1 is a view of the north anchor arm showing the condition of the work at the close of the season of 1914, the view being taken Dec. 4, 1914. At this time the traveler for the south half of the bridge was about half erected, but no steel had been placed in the south anchor arm.

Figure 2 is another view of the north anchor arm showing progress on Aug. 3, 1915. It will be noted that the staging (see Fig. 1) which carried the floor and the track for the traveler has been removed, leaving only the towers used to support the anchor arm until the cantilever arm is completed.

Figure 3 is a general view showing the erection progress on both shores on Aug. 3, 1915. By referring to this view it will be noted the staging for the floor and traveler has been erected on the south shore; the shoes and the bottom chords are also in place.

At the end of the season of 1914 there were in place on the north shore 12,750 tons of steel, and on the south shore 850 tons, including the approaches. During the present season, May 1 to Aug. 1, there have been erected 10,000 tons of steel on the north shore and 5,400 tons on the south shore. The total weight of the steel erected up to Aug. 1, 1915, is therefore 29,000 tons.

The bridge is being erected by the St. Lawrence Bridge Co., Ltd., of Montreal, Canada; George F. Porter, engineer of construction, W. B. Fortune, superintendent. We are indebted to Mr. Porter for the foregoing data and for the views shown.

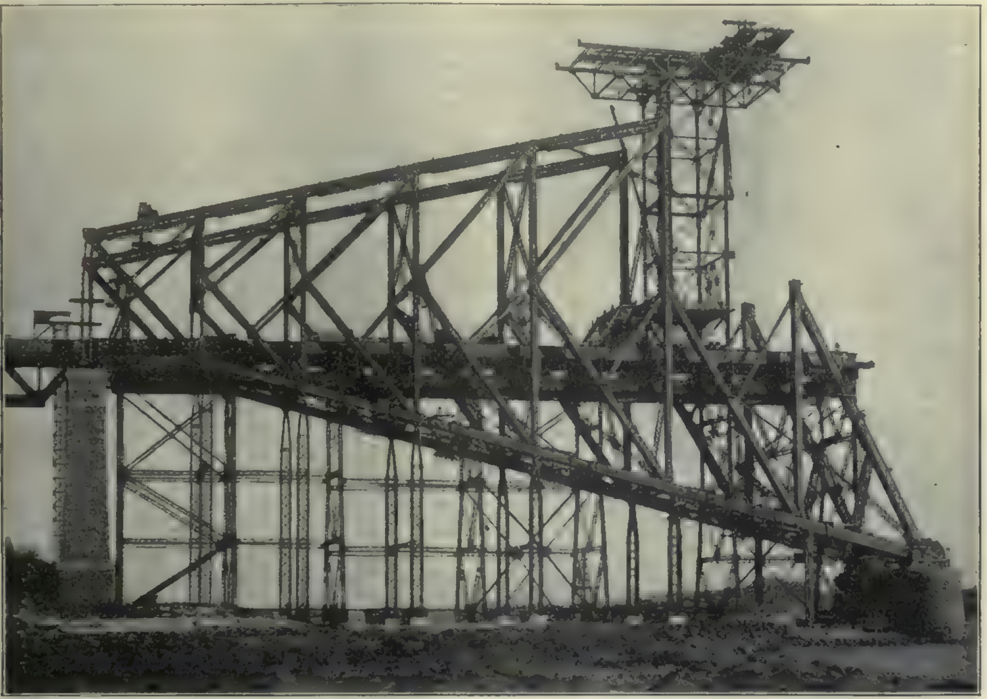


Fig. 1. View from West of North Anchor Arm of Quebec Bridge Showing Erection Progress at Close of Season of 1914—View Taken Dec. 4, 1914.

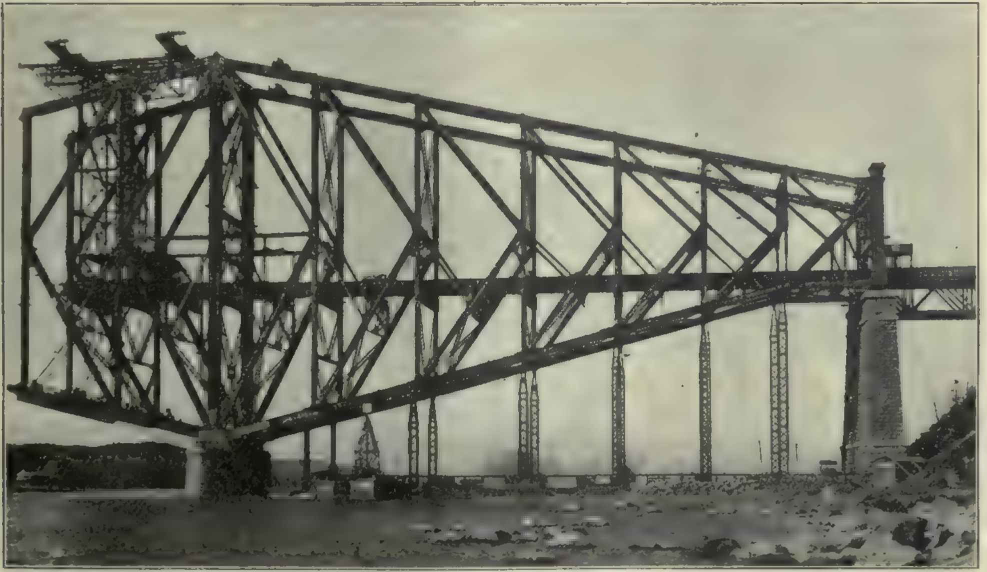


Fig. 2. View from East of North Anchor Arm of Quebec Bridge Showing Erection Progress on Aug. 3, 1915. Note That Staging for Floor and Traveler Shown in Fig. 1 Has Been Removed—About 10,000 Tons of Steeel Erected Since View of Fig. 1 Was Taken.

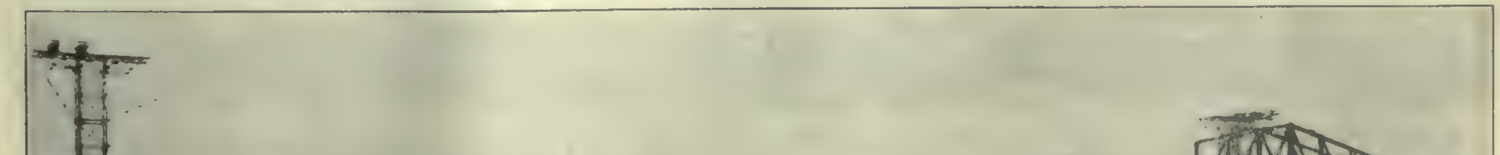


Fig. 3. View from East of Quebec Bridge and Site, Showing Erection Progress at Both Ends on Aug. 3, 1915.

Design, Construction, Operation and Cost of a 2,594-Ft. Steel Stocking Trestle at the Negaunee Mine, Negaunee, Mich.

(Staff Abstract.)

A common method of stocking ore is by the gravity system, the tracks being laid on the pile of ore as it is stored, at a grade sufficient to run the cars to the end of the pile. The cars are brought back either by a puffer or by trammers. For handling a large product the gravity system is often impracticable as the necessary grade reduces the height of the pile and therefore its capacity. As the height decreases the length of tram increases rapidly, and it is difficult and expensive to maintain the tracks in proper alignment. Moreover, delays in hoisting are frequent and expensive. It has been shown at mines of large production that it is more economical to erect wooden trestles and to use some mechanical means of stocking. On the other hand, the yearly cost of erecting and dismantling wooden trestles is large. With certain classes of ore the yearly breakage of trestle legs will amount to as much as 33 per cent. An actual record kept of a trestle at a large mine showed that in six years not a single stick of the original timber was in use.

PRELIMINARY INVESTIGATIONS.

For a number of years the writer has believed that it would be more economical to stock ore from permanent steel trestles. In 1909, when it was found necessary to sink a new shaft at the Negaunee mine, the writer began to collect data in order to make some preliminary estimates as to the comparative cost of wood and steel trestles. He submitted several sketches of steel trestles to J. F. Jackson, of the Wisconsin Bridge & Iron Co. When the cost of maintenance of wooden trestles had been explained to him, Mr. Jackson stated that it was his opinion that for a mine with a long life the cost of a steel trestle would not be excessive. He prepared some sketches and submitted approximate estimates of steel trestles. From these the writer was able to make some comparative estimates which showed conclusively that if a practicable steel trestle could be constructed it would mean a large saving for any mine which had a life of ten years or more. The bridge company was asked to make final drawings and to submit bids for a steel trestle. These bids were accepted, and the tresle was constructed.

The average wooden trestle used by the Cleveland-Cliffs Iron Co., costs approximately $6 per linear foot. The cost for labor each year in erecting and dismantling amounts to $1.20 per linear foot, and the entire stocking trestle must be renewed in about six years. A wooden trestle must be dismantled in order to load the ore with a steam shovel. It is not unusual during busy seasons for railroads to fail to supply mines with a sufficient number of cars to ship the current hoist from the shaft pockets; if this occurs after the trestle is dismantled, a great loss in time and money results from the delay. Even if a part of the trestle has not been torn down the ore can not be stocked by hand, because the modern top tram car is too heavy, and special cars would have to be provided. At other times the railroads are unable to supply the mines with cars because of strikes on docks, or because storms delay boats and a shut-down therefore becomes necessary. A permanent steel stocking trestle would provide against all such delays, as the tracks would not have to be disturbed to load with steam shovels, and it would therefore be possible to stock ore at any time. On a steel trestle permanent tracks could be maintained in the best possible condition for stocking, and no delays would be caused by cars falling from the trestle. On account of the foregoing reasons, but particularly on account of the large saving in money over a long period of years, it was decided to install a permanent steel trestle at the Negaunee mine.

COLUMNS AND FOUNDATIONS.

At intervals of 114 ft. there are concrete columns, the upper parts of which for a distance of 28 ft. 6 ins. are 4 ft. in diameter and the lower 10 ft. are belled out to a diameter of 6 ft. at the bottom. The plate shells of the columns are ¼-in. thick. They rest on and are bolted to pyramid-shaped reinforced concrete bases, which are 12 ft. wide, 26 ft. long and 6 ft. deep. Each base is reinforced with 52 ⅞-in. round rods, which radiate in all directions through the base and extend up into the shells for a distance of 20 ft. (see Fig. 1). In the bottom of each pyramid the rods are tied to seven old rails, which extend across the long dimension of the base. At a point about 20 ft. above the base the rods are attached and properly distributed around two horizontal rings in the shells. Above these rings other rods are spliced so that the reinforced bars extend to within a few inches of the top of the columns. The height of the trestle from rail to sollar is 42 ft.

When the excavation for the base of a column was made and the form constructed the rails and reinforcing bars were placed in position and wired to keep them from shifting. The six heavy anchor bolts, to which the steel shell is bolted, were suspended from a templet and lined up by the engineers. In order to allow a small clearance these anchor bolts were all set in sections of pipe. A concrete mixer was set over the edge of the excavation and the concrete dumped directly into the form. While one form was being filled the carpenters were busy constructing the form for the next base. In a short time after one base was completed the forms could be moved to the next excavation. In this way only a small amount of lumber was used. Before the bases were completed the bridge builders were on the ground and were ready to begin placing the steel shells in position. For handling the heavy shells a railroad track was laid along the entire length of the trestle.

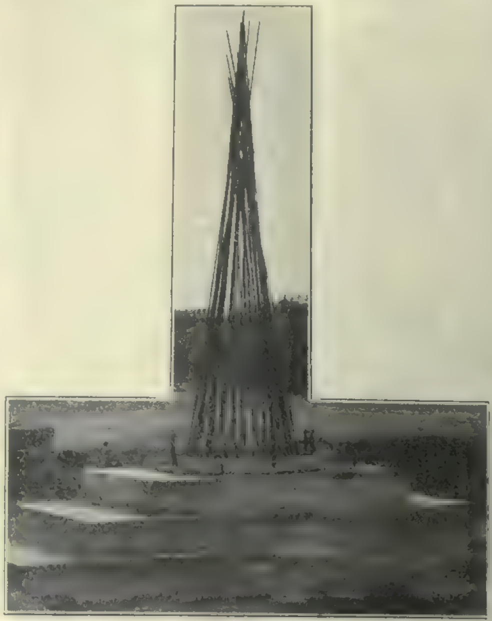


Fig. 1. Concrete Base and Reinforcement for Cylindrical Column of Stocking Trestle at Negaunee Mine.

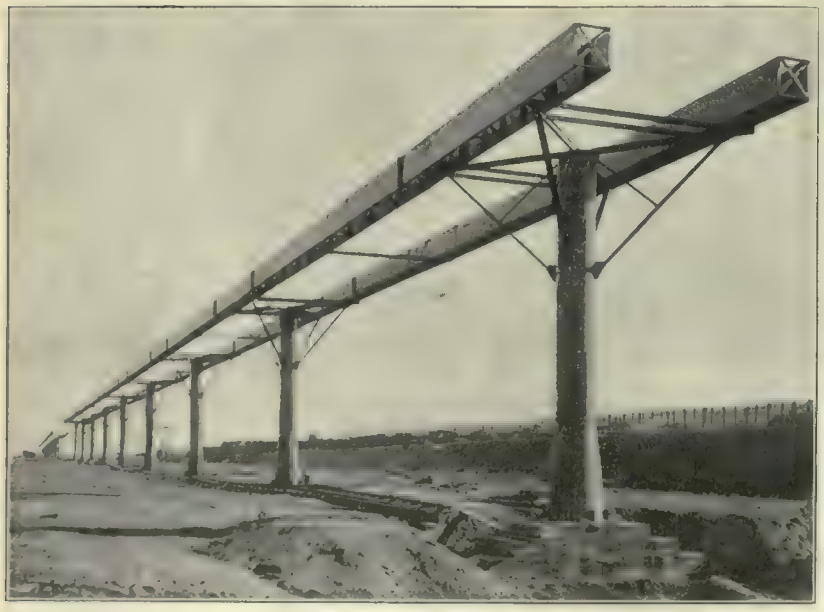


Fig. 2. View of Columns, Girders and Bracing for Stocking Trestle at Negaunee Mine.

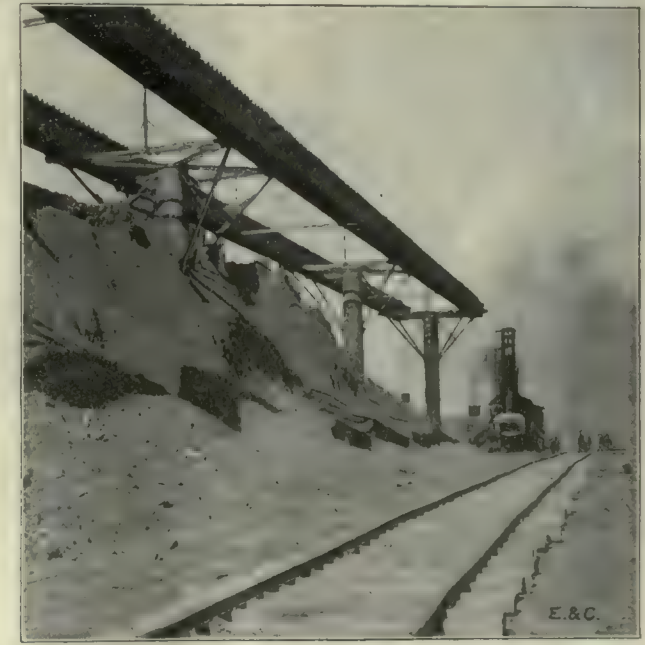


Fig. 3. View of End Portion of Stocking Trestle Showing Steam Shovel in Position for Taking Second Cut in Ore Pile.

The length of span between columns is 114 ft. Extending 19 ft. each way from the center of each column there are two short plate girders, each 38 ft. in length. Between these girders there are two other girders 76 ft. long, thus making the total span of 114 ft. (see Fig. 2). As soon as one span was bolted together two shells could be filled with concrete. A "puffer," operating two small steel cages, in balance, was set up midway between the two shells, thus filling them simultaneously. To one end of the drum of the puffer was attached a spool, and around this spool a ⅝-in. wire rope was wrapped four times. The ends of the rope extended from the spool at an angle of about 30° to sheaves supported about 6 ft. above the top of the shells. The cages were constructed to run on wire-rope guides from the ground to the top of each shell, the rope serving simply to keep the cages from twisting. The hoisting rope was so adjusted that when one cake was on the ground the other was above the shell. Concrete was loaded in small concrete buggies having a capacity of about ¼ cu. yd. As it was feared that the dumping of the material might throw the columns slightly out of line, if the shells were filled completely in one operation, they were filled a little over half full one day and completed the following day. After the shells were filled the surface was rounded off with a rich mixture and made as smooth as possible, to keep water from getting between the concrete and the steel jacket. The work was constantly inspected to insure that the shells did not shift or get out of alignment.

SUPERSTRUCTURE.

At each column the girders rest on horizontal 8-in. I-beams supported by four braces which are firmly connected to the columns and which extend down at an angle of 45° (see Fig. 2). The plate girders are made up of angles and two 42x¼-in. plates. The distance from center to center of girders, or center to center of tracks, is 20 ft. The entire length of the part of the trestle from which ore can be stocked is 2,094 ft. In addition, there are 500 ft. of curved trestle extending from the shaft and connecting with the stocking trestle. The legs of the curved part are built up of angles and channels, and the stringers are channels and I-beams. On top of the I-beams holes are provided for bolting 5-in. nailing strips. On top of these nailing strips are spiked a 5x7-in. sollar to serve as ties. The 40-lb. rails on the plate girders are spiked to 5-in. sawed ties 4 ft. in length. The gage of the track is 30 ins. On the outside of the girders the ties are bolted to 4x4-in. timbers placed snugly against the girders. These timbers prevent any shifting of the track at right angles to the length of the trestles. To prevent the ties from creeping they were attached at intervals, by hooked bolts, to the small angles inside of the girders. Since the tracks were completed, about two years ago, not a cent has been spent on them. They are now in as good alignment as when first put in.

OPERATION OF STOCKING TRESTLE.

The trestle was built under a guarantee to support a moving load of 10 tons. It was placed in commission during the fall of 1912 and has been used continuously since that time. No defects in construction or design have been discovered. No delays in loading with the steam shovel have been occasioned. In the second cut taken by the shovel the track runs fairly close to the piers (see Fig. 3). The operator, before reaching a point where the pier would prevent his boom from swinging, digs into the pile as far as possible. He then moves the shovel ahead until the front part of it is directly opposite the far edge of the pier. By digging in at right angles to the shovel he is able to get all of the ore in the cut except a small strip on the other side of the pier. The small amount of hand work required for this is negligible. With the wooden trestles there is considerable delay in pulling out legs, and consequently ore can be loaded more rapidly from the steel trestle.

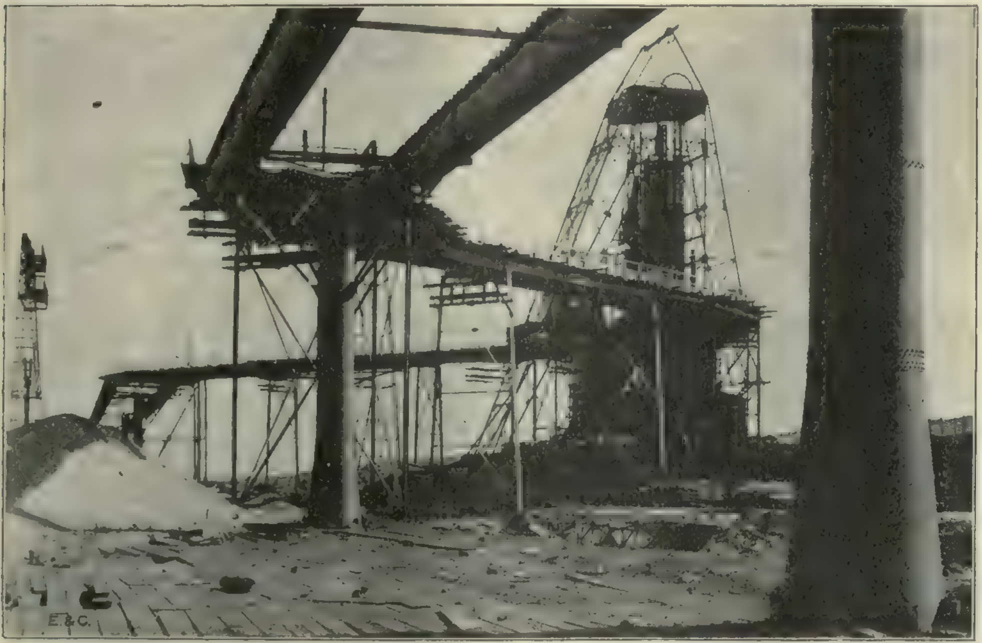


Fig. 4. View of Superstructure of Negaunee Mine and of Curved Portion of Stocking Trestle.

At the shaft the ore is dumped during the stocking season into special saddle-back cars of about five tons capacity. These cars are operated by the tail-rope system, the power being furnished by two 75-kw. motors. The cars are of special construction, and they dump automatically simply by running over a dump-jack placed between the tracks at the desired point on the trestle. This releases the catches and allows the doors to open. By shifting a lever on one end of the car, three grades of ore can be stocked from each track. On top of the plate girders, between the rails, the ⅝-in. rope is carried on wooden rollers. On the end of the trestle it passes around a roller-bearing sheave 2 ft. in diameter. Below the tracks the return rope is supported on small sheaves placed at intervals of about 30 ft. The slack is taken up by four special tighteners which are placed at the end of each track. Each tightener consists of a truck, to one end of which is attached a 2-ft. roller-bearing sheave, and from the other a rope passes over a stationary sheave to a large iron bucket suspended below the trestle. The slack in the rope is controlled by putting the proper weight in the bucket (see Fig. 3). The placing of the tighteners at the end of the line, rather than near the winding drums at the shaft house, has been found to be a great improvement. Figure 4 is a view of the mine superstructure and of the curved portion of the trestle.

The common method of disposing of the rock is to dump it into a special car which runs out on another trestle from a switch on the main line. At the Negaunee mine the rock dump consists of a wooden trestle built at the extreme end of one of the permanent trestles. Rock can be hoisted at any time and disposed of without delay or extra labor simply by throwing a lever on the end of the car and sending it to the rock dump. This method has been found to be very practicable and to save considerable time. Great care was used in laying the tracks on the entire trestle and in giving the curves the proper elevation, the consequence of which is that the cars can be run at a speed as high as 1,400 ft. per minute on the straight part without danger of their leaving the track.

COST DATA.

Table I gives the total and unit costs of the various items of the piers and trestle.

COMPARATIVE COSTS OF WOODEN AND STEEL TRESTLES.

From the figures obtained from several mines it has been found that in five years the total cost of repairs and renewals on wooden stocking trestles amounts to the original cost of the trestle. Breakage in legs is exceedingly high, often amounting to as much as 33 per cent per year. If, for any reason, ore is not shipped and the legs are allowed to remain in the pile for several seasons it has been observed that they rot rapidly. Weather conditions have considerable to do with the percentage of broken legs. If ore is dumped on a frozen face of the stock pile, and this new ore freezes rapidly, it will often move in a mass down on the frozen face and break the legs. Large masses of frozen ore also shift in this way during loading with the steam shovel.

The cost for erecting and dismantling was accurately kept at two large mines for a period of years, and was found to amount to $1.20 per foot. Under unusual conditions this cost has run as high as $1.60 per foot. The portion of the trestle between the shaft and the point where ore is stocked is usually called the permanent trestle, the other part being the stocking trestle. The permanent trestle is put up in a very substantial way and is very expensive, costing as much at $15 per foot. After a period of 10 years this permanent trestle is sure to be in bad repair. A few of the stringers not directly below the tracks will probably last for a short additional time, but for the sake of an estimate it can be assumed that the permanent trestle will have to be entirely rebuilt in 10 years. In making the following comparative statement of the cost of wood and steel trestles, the expenditure each year at 6 per cent compound interest has been used. This yearly expenditure has been capitalized and figured at compound interest for a period of 20 years. It is found that at 6½ years the costs for wooden and steel trestles of the same length are practically identical. As the length of time increases the capitalized amount for repairs, renewals, erecting and dismantling, figured at 6 per cent compound interest, increases very rapidly. At the end of 20 years the saving in favor of the steel stocking trestle is $117,000. It is impossible to estimate the saving due to better tracks and operating conditions, and consequently the minimizing of delays on the surface. With a wooden trestle a certain number of carpenters and extra laborers must be employed. Only a part of their time can be charged against the stocking trestle, but it is necessary to have them so that they can be used when repairs are needed. At the Negaunee mine we have only one carpenter, whose entire time is spent in the shop.

TABLE I.—TOTAL AND UNIT COSTS OF PIERS AND TRESTLE.

Piers.	Total cost.	Cost per yd.
Excavation, 1,800 cu. yds.	$ 994.65	$ .553
Concreting, 1,352 cu. yds.	5,142.70	3.80
Bolts, washers and forms	2,167.94	2.185
Reinforcing steel	1,423.89	1.053
Total	$9,729.18	$7.197
Average cost per pier	540.41	
Trestle (2,594 lin. ft.)	**Total cost.**	**Cost per lin. ft.**
Steel erected, 2,594 lin. ft.	$35,100.00	$13.53
Columns (18), covering 2,094 lin. ft.	9,729.18	4.65
Small piers for curved trestle (20), 500 lin. ft.	641.93	1.28
Decking, 500 lin. ft.	1,870.07	3.74
Ties and fastenings, covering 2,094 lin. ft.	1,627.59	0.78
Walk and railings, 500 lin. ft.	358.78	0.72
Temporary tracks for unloading, 2,594 lin. ft.	355.89	0.14
Rails and laying, 2,594 lin. ft.	1,545.48	0.60
Total	$51,228.92	$19.71

Table II gives the comparative costs of wood and steel trestles, taking the life at 6½ and at 20 years.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Stuart R. Elliott, local superintendent, The Cleveland Cliffs Iron Co., presented before the Marquette Range meeting of the Lake Superior Mining Institute.

TABLE II.—COMPARATIVE COSTS OF WOOD AND STEEL STOCKING TRESTLES.

	6½ years.	20 years.
Permanent wood trestle.		
Original cost, 500 ft. at $15.	$ 7,500.00	$ 7,500.00
Repairs and renewals, 10 per cent per year	4,875.00	15,000.00
Six per cent compound interest	4,692.29	30,798.02
Total	$17,067.29	$53,298.02
Temporary wood trestles.		
Original cost, 2,094 ft. at $6.	$12,564.00	$12,564.00
Repairs and renewals, 20 per cent per year	16,333.20	50,256.00
Erecting and dismantling, $1.20 per foot per year	16,333.20	50,256.00
Six per cent compound interest	14,063.33	122,822.09
Total	$59,293.73	$235,898.09
Total cost wooden trestles	$76,361.02	$289,196.11
2,594-ft. steel stocking trestle.		
Original cost	$51,228.92	$ 51,228.92
Estimated maintenance cost	1,300.00	4,000.00
Six per cent compound interest	23,949.51	116,867.78
Total	$76,478.43	$172,096.70
Net saving of steel trestle.	117.41	117,099.41

A Simple Method of Determining the Stresses in Concrete Arches Due to Temperature and Rib Shortening.

Contributed by Horace R. Thayer, Asst. Prof. Structural Design, Carnegie Institute of Technology.

This article will consider the problem of finding the reactions and stresses due to temperature and rib shortening in a plain or reinforced concrete arch. The methods are made as simple as possible in order to put them within the grasp of all engineers. For this reason the somewhat complicated underlying theory will be omitted here. It might be stated, however, that it is simply the conventional treatment as an elastic arch, solved graphically.

The effect of a change of temperature on a free arch would be to cause an alteration of length equal to the product of 0.000006 by the number of degrees Fahrenheit change in temperature by the span. The mean value of the second factor is about 30, varying with the climate and the exposure of the masonry, with a variation from the average of 50 per cent either way. Let us call the amount of the change, D_1, which will vary from ⅛ to ⅝ in. in each 100 ft.

The effect of rib shortening may be computed by dividing the average unit stress per square inch on the arch ring by 2,500,000 and multiplying the quotient by the span. Flexural stress must not be included in the first factor. The second value is E, the modulus of elasticity, also expressed in pounds per square inch. Let us call the amount of this change, D_2; it will seldom exceed ⅛ in. in 100 ft.

In a fixed arch the effect of either temperature or rib shortening will be to cause the application of two horizontal forces, H, equal and opposite, applied at about the middle height of the arch. For a rise of temperature these reactions will act as shown in Fig. 1; while for a fall of temperature or rib shortening they will be reversed. To find their magnitude for a symmetrical arch we proceed as follows:

(*a*) Divide the arch into sections for which the lengths *s*, divided by the cube of the depths of the arch perpendicular to its axis, *d*, are equal. In Fig. 2 we have a semi-circular arch of uniform depth, therefore s/d^3 is a constant. It is best to keep everything in pounds and inches. Assuming the half arch to be divided into nine equal parts the length, *s*, of each is:

$$\frac{20 \times 12 \times 3.1416}{36} = 20.94 \text{ ins.}$$

$$\text{Since } d = 12, \quad \frac{s}{d^3} = \frac{20.94}{1728} = 0.01212$$

(*b*) Compute distance of *H* above springing line. This may be obtained by adding together the heights above the springing line of the centers of the divisions, as obtained in (*a*), and dividing the sum by the number of divisions. For a symmetrical arch this need be done only for one-half the span. In Fig. 2, the sum of these heights for the semi-arch is 688.4 ins. (scaled or computed), the number of subdivisions is 9, and the distance of *H* above the springing line is 688.4÷9=76.5 ins.

(*e*) Next draw a horizontal line at a distance of $Ed^3 \div 12s$ above the springing line. Taking $E = 2{,}500{,}000$ lbs. per square inch and $s \div d = .01212$, this reduces to 17,240,000. This value should be laid off at a scale of, say, 1 in. = 600,000 in.-lbs. Since this would come outside the limits of the drawing, make the distance 4.31 ins., instead of 43.1, thereby increasing the deflection ten times, or, in other words, giving us the deflection due to $H =$ 100,000 lbs.

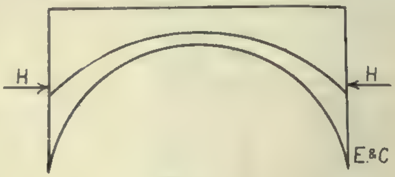


Fig. 1.

(*f*) Points are taken on the moment curve as, for example, p, Fig. 2, projected vertically to p_1 on the line mentioned in (*e*), thence radially towards the origin, *d*, until opposite the original point, *p*. A number of the latter, two of which are designated as p_2' in Fig. 2, define the "deflection" curve. A sufficient number of points should be chosen in order that the curve may be accurately located. This curve is represented in Fig. 2 by the letters *defgh*.

(*g*) Opposite each center of the divisions for the semi-arch, measure the ordinate to the deflection curve. Deflections away from *H* minus those towards *H* give the resultant deflection due to a load of 100,000 lbs.

(*h*) Then the resultant deflection due to a load of 100,000 lbs. divided by 100,000 equals D_1 divided by the value of *H* which causes *D*.

This expression also holds true if we substitute D_2 for D_1, the values being for a strip 1 in. wide, perpendicular to the paper.

For the case assumed (see Fig. 2) we find the following ordinates, these ordinates being to the scale 1 in.=60 ins.:

Opposite point—	Ordinates toward H, ins.	Opposite point—	Ordinates away from H, ins.
1	7.8	5	9.0
2	15.5	6	24.5
3	14.1	7	40.0
4	5.0	8	52.5
		9	61.0
Totals	42.4		187.0

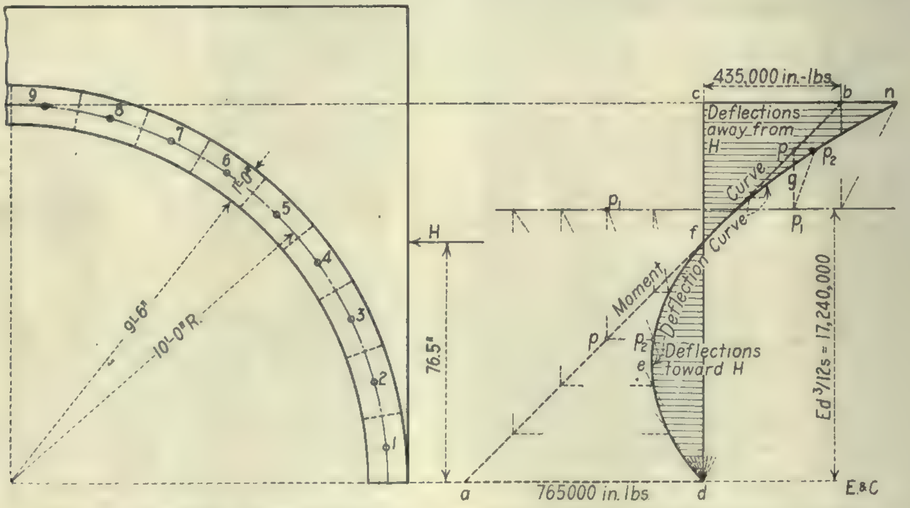


Fig. 2. Graphical Determination of Reactions Due to Temperature Change.

(*c*) Assume *H*. Any even value will do, but 10,000 lbs. is a good value for the usual case and we shall employ this in our sample computations.

(*d*) Draw the moment diagram *afbcfd* (see Fig. 2). This is the best done by computating the values, as *afb* is a straight line.

$$ad = 10{,}000 \times 76.5 = 765{,}000 \text{ in.-lbs.}$$

$$bc = 10{,}000 \times 43.5 = 435{,}000 \text{ in.-lbs.}$$

The resultant = 187.0 — 42.4 = 144.6 ins., away from *H*, which is the deflection due to a value of *H* of 100,000 lbs., provided the stresses are not beyond the elastic limit.

For a temperature change of 30° F., a span length of 240 ins., a coefficient of expansion of 0.000006, the expansion (which is equal to the deflection due to true *H*) = 30 × 0.000006 × 240 = 0.0432 in.

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The true *H* for a strip of arch 1 in. wide equals

$$\frac{0.0432 \times 100{,}000}{144.6} = 30 \text{ lbs.}$$

The values of *H* thus determined act toward each other for a rise and away from each other for a fall in temperature.

(*i*) Having found this true *H*, the moment at any section is equal to *H* multiplied by its lever arm. Resolve this into components parallel and perpendicular to the section; then the former represents the shear and the latter the direct stress.

(*j*) The maximum fiber stress at any section due to *H* is equal to:

$$\frac{6M}{d^2} \pm \frac{C}{d},$$

where *M* is the moment and *C* is the direct stress obtained as explained in (*i*), and *d* is the distance perpendicular to the axis, all values being in pounds and inches.

CURRENT NEWS

The Doings of the Week.

The important development of the week was the change of attitude of Germany regarding its submarine operations. The excellent prospects of a peaceable solution of this country's difficulties with Germany had an immediate effect on industrial and financial developments. As a result the general business outlook is considerably brighter than it was at this time a week ago. The New York Sun on Monday printed a symposium of opinions of business men on their prospects for the present season. The general opinion of these men was that business has reached the turning point and is preparing to negotiate an upgrade with confidence in its ability to overcome all obstacles. In the leading industries new demands were notably strong during the past week. Factory outputs showed distinct gains and the volume of payments through the banks increased. In the construction field numerous contracts came up for advertising for bids. But most of this work wasc omparatively small. In certain lines such as street paving and road work in the northern states the construction season is now well advanced. Much work of this sort, however, remains to be placed under contract. In a number of cities, also, plans are being made to take bids in the fall or early winter on paving jobs so that construction can be started in the early spring. The U. S. Reclamation Service has a considerable amount of work coming up this season and at present is taking bids on a number of fair sized undertakings. Government river and harbor works and building construction for the Treasury Department are offering much construction work. In the iron and steel trade there were many price advances during the past week. Pig iron, steel and a number of finished products advanced in price. Rail orders for the week amounted to 30,000 tons, making a total since Aug. 1 of 67,000 tons for domestic purposes. Foreign business running into many millions was placed. A feature of some of this business was that the deliveries were to be made next year, while in some cases the deliveries extend to 1917. Bars and structural shapes in the Chicago district are now selling around 1.35 cts. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Aug. 25 were as follows:

Finished Iron and Steel:	Aug. 25.	Aug. 18.
Per lb. to large buyers:	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.459	1.459
Iron bars, Pittsburgh........	1.30	1.30
Iron bars, Chicago...........	1.25	1.25
Steel bars, Pittsburgh.......	1.30	1.30
Steel bars, New York........	1.519	1.469
Tank plates, Pittsburgh.....	1.30	1.25
Tank plates, New York.....	1.469	1.469
Beams, etc., Pittsburgh......	1.30	1.30
Beams, etc., New York.......	1.519	1.469
Skelp, grooved steel, P'gh...	1.30	1.25
Skelp, sheared steel, P'gh...	1.35	1.30
Steel hoops, Pittsburgh......	1.35	1.30
Sheets, Nails and Wire:		
Per lb. to large buyers:		
Sheets, black, No. 28, P'gh..	1.90	1.85
Galv. sheets, No. 28, P'gh...	3.40	3.60
Wire nails, Pittsburgh.......	1.65	1.60
Cut nails, Pittsburgh........	1.60	1.60
Fence wire, base, Pittsburgh	1.50	1.40
Barb wire, galv., Pittsburgh.	2.40	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams 3 to 15-in.: channels, 3 to 15-in.; angles, 3 to 6-in. on one or both legs ¼-in. thick and over, and zees, 3-in. and over, 1.30 cents.

Railways.—No developments of importance in the railway construction situation took place during the past week. Promotion work is under way for a number of small projects and numerous new steam and electric railway companies have advanced their undertakings to the incorporation stage. The Southern Ry. double-tracking jobs appear to be about the only big contracts coming up for letting in the immediate future. Commencement of work on the $15,000,000 St. Paul union depot project has been postponed for one year.

Roads and Streets.—A considerable number of small sized highway jobs reached the call for bids stage during the past week. In the state highway field the principal development was the opening of bids by the New York Highway Commission for the construction of about 225 miles of roads and the repair of many additional miles. Pennsylvania is calling for bids on a few state highway contracts. The paving jobs advertised include 120,000 sq. yds. for Taylor, Tex., and 45,000 sq. yds. for Bethlehem, Pa. The contracts let include a $70,000 job for Fort Meade, Fla.; a $39,000 job at Belding, Mich.; an $83,000 contract at Defiance, O.; $127,000 county road job at Zanesville, O., a $103,000 paving contract for Ottawa, Ont., and a $63,000 street improvement contract at Greenville, Tenn.

Bridges.—County bridge construction furnished the bulk of the work in this field during the past week. Indiana and Ohio counties are asking bids on numerous small structures. Larger undertakings include a single leaf deck lift bridge at Westport, Conn., for the State Highway Commission, and a highway bridge over the Allegany River for the city of Olean, N. Y.

Drainage and Irrigation.—One of the largest drainage jobs of the year was placed under contract last week. The job called for 5,022,000 cu. yds. of floating dredge work for Drainage District No. 2 of Crawfordsville, Ark. The price was 7.59 cts. per cu. yd. The U. S. Reclamation Service is calling for bids on several fair sized jobs. One of these involves 25,000 cu. yds. excavation and 1,700 cu. yds. of concrete on the Milk River project, Montana; another calls for 215,000 cu. yds. of excavation for the Bowdoin Canal, Milk River Project; a third provides for 3,285 ft. 60-in. and 450 ft. 24-in. wood stave pipe for Belle Fourche Project, S. Dak. A good sized tile drain job in Mercer County, Illinois, is now ready for bids. Work calls for about 47 miles of tile ranging in size from 6 in. to 22 in., and is divided into three contract sections. The County Commissioners at Bradentown, Fla., open bids Sept. 6 on 1,140,000 cu. yds. of drainage work.

Waterworks. — Several small municipal waterworks undertakings are ready for bids. Proposals also are being asked on extensions, well construction, and the furnishing of pipe, pumps and other equipment. Whitehall, Mont., opens bids Sept. 23 for constructing waterworks and sewer system; Manchester, N. Y., is calling for proposals for waterworks to include 4 miles of mains, standpipe, pumps, etc.; Myton, Utah, is asking bids for waterworks, including well, standpipe, 7,100 ft. of mains, etc.; Miller, Ind., opens bids Sept. 15 on waterworks to cost $14,000; Macon, Mo., is asking proposals for filter plant, mains, pumps, etc. Contracts let include the following: New water supply system for Watervliet, N. Y., contracts amounting to $418,000; a $50,000 contract for waterworks for Maumee, O., and $72,000 worth of work for Chariton, Iowa; Wellsville, N. Y., awarded a $75,000 contract for waterworks improvements.

Sewerage.—New sewerage jobs coming up for advertising during the past week include the following: Sanitary sewers and disposal plant for Forest Grove, Ore., to cost about $90,000; sanitary sewer system for Hammond, La.; sanitary sewer system and disposal plant for Ogden, Ia. Dallas, Tex., awarded contracts amounting to $382,000 for work in connection with its new sewage disposal plant.

The Green Inspector.

A new inspector was on the job.. He was the friend of a politician and had secured his position because he controlled 22 votes in his precinct. His principal occupation previously had been the polishing of bars with his elbow. He discovered several defective lengths of sewer pipe and called the attention of the contractor's foreman to them. The latter waited until the city's representative had moved on and then rolled the pipe over so that the good side was uppermost. The inspector returned and being new to the game didn't discover the deception. A few minutes later, however, the engineer passing over the work found the damaged pipe and called the inspector to account. The man gave his explanation. It satisfied the engineer and he immediately jumped to the conclusion that the contractor, who knew nothing at all about the matter, was trying to put something over on him. As a consequence he threw every obstacle he could in the way of the work. The result was that the job cost the contractor several hundred dollars more than it should.

The War and Labor Supply.

The European war has drawn heavily upon the supply of foreign labor in the United States. It also has practically put a stop to emigration from Europe, Railroads of late have experienced some difficulty in securing laborers for even the small amount of work they were doing. Contractors in certain sections of the country already have felt the scarcity of foreign labor. The re-establishment of peace in Europe will have a profound effect on immigration. But what effect? Will there be a great influx of aliens seeking to escape from high taxes and the industrial paralysis of their countries? Or will the changed conditions in Europe resulting in abundance of work and high wages keep them at home? An international conference at San Francisco has endeavored to answer these questions. The conclusion reached was that immigration would be profoundly affected by the war, but in what way the wisest delegates differed. So there you are.

An Improvement.

The unexpected action of Germany in seeking a peaceable solution of the Arabic difficulty should remove one of the obstacles that have been holding back constructive undertakings. Capitalists have been extremely cautious in letting go of their money because they could not tell what a day would bring forth. It has been the uncertainties of the times rather than lack of idle capital that has made financing a difficult proposition. With the menace of a foreign war removed the future in this country becomes more predictable.

$160,000,000 of Subway Work.

New York City always has been the headquarters of many of the largest contractors in this country. But at the present time an unusually large number of the bigger firms are located in that city. An explanation of this is given by the statement that on Aug. 1, 1915, the total amount of rapid transit contracts under the Dual System plans on lines to be owned by New York City was in round numbers $160,000,000. The contractors on these lines and upon the lines to be owned by the two companies, namely, the Interborough Rapid Transit Co. and the New York Municipal Ry. Corp., are employing about 20,000 men. The total of $160,000,000 includes those parts of the new system which are already in operation, namely, the Center St. Loop subway in Manhattan, the Fourth Ave. subway in Brooklyn and the Queensborough Subway under the East River formerly known as the Steinway Tunnel. Out of more than 80 sections upon city owned lines contracts have been let for more than 60, so that only about 20 sections are left to award. These it is expected will be awarded before the end of the year.

The Lighter Side of Engineering and Contracting

Why Horses in Canada Have Shorter Legs on One Side Than on the Other.

LONG ago a "States" contracting company was engaged in constructing the first asphalt pavement in a Canadian city. Naturally, there was patriotic comment and criticism of the Yankee work by local contractors, newspapers and public-spirited "experts" who prabably had never before seen an asphalt pavement. Among other things, it was charged that the pavement was being given so high a crown that travel over it would be dangerous. As usual, when trouble became acute, the manager of the contracting company was sent for, and, on arriving in the city, called upon the chairman of "The Committee on Works," who had immediate jurisdiction in the matter. The chairman was a patriarchal looking old Scotchman with decided opinions and a vigorous way of expressing them. He was not just then in a pleasant frame of mind, and launched out in a tirade upon the cussedness, in general, of Yankee contractors. When he had relieved his mind on this topic, it was suggested that the immediate business be taken up by a visit to the street where the diabolical work was in progress. Arriving there he threw up his arms in disgust and broke out: "Now look at that, look at that. You damned Yankees must think we have horses up here with legs longer on one side than on the other."—S. W., New York.

* * *

A new use has been found for alligators. One of the sewers of a Florida city became clogged. A versatile city official secured an 18-inch alligator, tied a line to him and started him down the sewer. The 'gator went nearly 200 ft. and then gave up the job. A 4-ft. alligator was obtained and he worked his way for a distance of 400 ft. from manhole to manhole, carrying the line with him. A somewhat similar plan was tried at Mazon, Ill. Here a rat with a string attached to its tail, was used as the advance scout. After the rodent had made a fair start, in order to make it move more quickly, a ferret was placed on the trail. The scheme would have worked very nicely but the ferret caught up with the rat and killed it. In the fight, both animals became entangled in the line and so died martyrs to science.

* * *

THE first time Jack McCaughy, the contractor, crossed the lakes he became violently seasick. The captain chanced by while Jack was holding onto the rail and casting sad and longing glances and everything else onto the waters, "My boy," said the skipper, "You seem to have a weak stomach." McCaughy looked up in surprise, "Weak stomach, Oh, I don't know. I guess I throw it as far as any of the rest of the passengers."

A Leaf from the Diary of a Hobo in Camp.

MONDAY—Commenced work at quartering time for Jerry Hardpusher. He introduced me to a pick and told me he would expect me to hump myself vigorously. I humped; the remuneration was fixed at a dollar and two bits a day. Board three and a half, served rough, without frills. I can stand it, but like all self-respecting hobos I object to bunking with the enemy of every railroad mucker, a teamster.

Tuesday.—Me sleep was broken last night, the teamster slept with his boots on. He snored frightfully and whacked mules till daylight. I put in the day sloping a cut. Me well-trained eye enables me to dispense with a gauge. Good slopers are scarce. I ought to get $1.50 a day. I'll strike.

Wednesday—Struck for higher wages this morning; got a raise and a hint to do less moping and more sloping. The teamster had a nightmare last night; when he quit raving he commenced scratching.

Thursday—It was warm today. Me whistle was cracking and I yelled for water. The water boy told me to close me facial tunnel or I would eventually wreck my train of thought, and the boss asked me if the pick was tired. I wonder what they meant. That water boy is an imp. The teamster was very restless last night.

Friday—We had cod fish for dinner and the water boy earned his salary. The engineer examined the slope today. He said it was an elegant piece of work. I'm a corker. It's bossing I ought to be. I feel creepy. The teamster groomed himself continually last night. He must have the hives.

Saturday—The boss and meself are chums. He let me hold the tape today while he tried to locate a centre grade. I'll be bossing yet. We had no butter for dinner and the cook made a vicious pass at me with a cheese knife because I asked for a second piece of prune pie. I still have a creepy feeling, so has the teamster. He must be crazy. He reversed his underwear last night but he rested easier.

Sunday—I'll drag me time in the morning and drill down the line. Today was washday. The skinners went out to boil and I followed suit. When I removed my underwear the suit followed me. I blew myself at the commissary for clean duds that cannot travel. The clerk says I'm even and the cook gave me the chilly eye. May the teamster's days be filled with worry and may his nights be one unbroken, everlasting scratch.

* * *

ON a second track job in the South considerable switching of empty and loaded cars was required. The contractor hired a negro as switch tender and, after cautioning him to always have the switch ready for trains, went away. He came back in an hour and found the Ethiopian fast asleep, with his head resting on the rails. He booted him awake. "Dat's all right, boss," exclaimed the negro, "de train couldn't get by me without my knowing it."

A Letter from a Ditch Contractor to the Engineer.

MR BIL HAZEN, 27 juli 15.
drane enjaneer,
st. jo mo.

Dere fren—(jon doe)—com by the detch he sais why you not work i sais to moch dam mud he sais you finesh thes detch aug 1 or you doan get no monie i sais i see my fren bil hazen and he mak you pa me he sais i am boss i sais you li then we fite he knock me in the nos and i knock hem in the hed an in the mouth an he kick me in the lung and i knock hem in the hed and he fals in the mud and i kick hem in the slats then we stop he sais you dam pollok i get the law by you and he doez it cos me 11.50$ by the court hous a man sais why doan you get the law by hem i doez it cos hem 15.50$ by the court hous the gug giv it hem in the nek for he is makin fite first so it is alrite but my pa it is better you com here and cus hell out of that dam bohunk for he doan pa me for my work i be here may jun juli an notins doing for so moch rane and so moch dam mud the papr sais i do the detch for 90 dais if it doan rane an the skinner doan strik an some other words but mr bil you doan sa dam word lik mud i gas that dam bohunk put 1 over you wen you doan sa mud wen it rane like hel al tims i fir them dam skinners an they go st jo so i hav strik now it is better you doan com now 4 5 briges by crk is groan by mizuhri river i let you no mr bil you stik by me i deg thes detch like i sais and lik you sais and lik the papr sais an i stik by you an we mak that dam bohunk pa i let you no youre fren ———.

Momie sen lov and wen you com by shak she hav beg muligan redi.

Probably He Had Rancid Butter in Mind.

MANY of the best typographical errors never get into the paper at all. Such errors constitute one of the most compelling charms of the paper game. Something near the upper limit in typographical errors was attained a short time ago by a hyphenated compositor of French extraction. We wrote Arroyo de la Brea Sewer and he set it up to read Aroma de la Brie Sewer.

* * *

Skinner Mulvey says: Some of the byes are taking work these days with such long hauls that the boss shakes hands with the skinners ivry time they return with an empty scraper.

A $511,000 IRRIGATION SYSTEM DEVELOPMENT.

Work to Be Done for West Okanogan Project, Washington.

Contract Let to A. Guthrie & Co., St. Paul, Minn.

An irrigation development calling for an expenditure of over one-half million dollars was placed under contract a few weeks ago by the directors of the West Okanogan Irrigation Project, Okanogan County, Washington. The awarding of this contract at this time is significant for two reasons: It is the first contract that has been let for building an irrigation system under the district law in the State of Washington; it also is the largest undertaking of the kind that has been let for several months.

The project involves the construction of 67 miles of conduit, exclusive of the distributing system, of which about 56 per cent is earth canal, 36 per cent wooden flume and 7 per cent wood stave pipe. It will require about 4,000,000 ft. of lumber for building the flumes. The supply will be obtained from the Similkameen River, which heads in Whatcom County and traverses the lower part of British Columbia following the Similkameen Valley and emptying into the Okanogan River at Oroville, Wash.

The system will irrigate 9,400 acres of land lying on both sides of the Okanogan River commencing at the international boundary line above Oroville and extending southward as far as Tonasket, a distance of about 25 miles. None of the lands are over 3 miles from a railroad station and all of them can be seen at close range from passing trains. The lands are rolling benches lying from 20 to 100 ft. above the Okanogan River which is paralleled by the Okanogan branch of the Great Northern Ry. The soil is sandy loam and volcanic ash of excellent quality.

The directors of the district have fixed the price for water at $63 per acre, payable in 20 years, at 6 per cent interest. The directors also have entered into contracts with the land owners having lands under the project to sell their excess holdings at stipulated prices varying from $40 to $80 per acre, depending on the proximity to towns and other advantages. This makes the total cost of the irrigated lands from $100 to $150 per acre.

The contract for the construction of the irrigation system was awarded at Oroville, Wash., the headquarters of the district, on July 7 to A. Guthrie & Co., St. Paul, Minn., at $511,650. The contractors are now on the ground and will push the work to completion as rapidly as possible in order to have water available for the lands under the project for the season of 1916. Steam shovel work was started two weeks ago. Most of the work is being sublet and men and teams are arriving at Oroville every day.

D. C. Henny, Consulting Engineer, Portland, Ore., is the engineer for the district. J. C. Stevens is the engineer in charge. The contractors' work is being looked after by J. C. Baxter, General Manager of A. Guthrie & Co., and A. F. Hoffmark, Resident Superintendent.

A 1,200,000 CU. YD. EXCAVATION CONTRACT.

Work to Be Done for U. S. Reclamation Service.

First 10 Miles of Main Canal of Fort Laramie Unit of North Platte Project.

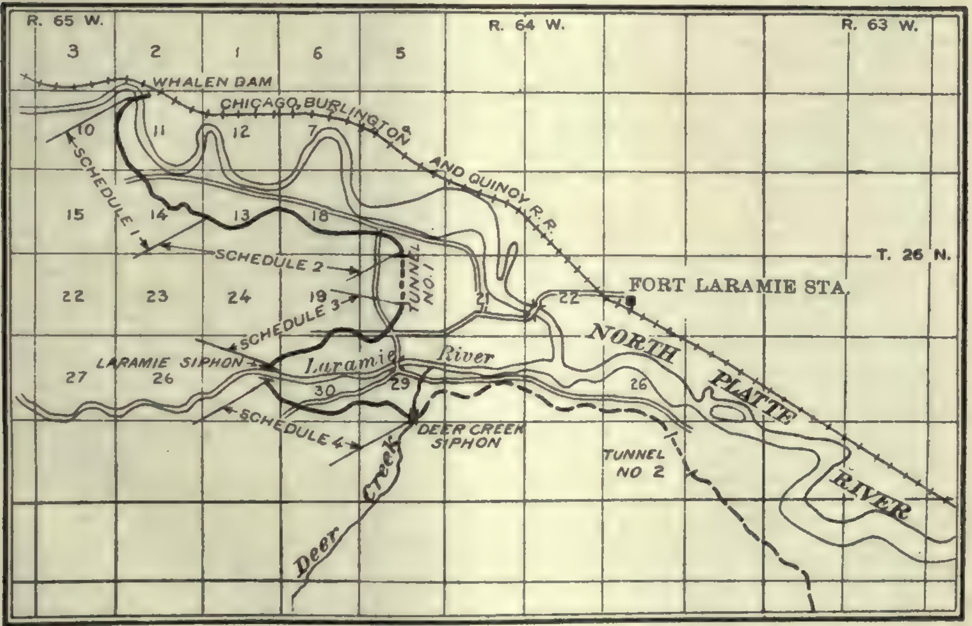
Bids are now being asked by the U. S. Reclamation Service for the first division of the Fort Laramie unit of the North Platte Project. The contract covers earthwork on about 10 miles of main canal and involves the excavation of approximately 1,200,000 cu. yds. of material. The work is situated near the Bridgeport-Guernsey line of the Chicago, Burlington & Quincy Ry., and extends from the Whalen Dam to a point about 1½ miles southwest of Fort Laramie, Wyo.

The work is divided into four schedules. Schedule 1 covers the portion of the canal from Station 3 to Station 104; Schedule 2 from Station 104 to Station 255; Schedule 3 from Station 282 to Stations 393 + 75 and Schedule 4 from Stations 396 + 45 to Stations 525 + 50. The section from Station 255 to Station 282 will be in tunnel and this work will not be included in the contracts now advertised. The approximate quantities under each schedule are as follows:

Excavation, cu. yds:	Schedule 1.	Schedule 2.	Schedule 3.	Schedule 4.
Class 1......	349,000	360,000	297,000	257,000
Class 2......	18,200	7,200	2,200	400
Class 3......	7,200	8,700	2,700	400
Overhaul	62,000	17,000	30,000	5,300

The greater portion of the canal will have a section with 45 ft. bottom, 2:1 side slopes and embankments with 12 ft. top. The distance from top of bank to bottom of canal will be 12 ft. From Station 42 to Stations 47 + 70 and from Station 253 + 50 to Station 255 the canal will be in cut with 24 ft. bottom and ½:1 side slopes. The canal also will be in cut from Station 282 to Station 289, the section here having an 18 ft. bottom and 1½:1 side slopes. From Station 47 + 70 to 50 Station 204 + 50 to 206 + 50, 208 + 50 to 214 + 25, 230 to 232 and from 289 to 298 the canal will be in cut with a bottom width of 45 ft.

Bids for the earthwork on the first 10 miles of the main canal, Fort Laramie Unit, will be received until Sept. 8, at the office of the U. S. Reclamation Service, Tramway Bldg., Denver, Colo.



Location of Earth Work on Main Canal of Fort Laramie Unit.

New York State Highway Lettings on Aug. 24 and Aug. 26.

Bids were opened Aug. 24 and Aug. 26 by the New York State Highway Commission on two of the largest road lettings of the year. Proposals were received on the first mentioned date on 23 contracts, covering about 119 miles of highway. There was fairly good competition on most of the jobs and the estimates of the three low bidders were fairly close. The largest contract called for the building of 8.34 miles of the Conesus-Wayland highway in Livingston County. For this work there were four bidders. The 5.4-mile section of Part 1 of the Salamanca-Ellicottville road in Cattaraugus County attracted only one bidder. There also was only one bidder for the 1 mile of highway in Spring Valley Village. The roads, lengths, high bids, low bids and number of bidders on each contract were as follows:

Road No.	Length, Miles.	High Bid.	Low Bid.	No Bidders.
1322	7.29	$82,556	$71,137	5
5241-A	3.15	41,723	37,832	3
1305	5.379	75,507	75,507	1
1310	4.02	47,350	40,537	7
1311	6.87	89,390	78,420	7
5585	6.18	50,979	47,815	7
5574	1.17	34,763	31,786	4
1162	5.16	61,788	51,750	12
1163	6.18	94,522	78,776	15
1235	5.44	62,985	52,327	[illegible]
1312	6.81	76,997	62,826	10
1313	6.86	70,919	64,341	6
1314	5.37	54,953	44,956	14
1304	1.17	28,431	26,878	5
5583	4.77	50,775	43,833	7
1318 & 1319	1.88	45,228	42,565	5
1321	8.34	120,191	100,840	[illegible]
5586	7.91	74,343	64,126	7
5539	7.31	82,195	69,481	17
5581	0.14	11,755	10,827	6
5576	4.69	2,850	2,641	8
5428	0.99	5,371	5,371	1
5388	2.16	20,721	15,201	4

The bids received Aug. 26 involved 24 contracts covering about 105 miles of highway. On several of the jobs the figuring was very close. On the one-third mile of road in Fulton City (Road No. 5408) there was a difference of only $5 in the two low bids. The totals also were close on the Thorn Corner-Teed Corner highway (Road No. 1325) and on the Whitehall Corner-Wright Corner highway (Road No. 1326). On the latter road the H. B. Sproul Construction Co. won out by $23. This company also was low on Road No. 1325 by the narrow margin of $46. The roads, lengths, high bids, low bids and number of bidders at the letting on Aug. 26 were as follows:

Road No.	Length, Miles.	High Bid.	Low Bid.	No Bidders.
5588	3.95	$157,624	$98,639	12
5579	6.55	67,782	63,072	8
5584	4.21	48,957	46,423	2
773	2.38	23,424	23,424	1
799	4.21	59,255	53,156	6
1315	8.00	112,286	97,340	[illegible]
1153	1.27	78,476	69,644	6
5408	0.36	18,652	16,491	10
817	3.57	38,316	34,960	7
1320	2.75	31,165	25,380	9
5575	4.12	43,629	35,161	8
5577	7.96	94,459	91,046	3
5253-E	5.52	49,978	38,796	8
1076	4.29	41,553	35,354	10
1077	4.72	44,999	36,148	10
1109	2.06	18,664	16,976	5
5578	1.89	32,366	29.582	4
1306	5.72	78,068	66,011	7
1307	1.89	27,428	22,231	3
1308	2.15	27,704	24,739	9
1309	6.63	76,788	67,954	4
1323	4.62	58,528	49,183	3
1325	2.81	28,135	25,795	7
1324	3.02	30,834	28,859	7

Irrigation in Alberta.—The first irrigation district under the new provincial irrigation act was formed at Barnwell, west of Taber, Alberta, early in July, when farmers owning 21,840 acres voted in favor of district as against owners of 960 acres against the proposition. This means the irrigation of 18,000 acres in the immediate Taber district.

NEW WATER WORKS FOR HUDSON FALLS, N. Y.

Development Proposed to Cost $270,000.

Reservoir—Supply Main—Conduit—Distribution System.

A $270,000 water works development is under consideration by Hudson Falls, N. Y., a village of 5,000 population, located on the east bank of the Hudson River in Washington County. The village is served by the Glen Falls branch of the Delaware & Hudson R. R. A report on this project was submitted a short time ago to the village trustees by Charles E. Perry, Consulting Engineer, Albany, N. Y.

The general scheme of the proposed supply provides for the use of Sly Pond, a body of water about 10 miles north of the village, as a storage reservoir. Into this it is proposed to divert the flow of the brook from the Three Ponds which lie west of Sly Pond. The stream bed of Sly Pond Creek will carry the stored water to the intake reservoir which will be located about 8 miles from the village. From the reservoir a pipe line will lead to the distribution system.

The work proposed to be built at this time consists of a diversion dam on the Three Ponds outlet brook and a reinforced concrete conduit to Sly Pond, an intake reservoir just north of Buttermilk Falls, a 12-in. cast iron conduit approximately 8 miles in length to the corporation line, an da distribution system consisting of about 18 miles of 4-in. to 12-in. cast iron pipe, and an elevated tower and tank. The principal elevations are as follows: Sly Pond, 904 ft.; Three Ponds Brook division dam, 951 ft.; intake reservoir, 670 ft.; elevated tank, 48 ft.; village, 298-240 ft. The estimated cost is as follows:

Three Ponds conduit	$ 6,454
Intake reservoir	8,501
Cast iron pipe conduit	77,486
Distribution system	78,932
Fire hydrants, valves, elevated tank, replaced pavement, etc	27,500
Land	6,000
Water, damages, and right of way	30,000
Contingencies, engineering, legal, etc	35,126

The principal proposed structures include a concrete weir dam, a 12-in. clean out pipe and a conduit of reinforced concrete, beginning with a section 48 ins. in diameter and reducing to 39 in. in diameter. Certain sections of this conduit will be above the ground and provision has been made at these places for drains to carry off the hillside flow. The outlet into the pond will be protected by a heavy headwall and riprap. The conduit to the village will for a large extent of its length be laid in the highway and normally will have a 4 ft. cover. Air valves are proposed for every summit and blow-offs at every depression. It is proposed to reduce the pressure from the reservoir's head to that due to elevation 475 and reducing valves for that purpose are to be located at the intersection of hydraulic gradient and elevation 475.

The distribution system has been designed to cover every street in the village, although it is proposed to omit at this time the laying of pipe in streets upon which there are no houses at present. The mains will be laid about 6 ft. below the street surface. There will be 140 fire hydrants.

The domestic rate of draft for the system has been assumed at 600,000 gals. per day and the fire draft at 432,000 gals. for 6 hours. The ultimate capacity of the conduit to the village will be 1,150,000 gals. per day.

New State Highway Law for Wisconsin.

Several changes were made in the state highway law of Wisconsin at the recent session of the State Legislature. The appropriation for the support of the State Highway Commission was reduced from $100,000 to $65,000 per year. The law also was amended so as to provide that hereafter surveys and plans shall be made by the counties at county expense. Provision was made, however, that on request of a county board the committee of the board dealing with state aid matters, the State Highway Commission should make the surveys and plans as previously and charge the cost to the county.

Under the new law the State Highway Commission is given power to approve plans and contracts and generally to control construction about as formerly. The County Highway Commissioner has charge of the actual construction but both the State Highway Commission and County Highway Commission must act with and co-operate with a state aid road and bridge committee elected by each county board. This committee has supervisory control of the general policy and conduct of the work in each county. The County Highway Commission is elected by the county board. The examination of candidates for this position is done away with under the new law.

The bill provides $785,000 annually for state aid highways, instead of $1,200,000 as heretofore. The percentage of state aid paid on bridges over 6 ft. span is increased from 20 to 33⅓ per cent, the same as for roads. State and county aid for road and bridge construction in cities of the fourth class is discontinued, as is the power of a village board to vote taxes. This matter is placed upon the electors of the village. Towns and villages under $600,000 valuation may vote two mills tax; between $600,000 and $1,000,000 valuation, 1½ mills tax; over $1,000,000, valuation one mill. Twice these amounts may be authorized by a two-thirds vote.

Lump Sum Provision for Extra Work in New York Subway Contracts.

The differences between the Public Service Commission for the First District, New York, and the Board of Estimate and Apportionment of the city in regard to the terms of construction contracts, which threatened to involve delay in the completion of the Broadway subway in Manhattan, have been settled and the work will proceed.

The point in question was a clause in the contract for the construction of Section No. 3 of Routes Nos. 4 and 36, covering that portion of the Broadway subway between 38th and 51st streets, which permitted the chief engineer of the Public Service Commission to agree with the contractor either upon unit prices or a lump sum for extra work not provided for in the schedule of unit prices upon which the contractor made his bid.

This contract was awarded to Holbrook, Cabot & Rollins Corp., the lowest bidder, for $3,740,913. The law requires that the Board of Estimate and Apportionment consent to such contracts and appropriate the money to pay for them. In this case the Board consented to the contract on condition that the lump sum clause for extra work be stricken out. The contractors objected and the Commission, under advice from its counsel, declined to amend the contract to comply with the Board of Estimate's condition, holding that it had no right to alter the terms of the contract and that the action of the Board of Estimate in consenting to the contract with conditions amounted to disapproval.

Holbrook, Cabot & Rollins applied to the Supreme Court for a writ of mandamus to compel the Board of Estimate to give its consent without conditions. This application was allowed by Justice Clarence J. Shearn, who issued a writ during the week. His decision sustained the position taken by the Public Service Commission. The Board of Estimate at its next meeting acted in accordance with the decision of the court and gave unconditional approval to the contract upon the understanding that the Commission will confer with the Board of Estimate as to any lump sum extra allowances in excess of 5 per cent of the value of the contract before allowing the same. This understanding was in conformity with a suggestion made by Chairman Edward E. McCall of the Commission to the Board of Estimate. That Board is still of the opinion that it has the power to alter the terms of contracts made by the Commission and expressed its intention of testing the question in the future. Not wishing to delay the construction of the Dual System, however, it yielded the point as to this contract and two contracts in Brooklyn having similar clauses. This action clears up the situation and the Public Service Commission will now proceed to execute all the contracts as to which the Board of Estimate made objection so that work may begin at once.

NEWS LETTERS

St. Louis Items.

The Brown Construction Co. of East St. Louis was low bidder for the work of deepening and straightening out two miles of the Cahokia Creek channel near the East St. Louis, Troy & Eastern Railway in Madison County, Ill. The Brown Construction Co. bid 8c per cu. yd. Other bidders were the Keeley Const. Co., Indiana Const. Co. and H. H. Hall.

The Bondurant Const. Co., Hickman, Ky., has 180,000 yds. of new levee work opposite Hickman, Ky., to sublet. This work is suitable for wheelers, or would be ideal work to use a small revolving shovel to load wagons.

The Standard Oil Co., whose refinery at Wood River was flooded following the storm a week ago, has made a formal demand on the East Side Drainage Commissioners that the Cahokia Diversion Canal levee be blasted in order to release the overflow water behind it. The water from Wood River was drained from the refinery yards, but water which overflowed into the plant from Schmidt's and Grassy Lakes had not receded, though a part of the plant resumed operation. The flood waters held by the East Side drainage levees have done immense damage to farms. Hundreds of acres were covered and the water has receded slowly. There has been talk of suits in which East St. Louis and the Tri-Cities would be defendants.

List & Gifford Const. Co. has removed its offices from the New York Life Bldg. to Room 216 Dwight Bldg., Kansas City, Mo.

H. H. Onstott, East Carondelet, Ill., has six teams that he wants to put to work on any kind of grading in this neighborhood. The high water a couple of weeks ago has flooded his farm and Onstott thinks he will not be able to do any more work on it for at least a couple of months.

Tom Newland is moving his outfit onto 7 miles of Mulvill Bros.' road work near Fulton, Mo.

M. L. Windham secured a couple of small jobs from the Illinois Central R. R. over in Illinois last week.

The Carter Const. Co., which was awarded the contract by the city of St. Louis for the construction of the Mill Creek joint district sewer here, has established a permanent branch office in the Railway Exchange Bldg., St. Louis.

Bauer Bros. of Belleville, Ill., submitted the lowest bid for the construction of the St. Clair Township High School. Their bid was $117,563. Thirteen other firms put in bids ranging from $135,723 to $165,000.

Costello Bros. have put 35 teams to work on the Norfolk & Western R. R. near Burkesville, Va.

The gulf storm which hit St. Louis and this vicinity last week put pretty near all of the railroads out of business for several days on account of washouts and landslides. The repair work is being pushed with large forces of laborers on all lines affected.

Mulvill Bros. of Alton, Ill., were awarded the contract last week for repairing the break in the Wood River levee near East Alton. They have some nice work to sublet on this job. Some of this is suitable for a traction shovel and others for teams.

A. Burke of Springfield, Ill., has taken four miles of cross state highway work between Fulton and Columbia, Mo., from Mulvill Bros.

A. B. Koenig.

PERSONALS

Mr. A. J. Himes, valuation engineer of the New York, Chicago & St. Louis, R. R., has been appointed engineer of grade crossing elimination, with headquarters at Cleveland, O.

Mr. Robert A. Zentmyer of Tyrone, Pa., has been appointed a member of the Pennsylvania State Water Supply Commission to serve out the unexpired term of Commissioner Birkenbine, deceased.

Mr. Vannoy H. Manning of Holly Springs, Miss., heretofore Assistant Director of Bureau of Mines, Interior Department, has been appointed Director, succeeding Dr. J. A. Holmes, who died recently.

Governor Dunne has appointed the following as members of the State Board of Examiners of Structural Engineers, created by the Structural Engineers' License Law passed by the last session of the Illinois Legislature: E. N. Layfield, Chicago, President; J. W. Musham, Chicago; C. C. Stowell, Rockford; Ira O. Baker, Urbana; James T. Hanley, Chicago, Secretary. The board held its first meeting in Chicago on Aug. 27, to organize for carrying out the provisions of the new law.

Mr. H. V. Jamison, Advertising Manager of American Sheet & Tin Plate Company, Pittsburgh, has been awarded a gold medal by the Panama-Pacific International Exposition Society for valuable services rendered in the installation of the large exhibits of the United States Steel Corporation and its subsidiary companies. When the Steel Corporation decided to make an extensive exhibit at San Francisco, Mr. Jamison was appointed Director of Exhibits. The results were so successful that the Steel Corporation and its subsidiaries were accorded the Grand Prize for the excellence of their exhibits and Mr. Jamison was awarded a gold medal in recognition of his services.

Mr. E. W. Lewis announces that he has opened an office at 243 Union Street, New Bedford, Mass., for general practice in civil engineering and surveying. Mr. Lewis was at one time assistant engineer in the city engineering department of Duluth, Minn. He left that department in 1896 to serve for two years with the U. S. engineer department on harbor work at the Duluth-Superior Harbor. He was assistant engineer for the Northern Pacific Railway on various location surveys and construction work from St. Paul to the Pacific Coast, from 1898 to 1906. Since 1906 he has been assistant engineer for the New York, New Haven & Hartford, at New Haven. Mr. Lewis is a member of the American Society of Civil Engineers.

A bill has been drafted for submission to Congress for the formation of an organized reserve corps of American engineers for immediate service in the event of war. The details of the proposed legislation are now being studied by the U. S. War Department. This action is the result of the conference last spring between representative engineers and Secretary of War Garrison. The committee in charge of the movement consists of the following: William Barclay Parsons, chairman of the committee of the American Society of Civil Engineers and general chairman of the joint committee; William H. Wiley, chairman of the committee of the American Society of Mechanical Engineers; Ralph D. Merchon, chairman of the committee of the American Institute of Consulting Engineers; Henry S. Drinker, chairman committee of American Institute of Mining Engineers; Bion J. Arnold, chairman of the committee of the American Institute of Consulting Engineers.

OBITUARIES

Isaac J. Griffith, a well known railroad contractor of Utica, N. Y., died in the city on Aug. 21. One of his jobs for which he will long be remembered in Utica was the construction of the original belt line of that city's street railway system.

Sidney T. Emerson, a well known railway construction engineer, died Aug. 28, at his home in Chicago. He was 88 years old. He came to Chicago in 1867 and obtained a position with the Illinois Central R. R. He also has been in the employ of the Pennsylvania R. R., the Missouri Pacific Ry., North Pacific, and the St. Louis, Kansas City & Colorado R. R. He did considerable engineering work on the Erie Canal and also work for the Government in townsite plotting in Indian Territory.

Edward B. Pleasants, Chief Engineer of the Atlantic Coast Line, died on board his private car, from an attack of paralysis, on Aug. 22. He had been at the head of the engineering department of that road for about 20 years. When a very young man Mr. Pleasants entered the service of the United States Coast and Geodetic Survey as an engineer and remained in that service for four or five years, attaining a high rank in the department. His inclination, however, was towards other branches of his profession and he entered railroad engineering. He built the Maryland and Pennsylvania Railway, now a part of the Pennsylvania System, and upon the completion of that work, went to Norfolk, Va., to be chief engineer of the Norfolk & Carolina railroad, which is now a part of the Atlantic Coast Line. Some 25 years ago, he completed his work with that line and came to Wilmington, entering the service of the A. C. L. Later upon the death of Mr. B. R. Dunn, he became chief engineer of the road and had been in that department ever since. When he first came to the Atlantic Coast Line, it was not the great system that it is now, and the development that has taken place in this property for the past 25 years has been, in an engineering way, directly under the supervision of Mr. Pleasants. Since coming to the Atlantic Coast Line it has absorbed the Plant System of Georgia and Florida, it has become a double-track line for nearly 50 per cent of its length and other great improvements have been made. Although a native of Virginia, where he was born August 2, 1850, Mr. Pleasants has successively made his home in Maryland and in Wilmington, N. C. He is survived by his widow and six children—two sons and four daughters. Both of his sons are in the service of the Atlantic Coast Line.

NEW CATALOGUES

"National" Products.—Folder, National Tube Co., Frick Building, Pittsburgh, Pa.

Shows a number of views of the exhibit of the National Tube Co. at the Panama-Pacific Exposition in the Palace of Mines & Metallurgy.

Meter Boxes.—Paper, 6x9 ins.; 4 pp. Modern Iron Works, Quincy, Ill.

Describes the Eclipse Meter Box and method of its installation. The box is composed of vitrified tile body, cast iron top frame and lid and cast iron base on bearing plate. Illustrated.

Mixers.—Paper, 8½x11½ ins.; 12 pp. Northfield, Minn.

Describes the Northfield Slush Mixer, a portable hand mixer, which can also be used for plaster and mortar. Explains construction details, gives some data as to capacity and costs and letters from purchasers. Illustrated.

Conveying Machinery.—Paper, 6x9 ins., 24 pp. Stephens-Adamson Mfg. Co., Aurora, Ill.

The July number of The Labor Saver, published by the above company, contains articles descriptive of coal, sand and gravel plants, etc., in which Sephens-Adamson handling equipment has been installed; illustrated.

Contractor's Supplies.—Paper, 7x9¼ ins., 148 pp., Crerar, Adams & Co., 239-259 East Erie St., Chicago.

Catalogue No. 25, showing a complete line of contractor's supplies and machinery. Each article is illustrated and described fully, with data as to dimensions, weights, price, etc. The line includes practically everything from steam pumps and concrete mixers to wire nails and rags for wiping machinery.

Hoisting Engines.—Paper, 3½x6¼ ins., 8 pp., folder, S. Flory Mfg. Co., Bangor, Pa.

Folder showing views of Flory hoist engines and boom swingers with brief descriptions of design and special uses. Also shows Flory cableways on Kensico dam construction. work.

Clay Products.—Card. Laclede-Christy Clay Products Co., St. Louis, Mo.

One of the "reminder" cards frequently sent by the above company. This one shows in color, the standard 9-in. and 9-in. series brick shapes. The back of the card gives some details of the company's service.

Tractors.—Paper, circulars, Knox Motors Associates, Springfield, Mass.

One of these folders describes the work of a Knox tractor for the Illinois Brick Teaming Co. The other shows the Knox tractor method of heavy hauling.

Aztec Asphalt.—Paper, disc-shaped, 5½-in. diameter, 20 pp., The United States Asphalt Refining Co., 90 West Street, New York City.

A booklet in novel form, entitled "The Aztec Way," and describing the product known as Aztec Asphalt, for road surfacing. Shows a number of roads and streets on which it has been used.

Mixers.—Circular, Koehring Machine Co., Milwaukee, Wis.

Describes and illustrates the various types of Koehring mixers, particularly the Koehring paver.

Diesel Engines.—Paper, 3¼x6¼ ins., 2 booklets, Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo.

Leaflet, 4 pp., showing views of the exhibit of the company at the Panama-Pacific Exposition. The 20 pp. booklet, entitled "Evidence," consists of quotations from letters written by owners and operators of the Diesel engines. Shows a number of plants in which their engines are used.

INDUSTRIAL NOTES

The Walter A. Zelnicker Supply Company of St. Louis, Mo., has purchased the good will and stock of the Bintliff Supply Co. (successors to Bintliff & Herb), who did a general railroad, mill and factory supply business and specialized in railroad track tools.

The Underpinning & Foundation Co., 290 Broadway, New York City, has been awarded the contract for the foundations for the addition to the Mohawk Hotel, 220-226 So. Center St., Schenectady, N. Y. Chas. A. Sussdorff, Architect, and J. F. Growe Construction Co. of Albany are the general constractors. The foundation consists of Underpinning & Foundation Co.'s standard Hercules steel piles.

The Snare & Triest Co., New York City, has purchased the business, good-will, plant, plans and records of R. P. & J. H. Staats, Inc., who for 27 years have been successfully established in New York City as engineers and contractors in designing and constructing piers, sheds and similar harbor work. Mr. R. P. Staats retires from active business and Mr. J. H. Staats, having secured an interest in the Snare & Triest Company, will associate himself with it as vice-president.

Among the contracts recently awarded to the Raymond Concrete Pile Co. of New York and Chicago, are the following: Concrete piling for new 9 and 12-in. Merchant Mills at Struthers works of the Youngstown Sheet & Tube Co., Youngstown, O.; concrete piling for warehouse and viaduct in rear of Municipal Dock No. 1, Portland, Ore.; concrete piles in foundation of the new building for Mr. W. E. Wroe, East Illinois and St. Clair Sts., Chicago. Sidney Lovell and W. E. Walker, Associate Architects.; contract for placing concrete piling for abutments and piers at 80th and 81st St. subways for the Chicago & Western Indiana R. R. Co. E. H. Lee, Chief Engineer.

RAILWAYS

BIDS ASKED.

Canada:

Prince Edward Island, Can.—Until noon, Sept. 8, by Department of Railways and Canals, Ottawa, Ont., for construction of station, water tank, engine house, transfer platform, standpipe pit, ash pit and turntable foundation for Carleton Point Ferry Terminal.

PROSPECTIVE WORK.

Alabama:

Mobile, Ala.—New Orleans, Mobile & Chicago R. R. has been reorganized and it is understood that the project of extending the line to Beaumont, Miss., to connect to the Louisville & Nashville, at a point near Bay St. Louis, will be taken up at once.

Mobile, Ala.—Legislature has passed bill authorizing city to issue bonds for construction of belt line railroad.

Dothan, Ala.—Project is under consideration for extension of Atlanta & St. Andrews Bay Ry. from Dothan, Ala., to Columbus and possibly to Atlanta.

Indiana:

Huntington, Ind.—Erie Railroad is reported to be contemplating letting contract soon for double tracking between Lomax and Griffiths, Ind.

Maine:

Skowhegan, Me.—Steps are being taken to raise subscriptions for making survey for 13 miles of electric railway from Athens to Skowhegan. Harvey D. Eaton, Waterville, Me., is the promoter.

Michigan:

Detroit, Mich.—Special election will be held Nov. 2 to vote on question of the city purchasing the street car system owned by Detroit United Ry. Co.

Ohio:

Cleveland, O.—Lake Shore & Michigan Southern R. R. and Big Four R. R. are reported to have purchased about 100 acres of land at Noble, 5 miles east of Cleveland, and are said to contemplate constructing yards.

Canton, O.—Wheeling & Lake Erie R. R. interests are reported to have taken options on land in east end of city, with the purpose of connecting main lines with the United Steel plant and proposed new blast furnace.

Tiffin, O.—Chamber of Commerce has been asked to raise $2,000 towards expenses of a preliminary survey for proposed interurban line from Bucyrus to Tiffin. A. W. Nyquist is promoter.

Oklahoma:

Oklahoma City, Okla.—Ft. Smith & Western R. R. is making surveys for an entrance to this city.

Cushing, Okla.—St. Louis & San Francisco R. R. is reported to be considering construction of a line from Depew northward into the coal field to connect with the Oil Field & Santa Fe line.

Tulsa, Okla.—Tulsa Traction Co. has been chartered with a capital stock of $100,000 and proposes to buy the Union Traction Co. and to build an extension south to Sapulpa and an additional line from Tulsa east to Okmulgee via Bixby. A. J. Biddison and W. E. Bennett, Tulsa, are incorporators.

Clinton, Okla.—Survey has been completed into the Texas Panhandle country for a western extension of the Clinton & Oklahoma Western R. R. Surveys are also to be made for an extension southeast from Clinton to Chickasha.

Oregon:

Grants Pass, Ore.—Stock of California & Oregon Railroad Co. has been transferred to Twohy Bros. and associates, of Portland. Twohy Bros. are understood to have agreed to finance the project and build the line, which will extend from Grants Pass to Crescent City, Cal. About 10 miles of line from Grants Pass already have been built.

Pennsylvania:

Lynch, Pa.—State Water Supply Commission has granted permission to Pittsburgh & Lake Erie R. R. to construct embankment along left bank of Youghiogheny River above Lynch, in Allegheny County.

Chester, Pa.—Southern Pennsylvania Traction Co., T. W. Wilson, Vice-President, has asked Council for franchise to extend its lines between this city and Eddystone.

South Dakota:

Huron, S. D.—Surveys are under way for the Duluth, Huron & Northwestern R. R. and it is reported that construction will be started in about 40 days from Huron. G. W. Morrow, President Huron Investment & Construction Co., is interested.

Aberdeen, S. D.—Aberdeen R. R. Co. has been chartered with capital stock of $250,000. It is understood the company will take over the existing system in this city and improve it and extend it. Charles A. Howard, Sam'l C. Hedger and Chas. N. Harris are incorporators.

Yankton, S. D.—The Yankton & Northern R. R. Co. has been chartered with capital stock of $2,000,000, and proposes building railroad from Yankton to Watertown. The Yankton County Bridge Co. also has been chartered with $1,000,000 capital stock and proposes to build bridge over Missouri River at Yankton. Incorporators of both companies include Senator E. S. Johnson and W. E. Heaton.

Texas:

Lubbock, Tex.—Santa Fe System is reported to have purchased Crosbyton & South Plains R. R., 40 miles in length, extending between Lubbock and Crosbyton.

Washington:

Seattle, Wash.—Until Sept. 6, by Alaska Engineering Commission, for supplying 40,000 steel bolts, 5,000 drift bolts, 103 kegs of boat spikes, 75 kegs of wire nails and 102,000 (100,000 lbs.) cast iron washers.

Wisconsin:

Ettrick, Wis.—State Railroad Commission has granted permission to Ettrick & Northern R. R. Co. to construct line of railroad through towns of Ettrick and Preston, connecting with Green Bay & Western R. R. John C. Gaveney, Arcadia, is President.

Ashland, Wis.—Plan is under consideration for construction of electric railway around Chequamegon Bay, connecting the cities of Ashland, Washburn and Bayfield. A. E. Appleyard, President Ashland Street Car Co., is interested.

Wyoming:

Shoshoni, Wyo.—H. O. Barber, general manager for Poposia Coal Co., Hudson, Wyo., is reported to have offered to build railroad grade from Shoshoni to Shot Gun coal fields, 43 miles, providing the Chicago & Northwestern Ry. would lay steel.

BIDS OPENED; CONTRACTS LET

Alberta:

Seward, Alaska—Colorado Fuel & Iron Co., Pueblo, Colo., has been awarded the contract for 4,950 tons of rail for first section of track on new Government railroad from Seward to Matunuska coal fields.

Minnesota:

Winsted, Minn.—H. F. Balch & Co., Minneapolis, Minn., have contract for 45-mile extension of Electric Short Line R. R. from Winsted, Minn., by way of Silver Lake to Hutchinson, Minn. Work includes 165,000 cu. yds. of earth excavation, 200,000 cu. yds. embankment, about 630 lin. ft. of pile timber bridges. John Westrodaht, Phoenix Bldg., Minneapolis, Minn. is Chief Engineer of railway.

Pennsylvania:

Harrisburg, Pa.—A. L. Anderson & Bro., Altoona, Pa., have been awarded contract for four miles of extension of Yellow Creek Branch of Pennsylvania Railroad.

South Dakota:

Aberdeen, S. Dak.—Haynes Co-operative Coal Mining Co. has awarded contract to John Geddes & Co., Forestburg, S. Dak., at $4,300, for grading 3½ miles of spur track to coal mines at Haynes, S. D. The coal company may be in the market for 45 to 60-lb. rails and ties to complete this track; also for small engine to handle the cars. T. W. Childs, Citizens Bank Bldg., Aberdeen, is Vice President of the coal mining company.

ROADS STREETS

BIDS ASKED.

Alabama:

Carrollton, Ala.—Until Sept. 22, by County Commissioners for surfacing with sand, clay or gravel top Carrollton and Reform Roads.

Thomasville, Ala.—Town wishes to contract with contractor for drilling deep well to give water supply of 200 gallons per minute. C. H. Pyson is Mayor.

California:

Riverside, Cal.—Until Sept. 8, by County Supervisor, for 8¾ miles of concrete road.

Alameda, Cal.—Until Sept. 3, by Streets, Sewers and Wharves Department, for surfacing Santa Clara Ave., Ninth to St. Charles St.

Eureka, Cal.—Until 8 p. m., Sept. 7, by J. T. Wunderlich, City Clerk, for grading Fairfield St.

Berkeley, Cal.—Until noon, Sept. 15, by W. F. McClure, State Engineer, Sacramento, Cal., for walls and walks around gymnasium building at California Institution for Deaf and Blind.

Los Angeles, Cal.—Until 2 p. m., Sept. 13, by H. J. Lelande, Clerk, County Supervisors, for improvement work on portion of Palmdale-Lancaster road in Road District No. 5.

Connecticut:

East Hartford, Conn.—Until 8 p. m., Sept. 7, by Frank F. Forbes, Clerk Commissioners of East Hartford Fire District, for constructing about 10,000 sq. ft. of concrete walk and about 3,200 ft. of concrete curb.

East Hartford, Conn.—Until 8 p. m., Sept. 7, by F. F. Forbes, Clerk Commissioners of East Hartford Fire District, for constructing about 2,500 ft. of macadam.

Florida:

West Palm Beach, Fla.—Until noon, Sept. 7, by Geo. O. Butler, Clerk County Commissioner, for furnishing 168,000 gals. of bituminous oil for road building purposes.

West Palm Beach, Fla.—Until Sept. 7, by Geo. O. Butler, Clerk County Commissioner, for hard surfacing county roads in district No. 5.

De Land, Fla.—Until Sept. 8, by City Clerk, for constructing cement sidewalks.

Jacksonville, Fla.—Until Sept. 9, by City Clerk, for paving on Adams, Pensacola and other streets. Isham Randolph & Co., Consulting Engineers, Jacksonville.

Illinois:

Park Ridge, Ill.—Until 7:30 p. m., Sept. 7, by Board of Local Improvements for about 17,000 sq. ft. of concrete sidewalk. Specifications with Secretary of the Board, A. W. Lorenz, Room 400, Pullman Building, Chicago.

Idaho:

Council, Ida.—Until Sept. 17, by C. W. Holmes, Clerk County Commissioners, for rock work on road between Goodrich and Cambridge.

Indiana:

Rochester, Ind.—Until 2 p. m., Sept. 9, by William C. Miller, County Auditor, for four gravel roads in Henry Township.

Rockville, Ind.—Until 11 a. m., Sept. 8, by County Commissioners, for combined curb and gutter, paving and sidewalk around the courthouse.

Noblesville, Ind.—Until 10 a. m., Sept. 11, by W. O. Horton, County Auditor, for road in Noblesville Township.

Anderson, Ind.—Until 10 a. m., Sept. 15, by J. B. Benefiel, County Auditor, for concrete road in Anderson Township.

Hartford City, Ind.—Until 2 p. m., Sept. 6, by J. L. McGrath, County Auditor, for two concrete bridges.

La Fayette, Ind.—Until 10 a. m., Sept. 8, by Geo. W. Baxter, County Auditor, for gravel roads as follows: Parry Township, 1

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Cost of Construction

EDITORS

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The Report of the United States Commission on Industrial Relations.

The recent report of the United States Commission on Industrial Relations is an interesting document in that it suggests numerous solutions for industrial unrest, some of which may well be given serious consideration by every citizen. It will generally be conceded that such factors in our industrial life as the relations between employers and employes, the distribution of wealth and income, and the reliability of courts are problems which demand a more satisfactory solution than has yet been devised. It is not to be wondered at that the commission was not able to present a unanimously-endorsed report, as conflicting interests were represented on it. The findings of the commission were submitted as three separate documents, one of which, drawn up by Basil M. Manley, director of research and investigation, and also signed by John B. Lennon, Frank P. Walsh, James O'Connell and A. B. Garretson, represents the employes; another, drawn up by John R. Commons and indorsed by Mrs. J. B. Harriman, represents the public; and a third, signed by Harris Weinstock, S. Thurston Ballard and R. H. Aishton, dissents to parts of both reports. Although the various phases of the subject are treated at considerable length it will only be possible here to point out a few pertinent findings.

The Manley report, among other recommendations to Congress, urges that an inheritance tax be enacted with generous provisions for dependents and minor children, but prohibiting accumulations of wealth to pass into the hands of those who have had no share in its production. It is recommended that this revenue be used to extend education and to develop social services and great constructive works in road building, reforestation and irrigation. To relieve unemployment it recommends that there be vigorous prosecution to regain land, water power and mineral rights secured from the government by fraud. It also urges a general revision of land laws so as to apply to all future land grants the doctrine of "superior use," together with provisions for forfeiture in case of actual nonuse. The tax on unused land is to be made the same as on productive land of the same kind. The report also advocates an amendment to the constitution providing for the protection of the personal rights of every person from encroachment by federal and state governments and by private individuals. In addition, it advocates the unlimited right of individuals to form associations, not for the sake of profit, but to safeguard their individual and collective interests.

The Commons report, which is signed with certain exceptions by Weinstock, Ballard and Aishton, asserts that the greatest cause of industrial unrest is a breakdown of the administration of labor laws and the distrust of our municipal, state and national governments by a large part of the people. Before new legislation is adopted it urges that the laws already passed be enforced through the creation of administrative machinery divorced from politics. This report proposes the creation of a federal fund for social welfare, maintained by an inheritance tax on large fortunes, and administered by a commission on industrial relations aided by an advisory council composed of representatives of both employers and employes.

The Weinstock report dissents from the recommendation that the secondary boycott be legalized; it finds that employes have many just grievances, and believes that they are justified in organizing. This report points out evils in industrial wars and blames both the employers and the unions for some of their methods. It states that the best results can be accomplished by the strongest kind of organization on both sides, both making it their duty to drive out of their ranks contract and law breakers.

It is to be regretted that the commission was unable to present a common report—although this was hardly to be expected. The labors of the commission, however, are not wasted, as we now have a clearer and more definite statement of fact and assertion from the representatives of both sides than would otherwise have been available. The problems of industrial relations are intricate and difficult of satisfactory solution, and the best results can only be attained by the general education of every citizen to a realization of his rights and duties.

Scientific Management Methods in Road Maintenance Administration.

There are published in this issue two articles on the administration of road repairs and maintenance. Both of these articles merit attention. The problem of maintenance is the most intricate of all the problems connected with highway work. It is also the chief problem of the future in highway work in America. Each state which has been long at the work of constructing improved roads has before it the task of devising legislation which will ensure regularly funds for maintenance and also the task of devising efficient methods of applying these funds to the work of maintenance. The first is a legislative task; the second is an administrative engineering task and is the one in the performance of which the two articles mentioned are a help.

Pavement maintenance is patch-work. This is very nearly as true of country roads as it is of city streets. The character of the work, its extent and the time when it is required differs for nearly every patch. To carry in mind the number of jobs and their variations is beyond the capacity of any administrative head. To keep written records in such a way as to provide at any instant a mental picture of conditions in detail and in general is almost as impracticable. Yet it is extremely important that the administrative head should be able to visualize these conditions. To enable this accomplishment is the purpose of the "planning board" described in one of the articles being considered. This article suffers in interest and forcefulness by our inability to present illustrations in colors, but by careful reading one may imagine the detail of the picture presented by the "planning board."

One thing only need be said in addition to the information given by the article and this is that the scheme is not a visionary one. These "planning boards" have been long enough in use in Philadelphia to have proved themselves wholly practical and great savers of time for the directing street officials.

The second article from a report by the efficiency engineer of the New York highway department is a more familiar means of recording data necessary for administrative planning and action. The manner of keeping the records, their nature and the use which can be made of them are sufficiently explained in the article. One feature only may be emphasized. Obviously the collation of the records described is but the first step of a useful efficiency study. From them an analysis must be made of the economic factors that enter into the highway maintenance problem and then from these factors by synthesis there must be built up a maintenance policy and a system of economic maintenance methods. These are tasks which demand the labors and justify the existence of an efficiency or statistical bureau such as the New York department of highways has inaugurated and, we trust, will continue in service. We trust also that as time makes publication possible the determinations of this bureau will be published for the service of engineers and other road officials.

How to Meet "Jitney" Competition.

The "jitney bus" is used primarily because of the pleasure of riding in the open air in a sort of vehicle that has hitherto been restricted to the well-to-do. The glamour of riding in an automobile will soon wear off, but the pleasure of "riding in the open" will remain. Can electric railways give an equal incentive to ride for the mere pleasure of riding? Undoubtedly a goodly number of people do use the street cars merely for pleasure purposes, particularly on hot summer nights. Can this number be increased, and how?

The answer is to be found by considering the attraction that the upper deck of an omnibus or stage has for all people in almost all sorts of weather save in rain or biting wind. Note, for example, the crowded upper decks of the Fifth Avenue buses in New York. The interior of a bus may be empty while not a seat remains vacant on its roof. Thousands of people pay 10 cts. to ride a few miles on the top of these busses and then pay 10 cts. to ride back again, merely to cool off and to be exhilarated by the ride. Surely there is a lesson here for the sorely tried manager of a street railway.

On the Pacific Coast and in the South, where snow and frost are almost unknown, there can be no doubt that double-deck street cars would be well patronized by pleasure seekers the year round, but the gain would not stop there. In the rush hours of the day, practically every patron would have a seat. Thus to dispense with strap-hanging would alone give the jitney bus a body blow that might put it out of the running.

Double-deck street cars have been used, particularly in Europe, but the cost of new equipment has probably prevented most street railway managers from giving serious consideration to this type of car. Now that the necessity of some sort of action is bearing hard upon many electric roads, there is likelihood that someone will take the lead in demonstrating to the rest that the "jitney" can be beaten at its own game—an exhilarating ride in the open and *sitting down*.

Investigate the Investigators and Regulate the Regulators.

For about ten years politicians have made capital of the "crying call" to investigate and regulate railway and utility companies. They have managed quite effectually to frighten capital and check progress in those fields, but, all in all, have uncovered relatively few instances of excessive profits in railway or utility company operation. On the other hand there have been few similar investigations of the management of public affairs, yet not one of those investigations has failed to disclose gross inefficiency if not actual dishonesty. The latest of these inquiries has stirred the taxpayers of New York City into as high a state of indignation as it is possible to stir people that have long been callous to evidence of wholesale and retail spoliation at the hands of their "servants."

Two of New York City's officials—Henry Bruere and Leonard M. Wallstein—have made a report entitled "A Study of County Government Within the City of New York," in which they show the absurd anachronism of county government within a large city. They trace the present form of county organization from the days of William the Conqueror, and the county or shire from the days of King Alfred.

It had long been generally known that the sheriff of New York County enjoys an income of $57,000 a year—$12,000 in salary and the balance in fees. But the real shock that this report gives to the taxpayer is found in the statement that this sheriff's fees are but a fiftieth part of the total waste incident to the support of fee-collecting county offices! Twenty-three county departments collect fees for their services.

The city of New York embraces five counties, each with its retinue of county "servants." There are forty separate county departments and no central head to whom they are responsible. The report recommends the consolidation of these to eight departments, with a resulting saving of $1,000,000 a year in salaries alone. Large as this amount appears it is only one-seventh of the total county budget for 1915.

One item of the budget is entitled "Restoring and Preserving Old Records," which for the last 17 years has cost the city an average of a quarter of a million dollars yearly. Generally speaking the county officers have clung to hand-copying rather than adopt book-typewriting or photographing of original documents. "The old method necessitates the employment of more copyists," and, of course, it would not do to disturb the vested privileges of public "servants."

Further recital of facts is unnecessary to indicate what a delicious plum orchard the politicians have found and cultivated these many years in the counties of Greater New York. Here is inefficiency on a grand scale, because the size of the community makes large wastes possible, without incurring bankruptcy. But the same percentage of waste probably exists in other cities and counties throughout America. What is urgently needed is the most thorough investigation of the efficiency of political administration everywhere, followed by some system of central regulation of accounting practice and administration methods. The U. S. Census reports have long urged the importance of uniform municipal accounting, for example, and have pointed out how very defective the accounting methods of most cities are.

What utility company would escape scathing denunciation were its accounting records even remotely as poor as those of the average American municipality? Yet the politicians damn the utility companies for extortions that exist mainly in imagination, while the real extortions that the public suffers at the hands of its alleged servants are almost unrecognized because of the lack of adequate accounting records and the entire absence of critical analysis of the records that are available.

We do not imply that proper accounting will cure all the ills of mal-administration. At best it can but serve to bulletin the facts, and thus bring before the public eye the throng of unsuspected wastes and thefts. This, at least, will make it easier for the public to rid itself of the most incompetent of its employes. It will also serve to check the progress of socialistic measures, such, for example, as the manufacture of valves and hydrants by the city of Chicago. For when the cold figures of unit costs are available, it will need a duller mind than that of the average voter to remain favorably impressed by the argument that a city should increase the number of its functions. When it is generally seen that not even in the simple functions that it exercises does the average city make a creditable economic record, there will ensue a desire to keep cities out of complex business enterprises.

When shall we have a Postal Commission to investigate the Post Office and make it so report income and expenses that intelligent decisions can be rendered as to its efficiency? When shall we have a Commission on Printing that will answer the public query as to the real worth of the myriad tomes and bulletins issued by the scores of government departments and bureaus? When shall we have an Agricultural Commission that will independently measure the worth of the work done by the Department of Agriculture, and study the efficiency of its many activities?

We have our Interstate Commerce Commission, whose seven members are diligently trying to regulate half the railway mileage on the globe. So busy, indeed, are they that the other day they cut the rates of the "anthracite rail group" about $8,000,000 per annum, after hearings attended seldom by more than one member of the Commission and often by not even that one! We have this Commission admitting a marked rise in operating expenses and a marked decrease in dividend rates, yet refusing to grant more than a pittance of rate increase for the Western group of railways. These evidences of drastic control of railways and utilities by commissions abound. Yet, where are the evidences of public willingness to test public administration by the same acid? Here and there, it is true, the acid is put on the glitter—as witnessed in the report of Bruere and Wollstein. The result is invariably a sizzle and smell of completely dissolving brass where at least some gold had right to be found.

WATER WORKS

Notes on Excavating and Timbering the Very Deep Trenches Required in Reservoir and Other Dam Construction.

(Staff Abstract.)

The writer has been employed on a number of water works construction jobs, on each of which the trench for the watertight cutoff wall went down to depths exceeding 80 ft. In one case the trench was nearly a mile in length and for the greater part of that distance the depth excavated exceeded 50 ft., while the maximum depth was 112 ft. The trenches were all dug through alluvial deposit for the most part and stopped either in clay or in rock.

There is a peculiarity about reservoir trenches not common to other excavations, that is, the difficulty of deciding even from borings what the probable extent of the trench will be, and it is often a condition of contract that three-fourths or even the whole trench must be taken down to approved watertight strata before filling commences. This stipulation is made to enable the engineer to follow out what he thinks is a good bed of rock or layer of clay and to prove its continuity before covering up a part of it.

There is one instance of a trench having been filled for a portion of its length with concrete when it was discovered in the open trench farther on that a pervious bed of rock ran in below the finished work. That this discovery was made when the work was so far advanced entailed a great additional expense, for it was necessary to put in a downward extension of the existing stop wall by a process of tunnelling. The total depth of this particular wall from the surface of the ground was over 200 ft.

A case like the above is well calculated to make engineers insist on seeing the bottom from end to end before commencing filling. Few engineers who have not had experience of this work realize what this means.

If there is a big deposit of loose material above the impervious ground it may mean having enough timber to fix a trench four or five thousand feet long by 50 ft. in depth. The timber in this may be tied up for possibly two years and all this time the contractor has a certain amount of anxiety as to the safety of his men.

The timber must all be placed in position and, as a rule, it must all be taken out again. Timber which has been in position for more than a year is not easy to handle, especially if the struts have so embedded themselves in the walings that they have to be sawed through to get them free.

The description of a particular piece of work is usually more interesting than generalization on a number of instances. Hence the following particulars having reference to a reservoir trench in Great Britain, on which the author acted as contractor's engineer, are given. The amount of the contract was over $1,000,000, so the work was extensive enough to bring out some interesting points.

The reservoir dam, as planned, consisted of an earthen embankment with an impervious core wall of concrete and puddled clay. The maximum height of the embankment was 100 ft., and the maximum depth of the core wall trench was 112 ft. The top width of the embankment was 25 ft. Water level in reservoir 5 ft. below top of embankment. Selected material was placed in the embankment, on each side of the core wall, of a width of about 30 ft. and the full height of the embankment. The core wall, from a point in the embankment above the water level in the reservoir to a point 45 ft. below the natural ground surface, consisted of puddled clay. Below this point the core wall consisted of concrete. The core wall had a tapering section beginning, at its top, with a width of 8 ft. and widening on a slope of 1 in 12 on both faces to the bottom of the embankment. About 6 ft. below the natural ground surface the puddled wall was drawn in to a width of 12 ft. and continued at that width down to the concrete portion of the core wall. The upper 5 ft. of the concrete core wall was 12 ft. wide, and this wall was drawn in to a thickness of 6 ft. in the next 15 ft. of depth, and continued at that depth to the bottom.

It was expected that rock would be met with at 50 ft. or less from the surface, and so it would be possible to go down with the narrow portion of the trench and fill it with concrete while the wider upper part could be formed of puddle clay. This forecast turned out to be fairly correct but a long stretch of trench had to be put down through running sand and mud and the pressure exerted by this ground on the timbers after two years put them badly out of shape and made it nearly impossible to withdraw them through a clay filling. It also made it very doubtful if a clay core would keep its thickness after the struts were taken out, so the general type was departed from for a long stretch of trench and concrete was brought up to within 15 ft. of the surface. This point will be brought out more fully in discussing the timbering.

The clause of the specification relating to the timbering of the trench read as follows:

> The trench shall be secured with timber of sufficient strength to prevent slipping or cracking of the ground, and be so arranged that, commencing at the bottom it can be withdrawn plank by plank as the puddle or

concrete is filled in; the sheeting shall for this purpose be placed horizontally, and shall be not less than 3 ins. in thickness, supported by walings and soldiers at least 4 ins. and 6 ins. respectively and struts having a sectional area of not less than 70 sq. ins.

A beginning was made with the excavation of the trench, using the horizontal method of mbering, and this worked well in good ground, as was to be expected, but whenever soft ground was reached trouble arose.

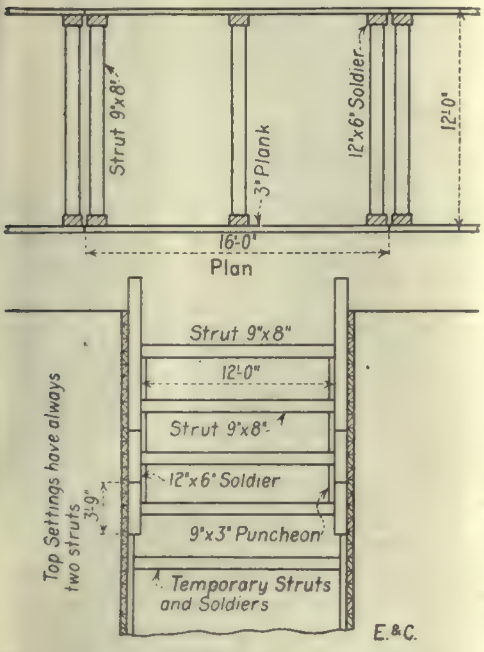


Fig. 1. Plan and Cross Section of Horizontal Timbering for Very Deep Trenches.

An example of horizontal timber is shown in Fig. 1.

The vertical soldiers covered five planks, as a rule, except for the first 5 or 6 ft., where longer soldiers were used, to permit the placing of two struts against them. It was necessary to have two struts against the top soldiers as any disturbance of surface conditions might put soldiers singly supported out of the vertical, for they would pivot on the strut end.

Except in very firm ground the procedure adopted was to excavate for the depth of one plank at a time, temporarily support this plank and lightly strut it and continue in this way till five planks were standing on "temporaries," as the men called them.

Then the permanent soldiers and struts were put in place. These squared timbers were all of pitch pine and the sheeting of hemlock. There are two points about this system of timbering which are objectionable: (1) It has no strength in tension vertically; when finished it is simply a series of planks laid one on the top of the other and, except for the spikes in the puncheons, has no vertical cohesion. (2) It is necessary to expose an area of the side of the trench equal to each plank at least before placing the plank in position. One advantage it has over the vertical system is that it is not necessary to step in with each new set of runners or piles and so the side of a trench can be maintained vertical to any depth.

Whenever bad ground was opened up the contractors urged the engineer to permit the use of vertical runners and finally the engineer consented to the use of vertical timbering for the first setting, as shown in Fig. 2. To take the greatest possible advantage of this permission to depart from the specification, very long runners were used, the planks being 11x3 ins. x 24 ft. long in some cases.

As the excavated material was being hoisted by three-ton traveling cranes with 18-ft. jibs, a difficulty arose in pitching these long planks on the side of the trench next to the crane; but this was easily overcome by starting short temporary runners in the dry sand of the top 6 ft. and, after a certain amount of trench was out, replacing them, one at a time, with the long permanent planks.

The type illustrated in Fig. 2 was adopted for several thousand feet of trench though not all of the runners were 24 ft. long, the majority being 17 ft. long. The running sand was hard to deal with and in places the horizontal timbering was abandoned in favor of a second setting of vertical timbers though this reduced the width of the trench.

From one cause and another much of this trench stood open for about two years with the result that the ground settled very heavily against the timbers. In many cases the soldiers, though 6 ins. thick and only 3 ft. 9 ins. long, were badly bent and a few were actually broken. At depths of 20 to 40 ft. in running sand every horizontal plank was broken in places for many bays in succession and alternate bays had to be closed with new struts and soldiers in the center while the bays left open for hoisting were dealt with as shown in Fig. 3.

As experience proved, the bays were too long for 3-in. planks in this ground. It is a point to be borne in mind with horizontal timbering that once the size of the bays is fixed it must be adhered to all the way down. The limit of a bay is the strength of a plank, while with vertical timbering, though the bays may be fixed, the spacing of the walings may be altered to suit circumstances.

There was no difficulty in excavating the trench where runners were used or was there much trouble experienced drawing them where the trench was filled with clay. In one section of the trench the ground settled all on one side with the result that some of the struts were nearly 2 ft. out of level but no accident occurred owing to constant care in placing raking struts as the weight came on.

It was specified that all timber was to be removed from the trench as it was filled. Having attempted to remove some of the horizontal timbering in running sand, as the concrete was being placed, without much success, and realizing the great pressure there was against the sides, the engineer decided to leave in the sheeting in the worst parts and to fill parts of the trench (originally intended for clay filling) with concrete up to the bottom of the vertical runners. This meant bringing the concrete up to within about 17 ft. of the surface instead of 45 ft., as planned for the typical section. Had all the circumstances been foreseen, it would have been much better to have formed the trench in this very bad ground with two or even three settings of vertical timbering, as the wall, even when thus reduced, would have been thick enough as formed in concrete.

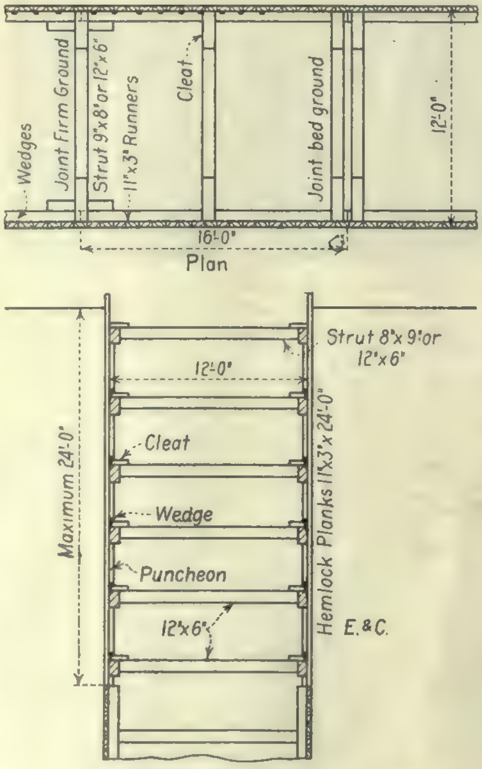


Fig. 2. Plan and Cross Section of Vertical Timbering for Very Deep Trenches.

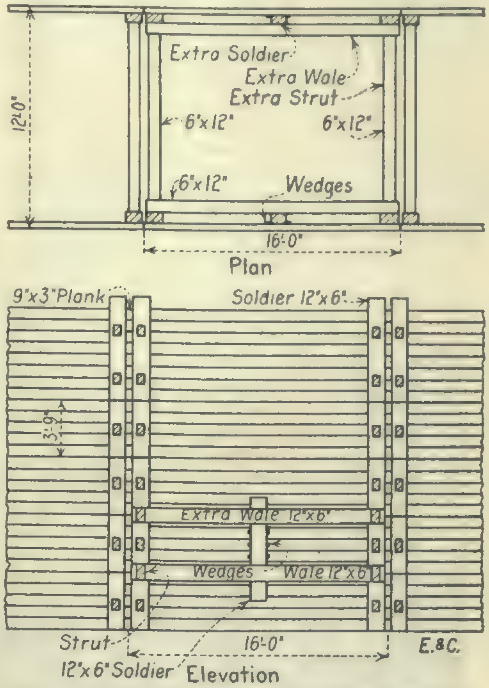


Fig. 3. Plan and Elevation of Extra Timbering for Use in Very Deep Trenches.

Another design of trench is that in which a definite width is fixed at the probable bottom or at the rock line and slopes outward sufficient to permit the insets of vertical timbering.

The first reservoir the writer was on was designed something after this plan and there was no difficulty in adhering to the original proposal as the work actually done by the contractor was about equal in quantity to that involved in the cross-section planned.

After experiencing the many makeshifts and uncertainties arising from the difficulties of adhering to the vertical sided trench in bad ground the writer is of the opinion that there is much to be said for a design which suits the use of vertical timbering. Why should not the design be such that it can be carried out in a safe manner and the payments be so made that the contractor has no inducement to do otherwise than follow the drawings? Of course, the engineer might take up the literal interpretation of his specification and say to the contractor, "Well, if you can't do it with vertical sides, take out the extra width necessary for your own system of timbering and fill in the extra width at your own expense"; but that is not a fair attitude, for the engineer by specifying a vertical sided trench has limited the contractor to a particular method of working and, if he (the engineer) has been mistaken in thinking this method possible then he has more or less misled the contractor and should help him out of the difficulty.

All these contracts were measured jobs and paid for at unit rates. There was in every case a rate per cubic yard for all excavation from the surface of the ground to 10 ft. in depth and another rate for excavation from 10 ft. to 20 ft. in depth, and so on.

Several large reservoir trenches have been excavated in Great Britain by force account, without the aid of a contractor, and there is a good deal to be said for this way of doing work where there is much uncertainty as regards probable depths to impervious strata.

One thing is clear: the engineer should never specify the form or size of timbering. It is even a mistake to say that the contractor shall submit drawings of his proposed methods of timbering for approval. The contractor takes the risk of accident and should, therefore, have a free hand to do his work in a way of his own choosing. Any approval of designs of temporary work carries with it more or less responsibility. Of course, if an engineer thought there was danger arising from the state of the timbering he would probably mention it to the contractor and the contractor would probably look into the matter, but that is a different thing from giving formal approval or disapproval of a proposal. Though an engineer should avoid interferences with temporary work, that is not to say he should not give the fullest consideration to the probable way in which the contractor will build the piece of work he is designing.

To return to the amount of pressure exerted by the earth against the timbers. The writer measured the deflection of many of the planks and, by loading a similar plank with bricks until it showed the same deflection, obtained an idea of the force acting against the sides. At 30 ft. from the surface in wet sand the deflection showed a pressure of over 1,000 lbs. per square foot. In this case, the ground had broken up to the surface where a crack could be seen about 20 ft. away from the side of the trench.

The illustrations, Figs. 1-2, give the exact dimensions of the trench timbering, so some measure of the pressure might be worked out in another way by multiplying the end area of a 9-in.x8-in. strut by the pressure per square inch necessary to force it 1 in. into the pitch pine soldiers and dividing this by the area of sheeting supported by the strut. The planks were actually broken at 20 ft. from the surface and so down to 40 ft., and there seemed to be little difference in appearance between one place and the other. The fibres of these timbers were sprung on the surface and showed as projecting splinters, but the planks were not so far gone that they fell out of their places because, before that happened, they had received new support. These planks were of hemlock and, of course, were always dripping wet.

There is very little enlightening literature on the subject of earth pressures. If one could get the measure of the pressures in a number of cases by deflections of timber, etc., these results of experience would be very useful.

Fortunately, timber gives warning before it breaks, as a rule, and errors of judgment can be rectified by adding more supports if the dangers are noticed in time. All trenches should be looked over every day by a practical timberman, especially if for any reason they have been standing open for some time.

It is astonishing how much silt will come through a knot-hole in a week, and once settlement has started, it is hard to keep timbering right.

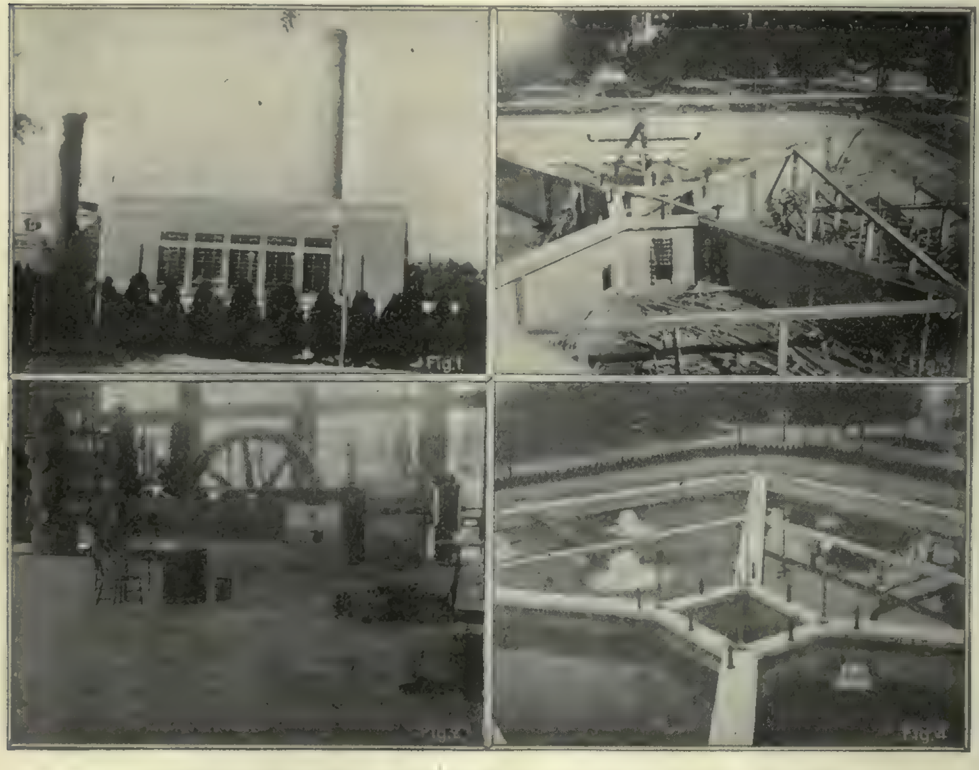
ACKNOWLEDGMENT.

The foregoing notes constitute the major portion of an article by Mr. J. M. M. Greig, A. M. I. C. E., in The Canadian Engineer.

New Water Works Improvements at Jacksonville, Fla.

(Staff Article.)

On account of increased water consumption, due to the growth of the city, it was decided in 1912 that it was necessary to make extensive alterations and enlargement of the water works system at Jacksonville, Fla. Several projects were considered and it was finally decided to abandon the old pumping station in favor of a new one, since constructed and shown in Fig. 1. There is room in the new pumping station for four 12,000,000-gal. crank and fly-wheel pumping engines. One of these pumps has been installed and is now in operation. It is shown in Fig. 2.



Views of New Water Works Improvement at Jacksonville, Fla.

Fig. 1—View of new pumping station. Fig. 2—Interior view of pump room showing new 12,000,000 gal. Epping-Carpenter Co. crank and flywheel pump. Fig. 3—Construction view of aerating basin. Fig. 4—View of aerating basin in service.

The new pumping engine was purchased from the Epping-Carpenter Co. of Pittsburgh, Pa. The manufacturer's guarantee on full load was 150,000,000 ft.-lbs. duty per 1,000 lbs. of dry steam, 146,000,000 ft.-lbs. on three-quarter load, 139,000,000 ft.-lbs. on one-half load, and 128,000,000 ft.-lbs. on one-quarter load. On full load test the pump exceeded its guarantee by 1.2 per cent; on three-quarter load by 2.7 per cent; on one-half load by 5.4 per cent, and on one-half load by 5.9 per cent.

The present supply is taken from 13 artesian wells, which yield a total flow of 12,000,000 gals. per day. The average daily consumption is 7,500,000 gals.

The water is aerated and the new aerating basin shown in Figs. 3 and 4 was constructed for this purpose. The construction view of the basin, Fig. 3, also makes clear the general design and shows the details of the piping. Special attention is called to the arrangements for electric lighting shown in Figs. 1 and 4.

The improvements were made under the authority of the Board of Bond Trustees, and under immediate charge of the Department of Public Works, of which Mr. L. D. Smoot is Commissioner. Mr. L. E. Murphy is Superintendent of the water department and we are indebted to him for the information here given.

Elements of Good Record Keeping by Water Departments.

(Staff Abstract.)

Because a water works is small is no adequate reason for laxity in its system of records and accounting. Records of all tests and repairs should be made and conveniently filed for reference. Indeed all the greater should be the necessity for accurate, convenient, systematic and comprehensive records. Good bookkeeping and well-kept records are absolutely necessary to the successful conduct of any enterprise, no matter how small or large it may be. Even in the smallest water works plant such a system should be employed as will disclose at any time the actual working conditions of the business. Moreover, it should be in such form that comparisons may readily be made with any corresponding period in the history of the enterprise. To the alert and wide awake manager such comparisons are fraught with many enlightening suggestions which he will find to be valuable aids in the prosecution of his work. For instance, in the purchase of coal, a comparison of the results obtained from the different grades will disclose which is best and most economical to use. A comparison from day to day of pumpage records, laboratory test records, coal consumption records recording pressure gage records and watchman's clock dial records, will be found to be abundantly worth while.

Likewise, a comparison from month to month of cash receipts and disbursements, when properly classified, will tend to emphasize conditions needing correction, and by so pointing out the way to the right sort of management as the business develops and grows, will make failure improbable and in some degree of success, at least, not too difficult to be realized.

The office records should show completely of what the physical plant consists. Every water main should be definitely shown as to location, connection and size. Every valve, fire hydrant, curb stop box and service pipe should be correctly mapped, and each service record be made to fully indicate every fixture and purpose for which it is to be used by the consumer. These really important matters, too many of our smaller cities entirely disregard.

Good accounting will not permit the capital investment account to be charged with replacements and repairs, nor will it attempt to deceive by failing to take into consideration the very important item of depreciation.

From paper by Mr. James W. Lacy, superintendent of water works, Brookfield, Mo., before Southwestern Water Works Association.

Data on Comparative Cost of Maintaining and Renewing Wooden and Steel Pipe at Seattle.

(Staff Abstract.)

The pipe line for the Cedar River Water Supply No. 1, of the city of Seattle, has now been installed fourteen years. This line is composed of wooden stave and riveted steel pipe. Decay in the wooden staves has proceeded to such a stage that the pipe line is now regarded as unreliable as a supply pipe and the reconstruction of the wooden staves during the next year or two has become a necessity. As the iron bands are still in good condition for use, and from all indications will be good for a third period of service after the second set of wooden staves has decayed, the life of the bands is estimated at 45 years. It appears that 15 years is the life period of wooden staves. There would thus be two stave renewals before the line as a whole would be worn out. Mr. L. B. Youngs, Superintendent of Water, makes the following cost analysis to show that it will be cheaper to renew the staves twice than it would have been to use only steel pipe in the original construction.

The cost of the original excavation for the line would naturally be greater than the cost of excavation for its renewal. There would be no stumps or roots to remove, no earth fills would be necessary, and the space occupied by a 42-in. pipe would reduce the quantity of dirt to be removed by 2,255 cu. yds. per mile; but the advance in laborers' wages by ordinance, together with the advance in the price of stave lumber since the original installation, would probably make the cost of the second installation equal to if not more than the first. In his estimate Mr. Youngs has taken the actual cost of rebuilding 1,600 ft. of pipe in the summer of 1913 as a basis for computing the whole cost of renewal of the staves, showing $211,294.23 as the probable cost of renewing the entire wooden part of the pipe (22½ miles). The staves for the original installation cost $31.25 per 1,000 ft. B. M. in place. The staves for the renewal of 1,600 ft. in 1913 cost $33.25 delivered at ditch. Adding to this latter cost the cost of wrecking old pipe, and erecting, cinching and painting the new, would bring the cost of staves in place up to $1.07 per running foot, exclusive of bands, excavation and backfilling, as against 81¼ cts. on the original installation.

ESTIMATED COST OF INSTALLING AND RENEWING 42-IN. STEEL AND WOODEN PIPE.

Estimated life of steel pipe	45 years
Estimated life of wooden staves	15 years

The riveted steel pipe originally installed varied in thickness from ¼ to 7/16-in., but as the ¼-in. is heavy enough for any pressure that the wooden staves will stand, the cost of this latter thickness has been used in estimating on the steel pipe to replace the wood.

The cost would then be as follows with common labor at $1.75 to $2.00 per day:

STEEL PIPE.	
Excavating and backfilling for 22½ miles of ¼-in. steel pipe (same as wood)	$ 73,170.00
Cost of 22½ miles of ¼-in. steel riveted pipe in place	961,092.00
Total cost	$1,034,262.00
Interest at 5% on $1,034,262 for 45 years	2,327,089.50
Total cost steel pipe	$3,361,351.50
WOODEN PIPE.	
Cost of original installation:	
Excavating and backfilling for 22½ miles of pipe	$ 73,170.00
Wood staves and labor of cinching	101,725.34
Cost of bands in place	148,056.87
	$ 322,952.21
Cost of first rebuilding:	
Excavating and wrecking old pipe	$ 43,157.66
Erecting, cinching, painting and tamping	55,594.48
Stave lumber @ $33.25 per M on ground	105,061.49
Paint	7,480.60
	$ 211,294.23
Cost of second rebuilding (same as first)	211,294.23
Interest at 5% for 45 years on $322,952.21	$ 726,642.47
Interest at 5% for 30 years on $211,294.23	316,941.34
Interest at 5% for 15 years on $211,294.23	158,470.67
Total interest charge	$1,202,054.48
Original cost plus two renewals	745,540.67
Total cost of wooden pipe	$1,947,595.15
Total cost steel riveted pipe	3,361,351.50
Difference in favor of wooden pipe	$1,413,756.35

ACKNOWLEDGMENT.

These data are taken from a book entitled The Seattle Municipal Water Plant, issued by L. B. Youngs, Superintendent of Water.

A Water-Borne Typhoid Fever Epidemic at Healdsburg, Cal.

(Staff Abstract.)

Between July 15 and Sept. 22, 1914, the city of Healdsburg, Cal., was visited by an epidemic of typhoid fever consisting of 90 reported cases and 7 deaths. Prior to that time, for several years, the city had been almost entirely free from typhoid. The population of the city is about 2,100. The epidemic was water-borne and the manner of establishing this fact is, of course, of interest to water works engineers and superintendents.

From Aug. 2 to Aug. 6 a field study of the epidemic was made by a representative of the California State Board of Health. Data were gathered from physicians and patients, the water supply was studied, and suspected sources of pollution of the Russian River as far north as Cloverdale were investigated. The city water had been used by all whose cases were investigated.

The case against the city water was strong from the outset in view of the fact that a sample of the water had been sent by a city official to the State Hygienic Laboratory on May 5, 1914, and colon bacilli had been isolated from amounts of the water as small as 1 c. c. A moderate pollution with intestinal bacteria was, therefore, demonstrable at least two months before the epidemic began.

The course of the epidemic is shown by the accompanying chart. The number of cases beginning on each day is shown by the height of the shaded area. Light shading indicates that the patient recovered, and dark shading denotes a fatal termination. The characteristics of a water-borne as contrasted with a milk-borne or food-borne epidemic, are shown by the gradual beginning and prolonged course. In epidemics due to a sudden, severe and brief infection of a drinking water supply the outbreak may be explosive, like a typical food-borne epidemic, but the Healdsburg outbreak represents the more usual type of water-borne epidemic. Some of the late cases were probably infected from the earlier cases instead of directly from the city water. This would account for most of the cases in the small group at the end of the epidemic. About the middle of July, when the epidemic was beginning, there were many cases of diarrhea among the people of Healdsburg. This is a not uncommon beginning for an epidemic of water-borne typhoid.

It was suspected by some of the local physicians that the diarrhea and the earlier cases of typhoid were due to the accidental inclusion of sewage in some new water mains. Some 1,500 ft. of new cast-iron pipe were laid in certain streets of Healdsburg, mostly in the business district, between June 23 and July 10. At one point a disconnected house-drain was said to have been seen discharging into a ditch which had been dug to receive the pipes. The contractor who laid the pipes denied the possibility of the inclusion of sewage. No cases of typhoid fever antedating the epidemic had come to the attention of the physicians of Healdsburg, and the laborers who dug the ditches and laid the pipes were all local men who were apparently well. The parts of town which received the least water through the supposedly infected pipes had their full share of cases. Moreover, at the time of the field investigation the daily number of new cases was increasing, although over three weeks had elapsed since the last pipe was laid. The epidemic was evidently not due to sewage accidentally admitted to the new pipes.

THE WATER SUPPLY.

The Healdsburg water supply is pumped from five wells situated a short distance above the city in the bed of the Russian River. The wells are in that portion of the wide river bed which is submerged only during high water. Three of the wells, 1, 2 and 3, were bored to depths of 54, 34 and 36 ft., respectively. They were 20 ins. in diameter and had been sealed at the top with concrete to prevent the entrance of river water during freshets. Well No. 4, the one nearest the river, is an old dug well with a brick curb, and is 10 ft. in diameter and between 25 and 30 ft. deep. A wooden cover bolted in place was intended to prevent the entrance of river water. This well is 126 ft. from the edge of the water in the river at the summer level. Well No. 5 is a large dug well situated near well No. 4 and almost as near to the river. This well is 12 ft. in diameter and 40 ft. deep, and is protected by a wooden cover. All five of the wells were sunk into the gravel and sand of the river bed without encountering any impervious strata.

The pipes from the five wells are all connected and it is impossible to tell how much water comes from each. From the pumping station the water goes to two reservoirs on a hill 122 ft. higher than Healdsburg. Their combined capacity is 500,000 gals. The wells furnish between 500,000 and 600,000 gals. a day.

On Aug. 3 and 4 samples were taken at the surface of the water in each of the two dug wells, at the surface of the water in each reservoir, from the pipe carrying the mixed water of the five wells from the pumping station, from a faucet in the center of the city, and also from the Russian River opposite the wells. These samples were packed in ice and sent to the State Hygienic Laboratory for bacteriological examination.

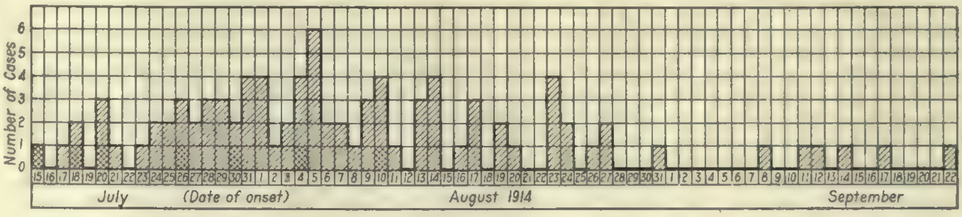


Chart Showing the Course of a Water-Borne Typhoid Fever Epidemic at Healdsburg, Cal.

At the laboratory it was found that the total number of bacteria in the samples from the two dug wells and from the pipe carrying the mixed water from the five wells was approximately half the number found in the samples from the river opposite the wells. The bacterial count of the water in the reservoirs exceeded that of the river water, and the bacteria in the water collected in the city were five times as numerous as those in the river.

These variations were due largely to water bacteria and were not so important to the investigation as were estimates of the numbers of intestinal bacteria, represented by the colon bacillus. In the river water colon bacilli were isolated from amounts of the water as small as 1 c.c., but not from 0.1 c.c. In well No. 4 they were found in 3 c.c. and not in 1 c.c. In well No. 5 they were not found in 3 c.c., although bacteria producing gas in glucose medium were demonstrated in 1 c.c. of the water. In the sample from the mixed water of all the wells colon bacilli were found in 2 c.c., but not in 1 c.c., and in each reservoir they were found in 5 c.c. but not in 3 c.c. In the sample from a faucet in the city, taken Aug. 4, the colon bacilli were isolated from 1 c.c. and not from 0.1 c.c., a result the same as that for the sample in the Russian River and for the sample previously taken from the distributing system on May 5, 1914. The samples taken where the water was kept agitated, as in the river and in the pipes above the pumping station and in Healdsburg, as a rule showed a number of colon bacilli which was greater than where the water was quiet and undergoing sedimentation, as the surfaces of the reservoirs and of the dug wells when the pumps were not running. When the pumps are in operation, a large part of the water enters the distributing system without passing through the reservoirs, and there is, therefore, little purification by sedimentation between the wells and the consumer.

In brief, the laboratory examinations showed that the water in the river was polluted with sewage and was not appreciably purified by passing through at least 125 ft. of gravel and the city water system. The pollution in the river was about equal to that in the distributing system of the city. In each instance colon bacilli were demonstrated in 1 c.c. of the water, but not in 0.1 c.c. The same grade of pollution had been demonstrated in the water previous to the appearance of typhoid fever, *i. e.*, on May 5, 1914.

In order to complete the demonstration that the city water came from the Russian River, samples were taken from a faucet in the city and from the river and sent for chemical analysis to Prof. M. E. Jaffa, director of the State Food and Drug Laboratory. The reports of the analyses were almost identical, and Prof. Jaffa stated in the letter with his report, "It would appear from the enclosed data that these waters are practically from the same source."

THE POLLUTION OF THE RIVER.

Many towns and the city of Ukiah are situated on the Russian River above Healdsburg, and some sewage pollution, coming from many sources, would be expected. The principal communities as far up the river as Cloverdale were visited and their sewage systems investigated, without discovering evidence bearing directly on the epidemic. The banks of the river in the vicinity of Healdsburg were carefully studied. About a mile above the city wells a sewer from a summer resort was found discharging fecal matter into a part of the river freely used for boating and swimming. There had been no case of typhoid fever at the building from which the sewage came, but a typhoid convalescent or a chronic typhoid carrier may have been among the summer guests or servants. Some connection between the epidemic and the summer guests is probable, because the height of the season for the summer resorts was early in July, just before the epidemic began. The resort whose untreated sewage was found flowing into the river had only six guests at the time of the investigation, but had had over a hundred early in July.

At the time of greatest population in the camps and taverns along the river it is probable that the sewage pollution was greater than at the time of the investigation. A number of cottages have cesspools in the bed of the river where the water can quickly drain through the loose sand and gravel and pollute the stream.

So long as the Russian River is used extensively for boating and swimming, the pollution of the river by the entrance of raw sewage, the untreated effluent from septic tanks, and the seepage from cesspools situated in the river bed should be prohibited. Otherwise typhoid fever and other waterborne diseases must be expected.

SEWAGE DISPOSAL.

The sewage of a city in which typhoid fever is prevalent is a source of danger. The Healdsburg sewage passes through a septic tank and is then conveyed to Dry Creek, which empties into the Russian River several miles below Healdsburg. Inspection of the creek showed a condition typical of many California water-courses in summer. There was a wide gravelly creek-bed through which flowed a small stream sometimes rippling over the stones, often concealed under the gravel for 60 ft. or more, and occasionally standing in shallow pools. A sample of water was taken from a pool about 300 ft. below the sewer outlet. The water had flowed through three pools for a total of 450 ft. and through two stretches of gravel for 140 ft. Colon bacilli were isolated from 0.001 c.c. of the water, which was not tested in smaller amounts. Such a test demonstrates only the facts, well known to sanitary engineers, that the septic tank can not be depended upon to remove colon bacilli from sewage, and that the same can be said regarding rapid percolation through loose gravel. Investigations of septic tanks under favorable conditions have shown that the content of intestinal bacteria as indicated by the number of colon bacilli, is not greatly reduced when the sewage passes through a septic tank. Likewise, typhoid bacilli and many other pathogenic organisms can survive the septic tank, as the conditions are not sufficiently unfavorable to bring about their destruction. The function of the septic tank, whether it be of the Cameron type, of the Imhoff type, or of any other variety, is to reduce the amount of suspended solids by sedimentation and putrefaction of the sediment under anaerobic conditions. The effluent from the tank is about as dangerous as the same sewage without treatment, but owing to the decrease in putrescible solids, it becomes less of a nuisance. The effluent should undergo further treatment if it is to enter a stream which is used, unpurified, for drinking purposes.

The flowing of polluted streams through the gravel of their beds, under the summer conditions exemplified in Dry Creek, does not purify the water, and the drinking of water from the pools or "springs," as they are sometimes called, is dangerous. It is obvious that water running rapidly through gravel, either from a river to shallow wells or in the bed of a stream, does not allow sufficient time factor to insure adequate filtration. Both the rapidity of flow and the coarseness of the material are such that sufficient purification by filtration is not effected.

The epidemic of 350 cases of typhoid fever of Centralia, Wash., in December, 1913, and January, 1914, was caused, like the Healdsburg epidemic, by taking water from wells sunk into the gravel at the edge of a polluted river. The water had to pass through at least 20 ft. of gravel. The percentage of the population involved (3.5 per cent) and the case mortality (6.5 per cent) were almost the same as the corresponding figures for the Healdsburg epidemic.

CONTROL OF THE EPIDEMIC.

Prior to the investigation, the city health officer suspected the city water supply as the source of the infection and instructed the people, through a local newspaper, to boil all drinking water, to protect food from flies, and to avoid the eating of raw vegetables. The public was slow to heed this advice, and one of the principal hotels continued to serve raw city water until specially warned.

When the source of infection had been determined, recommendation was made to the city authorities that the city water be treated with hypochlorite as an emergency measure. An emergency plant for introducing hypochlorite at the pumping station was set up under the direction of Prof. H. S. Griswold of the University of California, and was operated by local men, beginning on Aug. 7. Six days after the treatment began examination showed that colon bacilli could still be demonstrated in 1 c.c. of the water, although the total bacterial count had fallen from 600 to 20 per c.c. The amount of hypochlorite was then increased. Twenty days after the treatment began the local authorities sent another sample, which showed that the water was entirely safe. The bacterial count was 1 per c.c. and colon bacilli were absent in 10 c.c.

The new cases continued to be reported in considerable number for 20 days after the first application of the hypochlorite treatment, but after that there were only scattered cases, probably secondary to earlier cases. In order to reduce the number of new infections from the city water and from the earlier cases, the physicians administered typhoid vaccine to many persons.

ACKNOWLEDGMENT.

From a paper by Dr. Wilbur A. Sawyer, Director of the Hygienic Laboratory of the California State Board of Health, before the Alameda County Medical Association.

Water Waste Curtailment at Syracuse May Save $600,000.—At Syracuse, N. Y., there is a good illustration of the saving effected in water waste curtailment by deferring the construction of additional supply works. Mr. Charles A. Windholz, Superintendent of Water Works, estimates that the daily wastage is 6,000,000 gals. The average daily consumption is within 2,300,000 gals. of the total capacity of the two conduits from Skaneatles Lake. A new conduit would cost $1,333,000. Interest on this cost is given as $60,000 a year. By saving the 6,000,000 gals. now wasted daily the construction of the third conduit can be delayed ten years at a total saving of $600,000. The cost of making a pitometer test of the entire system will be about $15,000.

Sixty Water Bill Collection Districts in New Orleans.—For the purpose of preventing congestion at the collection windows of the water collection department, which necessarily resulted from having two last days for payment of water rates each quarter, and also with a view to equalizing the work of the various clerks in connection with both the outdoor and indoor departments, the Water and Sewerage Board divided the city into 60 sections, making 20 last days for payment fall in each month. This change took effect Jan. 1, 1915. It is hoped that this change will greatly facilitate the public in paying their water bills and will prevent crowding.

POWER PLANTS

Good Practice in Pipe Line Construction for High-Head Hydro-Electric Plants.

(Staff Abstract.)

On account of the high pressure carried and their length pipe lines for high-head hydroelectric plants, and particularly for plants having 1,000 ft. head or over, present a problem of engineering importance. Cast iron pipe with bell and spigot joints has been used in a few installations in the past on heads as high as 700 ft. Pipe lines of this kind are not very satisfactory since the cast iron is not well adapted to withstand shock from a sudden change in water pressure nor the stresses set up by changes in temperature. The joints cannot of themselves withstand the tendency to pull apart hence the pipe must be held in alignment by being covered with earth or must be supported on a continuous line of concrete piers. While it may be the best material for high-pressure fire-systems the conditions on a steep hillside are so different from those in a city street that cast iron is no longer considered a suitable material for high-head pipelines, and it has been abandoned in favor of other materials.

Present practice favors the use of steel with either riveted or welded joints. The use of riveted pipe in California is, in a way, a development of the practice which was followed by the hydraulic miners. One of the most noteworthy examples of early practice in the use of riveted pipe is the syphon crossing the west branch of the Feather river near Cherokee, which has a maximum head of 887 ft. and a diameter of 30 ins. This pipe was installed in 1870 and is still in fair condition. Riveted pipe is reliable since flaws in the plates are rare and the strength of the joints can be determined with accuracy. It is so flexible that bends up to about 9° can be made at any round-about joint and small changes or corrections made at every field joint. Pipe of this type has been cold-rolled and cold-punched up to 1¼ ins. thickness and down to 52 ins.

diameter. Thicker riveted pipe has been made but the holes in this have been drilled and the process of manufacture is more like that of boilers than of typical riveted pipe.

The disadvantages of riveted pipe are the excess weight in the cross-section due to the efficiency of the riveted joints being 87 per cent or less, and the higher co-efficient of friction due largely to the protruding rivet heads. Pipe with welded longitudinal seams and with either riveted or flanged round-about joints has the advantages of minimum weight and low friction losses and is being used for high-head work. In general welded pipe has not proved quite as reliable as riveted pipe but the process of welding has been rapidly improved and the new welded lines are satisfactory.

It will generally be found that a material saving in weight can be made by tapering the diameter of a high-head pipe-line in such a way that the total head lost in friction will be the amount considered permissible, rather than by selecting a uniform diameter which will give the same total friction-head. This is particularly true where the profile is such that the slope increases as the head increases. In a recent riveted line whose profile had this characteristic, the diameter was tapered from 72 ins. at the upper end to 52 ins. at the lower end where the head was 1,375 ft. One of the latest welded lines has been tapered from 42 ins. diameter to 36.8 ins. equivalent diameter, the 42-in. pipe being divided into two 26-in. pipes.

The problem of anchoring a pipe on steep slopes is important. The weight of the pipe and the stresses set up by changes in temperature have to be considered. The lines must be rigidly anchored at the power-house and should be anchored to concrete piers at sharp bends. Expansion stresses in a straight line held rigidly at each end are about 195 lbs. per square inch for each degree Fahrenheit change in temperature. Experience indicates that horizontal and vertical bends in a long pipe are of great advantage in absorbing the changes in length due to these stresses. Slip-joints have been used at various points along the pipes, but they are a cause of serious trouble in that the pipe tends to blow apart at the joint. The present tendency is to avoid long runs of straight pipe and to use slip-joints only at points near the upper end of the pipe.

ACKNOWLEDGMENT.

This discussion is from a paper by J. P. Jollyman, engineer with the Pacific Gas & Electric Co. of San Francisco, before the convention of the National Electric Light Association held at San Francisco in June.

Experience with Lead and Tar Paints on Hydraulic Apparatus, Minidoka Power Plant, U. S. R. S.

(Staff Abstract.)

The painting of the penstocks and draft tubes of the Minidoka turbine installation has been a source of considerable trouble. Several trials were made before anything which would withstand the action of the water was found.

The shop paint was of red lead, or iron oxide, and oil. A further coat of red lead and oil was applied on the job, after assembling and riveting the pipes. After two years' service an examination showed that this paint had practically disappeared.

After considerable study and experiment, with unsatisfactory results, the following formula for red-lead paint, obtained from one of the largest paint manufacturers in the country, was adopted, the lampblack being used as a hardener for the surface:

First coat: 30 lbs. red lead per gallon of linseed oil, using one-third boiled and two-thirds raw oil.

Second coat: Same as above, with 4 ounces of lampblack per gallon.

Third coat: Same as above, with 4 lbs. of lampblack to the gallon.

Paint was applied according to this formula during the winter 1912-13. After part of this work was done the chief electrical engineer suggested that we try the material used on the Los Angeles aqueduct, and in accordance with his instructions we ordered water-gas tar for the first coat and coal-gas tar for the second and third coats. This was applied to penstock and draft tube No. 1.

At the end of the 1913 season the red-lead paints applied according to the above formula showed decided deterioration where in contact with water, while the tar was in very good shape, except for slight rust spots showing around some of the rivets, where cleaning evidently had not been properly done. At the end of the 1914 season the lead paint had almost entirely disappeared where exposed to water and the tar paint was in good condition on the penstocks, but was apparently getting rather thin on the outside of the draft tube. Where the red lead does not come in contact with the water, as is the case on the upper part of the exterior of the draft tubes, it shows no deterioration and is now in excellent condition.

During the fall of 1914 the parts exposed to water on all the draft tubes were scraped. cleaned, and repainted with water-gas and coal-gas tar. Table I shows the cost of this work. There was a considerable variation in the condition on the different tubes, due to the fact that some had two coats of lead and some three, and also due to the fact that in some cases the weather was cold when the paint was applied, and it therefore may not have set sufficiently before being submerged in the water. The tar paint on draft tube No. 1 would, under ordinary circumstances, have gone a much longer time without renewing, but it was thought advisable to go over it in order to determine what condition the tar coating was in, and also to find out what was the condition of the iron underneath.

TABLE I.—COST OF CLEANING AND PAINTING FIVE DRAFT TUBES, MINIDOKA POWER HOUSE, U. S. R. S.

Draft tube.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	Total.
Total surface, sq. yds	170	170	170	170	170	850
Area cleaned and painted, sq. yds	150	150	150	150	150	750
Cost of scaffolding:						
Labor	...	...	...	...	...	$ 52.32
Material	...	...	...	...	...	22.74
Cost of cleaning:						
Sharpening scrapers	...	...	...	...	...	52.76
Labor	$37.42	$92.98	$58.00	$48.28	$85.10	321.78
Cost of painting, labor:						
First coat (water-gas tar)	7.40	11.99	2.60	6.70	12.93	41.62
Second coat (coal-gas tar)	10.95	16.69	10.16	10.10	12.06	59.96
Third coat (coal-gas tar)	None.	None.	None.	8.50	None.	8.50
Total labor, painting only	18.35	28.68	12.76	25.30	24.99	110.08
Material (all coats)	2.40	2.11	1.60	2.40	1.88	10.39
Total cost	.....	.....	.....	.....	.....	$570.07
Cost per sq. yd. cleaned and painted:						
Scaffolding, labor and material						$0.100
Cleaning, sharpening scrapers, and labor						.499
Painting—						
Labor						.147
Material						.014
Total per sq. yd						$0.760

It will be noted from the accompanying schedule that a very large part of the cost of the work was involved in the cleaning. This cleaning was done by means of steel scrapers and brushes. With the lead paint the iron pitted badly, and it was necessary thoroughly to clean out the loose scale before attempting to repaint the metal.

The rivet heads particularly presented a serious difficulty with these scrapers, and we found it very slow to do a good job cleaning around them. After finishing this work on the draft tubes, a special brush was made up which could be fitted over the rivet heads and revolved in a breast-drill frame. This worked very satisfactorily, and it materially reduced the cost of cleaning the penstocks.

The men working on this scraping were affected by lead poisoning, and precautions had to be taken to make their work intermittent. Even at that it was necessary for some of them to lay off for a considerable time to overcome the effects of the lead dust. After thoroughly scraping the iron, it was brushed down with scratch brushes, to remove the loose scale, but no attempt was made to get off all the dust prior to applying the water-gas tar.

In scraping draft tube No. 1 we found an excellent adherence between the metal and the tar paint, which had been on 1½ years at that time. Where it was scraped down to the metal it left a bright surface. On one patch, of about 1 sq. yd., apparently the iron had not been well cleaned before applying the paint, as it was in a place difficult to reach, and here scale had formed on the iron, but this was the only place the iron had not been protected from the water. There was a marked difference in the ease with which this tar was cleaned off preparatory to repainting as compared with the work involved on surfaces which had been covered with red lead paint, and which had become pitted. It will be seen from the cost data that No. 1 tube was cleaned for about one-half the average for the other four tubes. Altogether, the results with the tar have been most satisfactory.

There was quite a variation in the consistency of the water-gas tar purchased at different times. As ordinarily obtained, it was necessary, in the cool weather during which we painted, to mix a little gasoline with it. Usually the mixture was about 1 quart of gasoline to from 3 to 5 gals. of tar. This tar was then spread on carefully with a brush in the same manner as ordinary oil paint, working it carefully into all pits and around rivets. One gallon of tar covered about 30 sq. yds. with one coat. The cost was about 15 cts. per gallon, about one-half of which was freight charge from Chicago to Minidoka.

The tar is rather slow in setting even if the weather is warm. It hardens when the thermometer drops, but when the weather warms up will become sticky even after a considerable period. As most of our work was done in cool weather, it was possible to apply the second coat within 10 to 14 days. In only one case (No. 4 draft tube) were we able to get a third coat on prior to the time when the weather turned so bad that it was impossible to do outside work. It does not appear to affect the tar to put it into the water before it is thoroughly hardened.

NOTE.—The Service is now testing the tar coating described above on a number of structures, both earth covered and exposed to the weather, under different conditions as to extremes of temperature, alkali action, etc. In due time we hope to have something for publication on these tests.

The foregoing information is an extract from a report by Barry Dibble, engineer in charge of the Minidoka power and pumping stations, as published in The Reclamation Record for September.

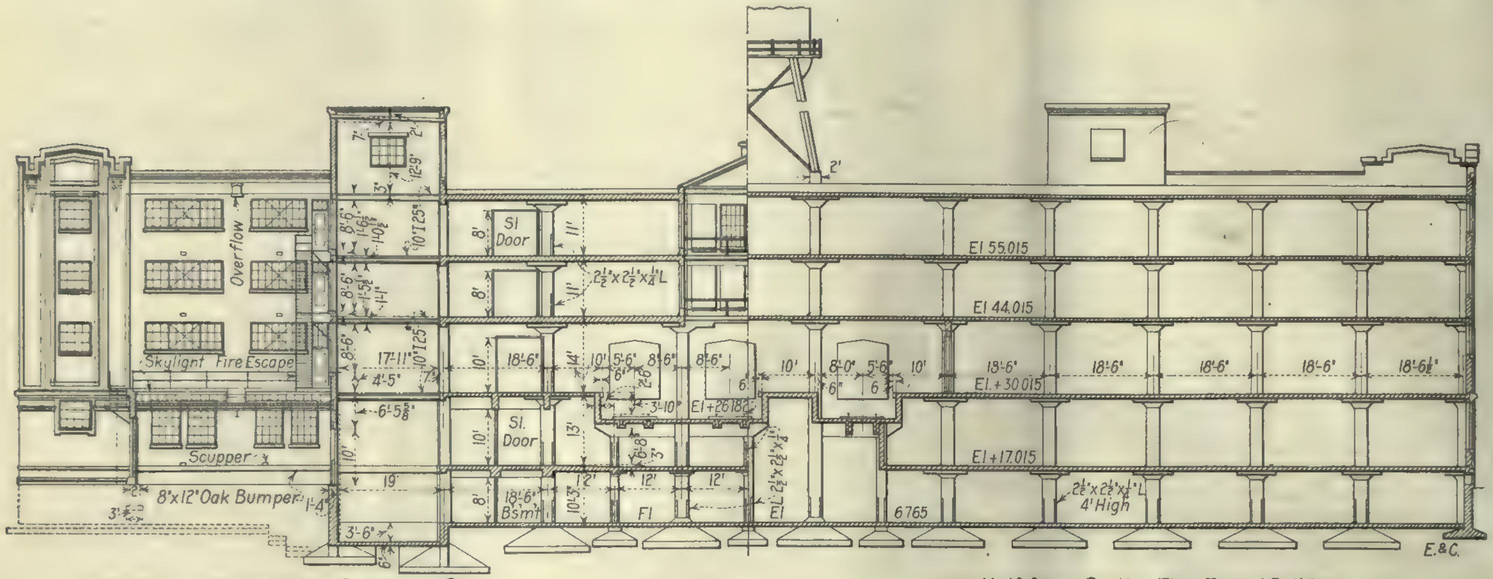
Low prices on paving work have been features of recent lettings of the Board of Local Improvements of Chicago, Ill. At the opening of bids last week one contractor submitted a bid of $1.29 per square yard on asphaltic concrete. The original bid on this job was $1.89 per square yard.

BUILDINGS

Design and Construction of Midland Warehouse, Chicago, Ill.

(Staff Article.)

The new building of the Midland Warehouse & Transportation Co., which is under construction in Chicago, occupies the area included between 15th St. and 15th Pl. and between Western Ave. and the right-of-way of the Chicago Junction Ry. The structure has a frontage of 260 ft. on Western Ave., it extends back 405 ft. and is four stories high with basement. At intervals of 115 ft. 8 ins., on both 15th St. and 15th Pl., there are courts 29 ft. 4 ins. wide, extending into the building about 60 ft. Four cross fire walls at these courts divide the typical floor into three sections of about 30,000 sq. ft. each. With the exception of a three-track steel viaduct, which enters the building at a level 3 ft. 10 ins. below the second floor and extends practically the entire length of the structure, the building is of reinforced concrete construction with 13-in. brick curtain walls. The exterior finish will be pressed brick, trimmed with enameled terra cotta.



(a) Half Cross Section Thru Courts and Passage (b) Half Cross Section Thru Typical Building

Fig. 1. Cross Section of Midland Warehouse, Chicago, Ill., Showing Floor Construction Between Courts.

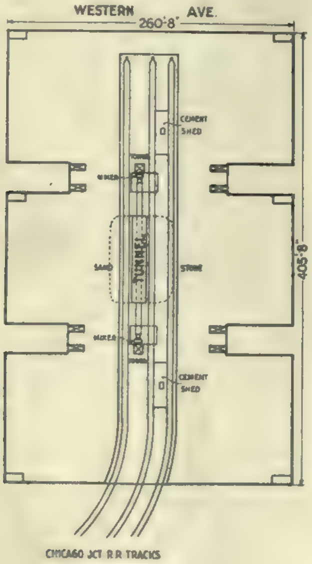
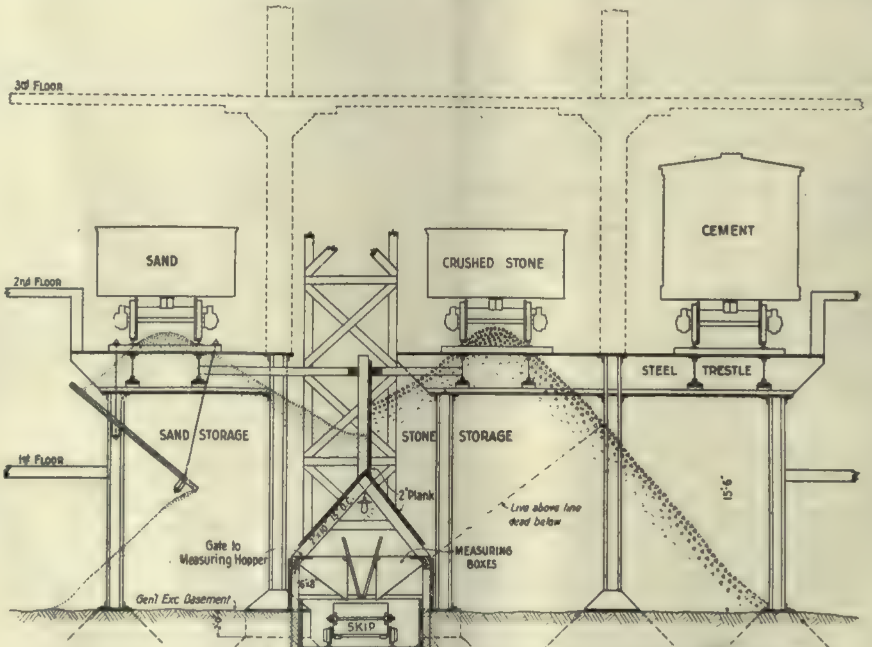


Fig. 2. Block Plan Showing Layout of Equipment and of Concrete Materials for Midland Warehouse.

DESIGN FEATURES.

The story heights of the building are as follows: Basement, 10 ft. 3 ins.; first story, 13 ft.; second story, 13 ft. 8 ins.; third story, 11 ft.; and fourth story, 11 ft. The thickness of floor slab varies from 7½ to 13 ins., according to the allowable live loads, which are as follows: 400 lbs. per square foot for the first floor; 350 lbs. for the second floor; 300 lbs. for the third floor, and 250 lbs. for the fourth floor. The "Leonard" type of flat-slab construction with four-way reinforcement is used, the typical bays being 18 ft. 6 ins. by 18 ft. 8 ins. The interior columns are round and are reinforced both spirally and with longitudinal bars. As has been noted, the track construction and the columns supporting it are steel. At the track level two lines of these columns, between the three tracks, are capped and are continued upward as reinforced concrete members. To prevent displacement of these concrete columns the steel caps are fitted with angles arranged in the form of a cross.



Note—Footings for Columns A & B were depressed 2'-0"± to give necessary headroom for Plant

Fig. 4. Cross Section of Trestle Showing Arrangement of Tracks, Storage Piles and Tunnel for Skip Cars—Midland Warehouse.

All windows will have maximum width, with the head at the ceiling line and the sills about 5 ft. from the floor line, to allow the contents to be piled against the walls. The arrangement is such that it will be possible to double the window area, if desired in the future, simply by removing the 13-in. curtain wall and lowering the terra cotta sill. In addition, there are two light and vent shafts, each 30x34 ft., which extend from the train shed up through the third and fourth floors; these serve the triple purpose of lighting the train shed, ventilating it, and lighting the third and fourth floors.

The building will be equipped with an automatic sprinkler system, fed from a 50,000-gallon tank on the roof and a 1,000-gallon-per-minute fire pump.

Six electric freight elevators, having a capacity of 8,000 lbs. each, will be installed. Space is also provided for the future installation of six additional elevators, or two elevators and four spiral conveyors or chutes. Four electric whips, a barrel conveyor and four lowerators will be provided to facilitate the rapid handling of freight and to reduce horizontal trucking to a minimum.

The three railroad tracks, which enter the building from the rear, will provide accomodations for 30 cars within the structure. Each track is served from an individual platform, unobstructed by columns and extending for its entire length, thus eliminating the necessity of spotting cars. These tracks occupy the central portion of the building and are 3 ft. 8 ins. below the level of the second floor. Special attention has been given to the arrangement of the shipping courts on each floor; these are in direct connection with the various units of the building and with the elevators. The courts connect with a motor runway and platform on the first floor.

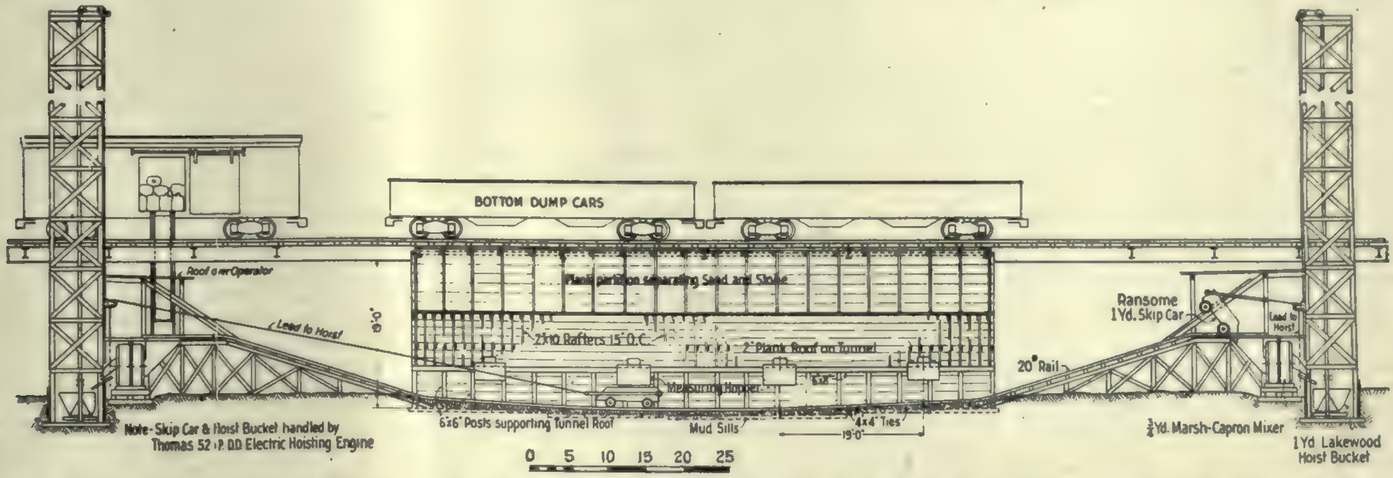
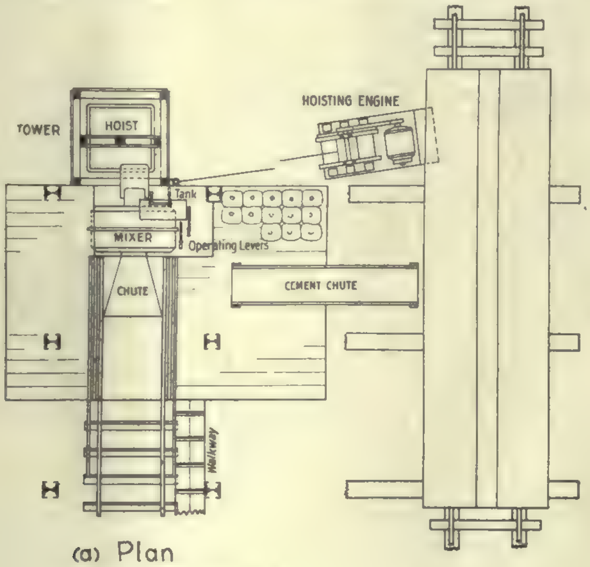
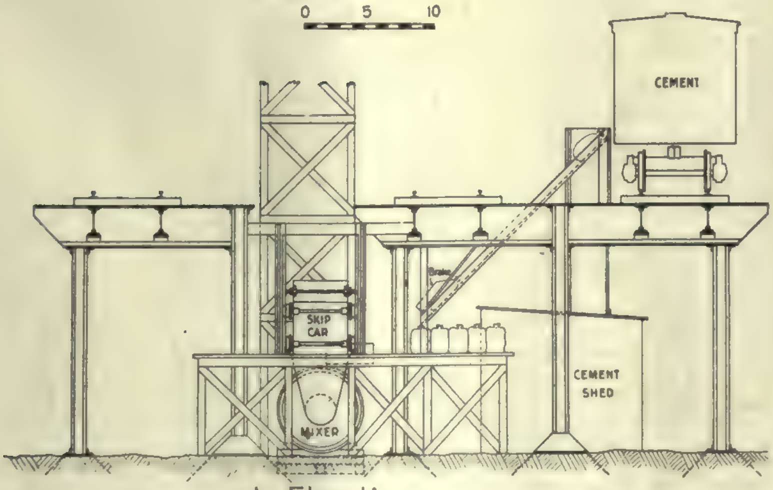


Fig. 3. Longitudinal Section of Trestle Through Midland Warehouse Showing Arrangement of Concreting Plant and Storage Bins.



(a) Plan



(b) Elevation

Fig. 5. Plan of Mixer Platform and Elevation of Mixing Plant Used in Constructing Midland Warehouse.

The general arrangement and lighting of the building is such that it will be possible to change from its use as a heavy warehouse to that of light manufacturing, and for the addition of an extra floor.

The walls and columns have spread footings, these footings being 18 ft. 8 ins. square and extending 3 ft. 9 ins. below the basement floor. Figure 1 is a half cross section of one of three typical sections into which the building is divided by the courts and a half cross section through the courts. This drawing shows the position of the railroad tracks and indicates the general structural features of the building.

CONSTRUCTION PLANT AND CONCRETING METHODS.

As the building is bounded on three sides by streets and on the fourth side by the right-of-way of the Chicago Junction Ry., it was necessary to store the materials and to lay out the construction plant within the building site. This was accomplished by erecting at the start the steel trestle which carries the railway tracks through the central portion of the building. This trestle was then utilized as a part of the construction plant, the concrete materials being stored beneath it.

Figure 2 is a block plan of the building showing the construction plant layout; Fig. 3 is a longitudinal section through the trestle showing the arrangement of the concreting plant and of the storage piles; Fig. 4 is a cross section of the trestle indicating the manner in which the three tracks are utilized in delivering, storing and conveying concrete material; and Fig. 5 shows a plan and an eleva-

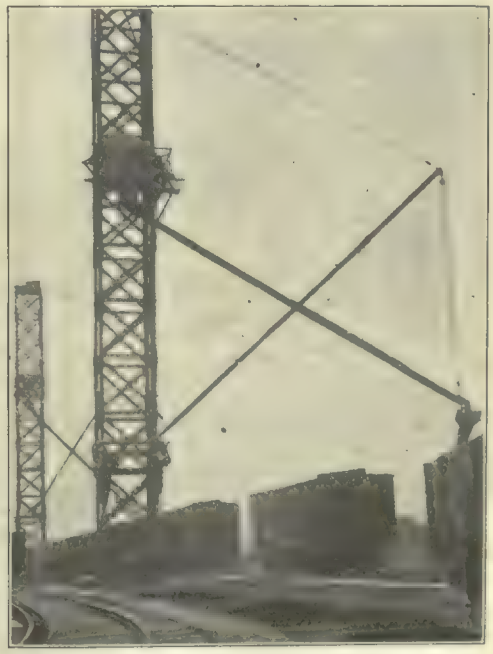


Fig. 6. View of Trestle, Towers and Chutes Used in Concreting Midland Warehouse.

tion of the mixer platform, concrete mixer and conveying equipment.

As will be noted by referring to Figs. 3 and 4, the sand and crushed stone are discharged from bottom-dump railway cars into storage piles beneath the trestle. The sand and stone piles are separated by a longitudinal partition, the base of this partition resting on the A-shaped roof of a tunnel through which the 1-cu. yd. "Ransome" skip cars operate (see Fig. 4). By means of gates located at the base of the sloping roof of the tunnel the sand and stone are delivered into measuring hoppers at four points along the trestle. From these hoppers the materials are delivered, by means of inclined floors and swinging gates, to the skip cars. After being loaded the skip car is pulled up an inclined track and automatically dumps its load into a ¾-cu. yd. "Marsh-Capron" motor-driven mixer (see Fig. 3). The mixer discharges into a 1-cu. yd. "Lakewood" hoist bucket, which is then elevated in the hoisting tower. The concrete is dumped into a chute hopper, set at the proper elevation, from which it is spouted to storage hoppers located at convenient points on the various floors (see Fig. 6). Both the skip car and the concrete hoist bucket are operated by a 52-hp. motor-driven, double-drum "Thomas" hoist. By referring to Fig. 3 it will be noted the mixing, hoisting and spouting equipment is furnished in duplicate.

As shown in Fig. 5, the cement is unloaded from the railway car and chuted directly to the mixer platform. The locations of the cement storage sheds for the reserve supply are shown in Figs. 2 and 5.

For the formwork a small carpenter shop was constructed, this shop being equipped with a cutoff saw and with rip and crosscut table saws and other minor equipment.

In concreting the third and fourth floors and the roof the chutes will be discontinued, as the floor slabs are unbroken over the trestles (see Fig. 1). By referring to Fig. 5 it will be noted that the spouting method is used to good advantage for the lower floors as the concrete can thus be spouted over the cars without interfering with their operation over the various tracks.

The plant was designed to place all the superstructure concrete, about 17,300 cu. yds., between March 18 and June 4 (about 11 weeks), but the work was partly stopped on April 15 and completely stopped about May 1, by a general strike of workmen in Chicago. At the time of interference by labor troubles the concreting operations were considerably ahead of the schedule.

PERSONNEL.

The building was designed by S. Scott Joy, architect, of Chicago, and is being constructed by the Stone & Webster Engineering Corporation, of Chicago and Boston.

Some Data on the Strength and Elastic Properties of Concrete-Filled Pipe Columns.

(Staff Abstract.)

The following data gave the results of some tests made to determine the strength and elastic properties of concrete-filled pipe columns. It was desired to determine whether a column made by filling a steel pipe with concrete was perfectly elastic under the lower loads; whether it had a definite elastic limit; and if such proved to be the case to determine the stress in the concrete and in the steel at this load. The columns used in the tests ranged in size from a 4-in. light weight boiler tube to a 6⅝-in. standard weight steam pipe. All were filled with a 1:2:3 mixture of concrete containing ½-in. screened crushed stone. Some 8x8x24-in. test blocks were also cast at the same time as the columns.

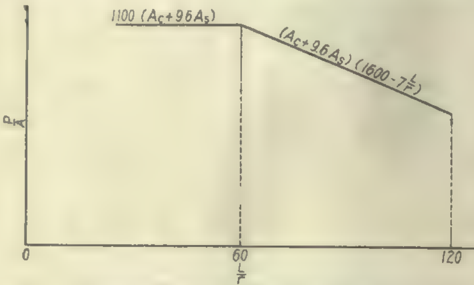


Fig. 1. Stress-Deformation Diagram for Concrete-Filled Pipe Columns.

TABLE I.—RESULTS OF TESTS ON CONCRETE-FILLED PIPE COLUMNS.

Column No.	Outside diameter, and kind.	Nominal thickness, ins.	Length, ft.	Ratio of length to diameter.	Weight, lbs. Unfilled.	Weight, lbs. Filled.	Ultimate load, lbs.	Average of three tests, lbs.	Elastic limit, lbs.	Ratio of elastic limit to ultimate load.
1......	4-in. light	9/64	8	24.0	44.5	137	85,400	88,700		
2......	4-in. light	5/32	8	24.0	47.0	139	92,600			
3......	4-in. light	9/64	8	24.0	46.0	139	88,200		20,000 (No. 3)	0.227
4......	4-in. light	9/64	10	30.0	55.0	169	67,900	74,900		
5......	4-in. light	9/64	10	30.0	61.0	168	78,400			
6......	4-in. light	9/64	10	30.0	57.0	165	78,300			
7......	5-in. light	5/32	10	24.0	80.0	263	165,100	160,100		
8......	5-in. light	11/64	10	24.0	82.0	258	148,000			
9......	5-in. light	5/32	10	24.0	80.0	265	167,300		45,000 (No. 9)	0.269
10......	5-in. light	5/32	14	33.6	115.5	370	144,800	143,100		
11......	5-in. light	5/32	14	33.6	110.5	364	145,300			
12......	5-in. light	5/32	14	33.6	105.5	360	139,300			
13......	6-in. light	11/64	10	20.0	101.0	365	210,000	241,200		
14......	6-in. light	3/16	10	20.0	104.0	377	261,600		56,000 (No. 14)	0.214
15......	6-in. light	3/16	10	20.0	105.0	377	251,900		73,500 (No. 15)	0.292
										Aver.=0.253
16......	6-in. light	3/16	14	28.0	147.0	522	199,900	204,300		
17......	6-in. light	11/64	14	28.0	145.0	520	243,700			
18......	6-in. light	3/16	14	28.0	144.5	512	169,300			
19......	4-in. heavy	7/32	8	24.0	69.0	155	147,400	144,300		
20......	4-in. heavy	15/64	8	24.0	72.5	159	144,700		40,000 (No. 20)	0.277
21......	4-in. heavy	7/32	8	24.0	71.0	156	140,900			
22......	4-in. heavy	¼	10	30.0	90.0	194	130,900	129,700		
23......	4-in. heavy	15/64	10	30.0	91.0	194	133,100			
24......	4-in. heavy	15/64	10	30.0	92.0	198	122,200			
25......	5-in. heavy	¼	10	24.0	124.5	295	200,200	200,000	60,000 (No. 25)	0.299
26......	5-in. heavy	15/64	10	24.0	120.0	295	199,900			
27......	5-in. heavy	15/64	10	24.0	121.0	291	199,900			
28......	5-in. heavy	¼	12	28.8	144.5	345	180,500	196,500		
29......	5-in. heavy	¼	12	28.8	151.0	357	199,900			
30......	5-in. heavy	¼	12	28.8	148.5	356	208,900			
31......	6⅝-in. heavy	9/32	12	21.7	222.0	592	not tested	304,200		
32......	6⅝-in. heavy	17/64	12	21.7	215.0	592	303,300			
33......	6⅝-in. heavy	9/32	12	21.7	221.5	597	*305,000		90,000 (No. 33)	0.295
34......	6⅝-in. heavy	9/32	16	29.0	286.5	790	300,000 (not broken)			
35......	6⅝-in. heavy	9/32	16	29.0	304.0	767	274,900			
36......	6⅝-in. heavy	19/64	16	29.0	321.5	801	300,000 (not broken)			

*Failed at a load slightly above rated capacity of machine, which was assumed to be 305,000 lbs.

METHODS.

The methods employed in making and testing the specimens were as follows: The pipes were placed on end on the flat table of a specially constructed machine and then filled with machine-mixed concrete from an overhead hopper. Air was admitted to a cylinder under the table of this machine, lifting the machine about 2 ins. By releasing the air the table and its load were allowed to drop freely, with a considerable shock, upon the heavy base of the machine. This jarring process continued at the rate of 150 shocks per minute, concrete being added at intervals until the pipe was filled.

After the concrete had become somewhat seasoned the ends of the columns were trued in the following manner: Each column was strapped in V-shaped blocks on the horizontal table of a cup-wheel grinder. The wheel was brought up against the end of the column, and then carried across the end, at right angles to the column axis. After each trip the grinder was set ahead before starting the return cut. This procedure gave a perfectly square cut across the full area of the pipe and concrete. The column was then turned end for end, and the grinding repeated.

The average metal area of the cross section was determined from the weight of the pipe before it was filled, and this value was used in making all computations.

RESULTS OF TESTS.

The results of the tests on the columns are given in Table I.

DISCUSSION OF RESULTS.

The results of the tests show that the filled columns are perfectly elastic when subjected to the lower loads, no permanent set taking place until after the elastic limit is reached. With the exception of one column the stress-deformation diagram consisted of two straight lines intersecting at the elastic limit, as shown in Fig. 1.

It was evident that in the filled column the steel tube prevents the permanent set from taking place in the concrete below the elastic limit. The assumption was therefore made that the stress-deformation diagram for the concrete, restrained by the pipe, was the same as would be obtained for the unrestrained concrete with the sets deducted. On this assumption, and the further assumption that the modulus of elasticity of the steel pipe was 30,000,000 lbs. per square inch, the following values of the modulus of elasticity of concrete were obtained:

(a) From diagram with sets deducted,

$$E_c = \frac{55{,}000 \times 20}{64\ (0.0074 - 0.0011 - 0.0008}$$

$= 3{,}125{,}000$ lbs. per square inch.

(b) From diagram with sets not deducted,

$$E_c = \frac{55{,}000 \times 20}{64\ (0.0074 - 0.0008}$$

$= 2{,}605{,}000$ lbs. per square inch.

Using the value from (a), and taking the modulus of elasticity of steel at 30,000,000, we have,

$$\frac{E_s}{E_c} = \frac{30{,}000{,}000}{3{,}125{,}000} = 9.6.$$

Using this ratio of 9.6, the proportion of the load carried by the concrete and by the steel was determined. It was found that the stress in the concrete at the elastic limit checked almost exactly with the stress in the unrestrained concrete at its elastic limit. It was

TABLE II.—ELASTIC LIMIT OF CONCRETE-FILLED PIPE COLUMNS.

Column.	Area of steel, sq. ins.	Total equivalent area, sq. ins.	Stress in concrete at elastic limit, lbs. per sq. in.	Stress in steel lbs. per sq. in. at elastic limit.
A*.........	...	64.0	1,170	.....
3.........	1.69	27.10	740	7,100
9.........	2.35	39.85	1,130	10,800
14.........	3.06	54.58	1,030†	11,400
15.........	3.08	54.74	1,350†	.....
20.........	2.66	35.46	1,130	10,800
25.........	3.66	51.10	1,170	11,200
33.........	5.43	81.16	1,110	10,700

*Concrete block.
†Average, 1,190.

therefore evident that the elastic limit of the concrete was determined by the elastic limit of the enclosed concrete.

The elastic limits of the columns are given in Table II.

An explanation of the low value obtained for column No. 3 was found upon inspection of the deformation readings. The compression was confined almost entirely to one side, but whether this eccentric loading was due to a defective pipe or to improper bearing is not known.

An investigation of the ratio of the elastic limit to the ultimate load in each case (see Table I) would indicate that a load of at least 25 per cent of the ultimate would be a safe working load, and that an even higher value might be used in certain cases.

COLUMN FORMULAS.

As a result of these tests the column formulas given in Fig. 1 were devised to take into account the stiffness of the column. In these formulas:

A_c = area of concrete in cross section.
A_s = area of steel in cross section.
E_c = modulus of elasticity of concrete (sets reduced).
E_s = modulus of elasticity of steel.
$E_s \div E_c = 9.6$.
L = length of column.
r = radius of gyration, solid section.
$P \div A$ = safe working load, pounds per square inch.

The formulas as given apply only to columns made of the same 1:2:3 mix of concrete as was used for the columns tested, but the constants can easily be modified to adapt them to any other mix.

ACKNOWLEDGMENT.

The foregoing data were reported in a paper by F. W. Swain and A. F. Holmes, presented before the 18th annual meeting of the American Society for Testing Materials.

Estimating the Cost of Mill Buildings.

(Staff Abstract.)

Although there are several publications which purport to give the approximate costs per square foot of various types of buildings, in very few cases are the size and shape of the buildings taken into account in these costs, although these are important factors. For example, a 25 x 25-ft. building will require more brick per square foot of floor area than a building 100 x 100 ft. The former would require 100 lin. ft. of wall to enclose an area of 625 sq. ft., or 1 lin. ft. of wall for each 6¼ sq. ft. of floor area; while the latter would require only 400 lin. ft. of wall to enclose an area of 10,000 sq. ft., or 1 lin. ft. of wall for each 25 sq. ft. of floor. The same condition applies to footings, copings, wall flashings, etc. Such items as floor construction and roofing are almost directly proportional to the floor area, but the items included in the wall construction affect the total cost to such an extent as to make it unwise to attempt to give an approximate estimate of the cost per square foot without carefully considering the effect of size and shape.

TABLE I.—NUMBER OF BRICKS PER SQUARE FOOT OF FLOOR FOR VARIOUS SIZES OF MILL BUILDINGS.

Height, stories.	Dimensions of building, ft.	Number of bricks per sq. ft. of floor.
1	32x 85	35
1	35x 89	25.4
1	36x100	23.2
1	50x106	17.7
1	67x 97	15.4
1	69x 92	8.3
1	53x181	8.8
1	75x120	16.5
1	80x100	8.7
1	82x253	6.6
1	60x218	12
1	140x180	6.3
2	42x 82	14.1
2	94x126	6.7
3	40x146	10.6
3	50x 96	13.4
4	50x100	16.2
4	111x201	9.4
5	72x102	10.9
5	72x157	17.5

To show the effect of changes in size and shape on the number of bricks required per square foot of structure the data in Table I are given, these data being taken from estimates on actual buildings. The buildings are of the ordinary standard mill building type, that class being selected because it is in mill construction that we find the greatest uniformity and standardization of design; the values can therefore be considered fairly representative.

TABLE II.—APPROXIMATE COST OF ORDINARY BRICK MILL BUILDINGS.

Size, ft.	1-story.	2-story.	3-story.	4-story.
25x 25	$ 1,250	$ 2,500	$ 3,750	$ 5,000
50	2,400	4,800	7,200	9,600
75	3,440	6,700	9,600	13,100
100	4,200	8,100	11,850	16,200
50x 50	3,800	7,500	11,200	13,800
75	5,100	9,750	14,100	18,750
100	6,450	12,100	17,400	23,600
125	7,750	14,500	20,600	27,000
150	9,175	16,950	24,100	31,800
75x 75	7,050	11,900	19,500	25,600
100	8,925	16,200	23,900	31,800
125	10,680	20,250	28,125	37,500
150	12,500	23,000	32,700	43,600
100x100	11,400	21,600	28,200	37,200
125	13,500	24,500	33,200	44,000
150	15,900	28,500	38,700	51,000

It is evident from Table I that if a sufficient number of observations was made a series of curves could be prepared which would show approximately the number of bricks which would be required to construct a standard mill building of any size. It is evident, also, that these curves would show a diminishing quantity per square foot as the size of the building increased so long as its shape or plan remained square, but that it requires a greater quantity of material to enclose the same area in an oblong building than in a square building, and that this quantity increases as the ratio between the length and width increases.

Table II may be taken as a guide by an engineer or architect who desires to determine the approximate cost of a projected mill building having brick walls and located in the vicinity of—but not within—New York City. The costs are based on buildings in which the story heights are not over 12 ft. In New York City the costs may run from 5 to 10 per cent higher, on account of the high cost of transporting materials, etc.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by Charles F. Dingman, in The Engineering Contractor for June, 1915.

Design and Construction of a Unit-Cast Mill Building in Victoria, B. C.

(Staff Article.)

The following data refer to the design and construction of a reinforced concrete building of the saw-tooth type built for the Vancouver Portland Cement Co., of Victoria, B. C. The structure, which is of "unit" construction, consists of 18 bays, each bay being 18 ft. x 18 ft. 9 ins. x 27 ft. 3 ins. high from floor to top of columns. The unit type of construction was adopted on account of the duplication of bents, the height of the columns, and the necessity of keeping two rotary coolers in continuous operation during the construction of the building. The locations of these coolers are shown in Fig. 1, which is a sectional elevation of the structure. This drawing also shows the special constructions required at the locations of these coolers. The coolers are used for handling clinker from the rotary kilns at a temperature of about 1,500° F., the heat from which was too great to permit the use of timber forms near them. In addition, it was necessary to keep clear a railway track which occupies the space between the two coolers.

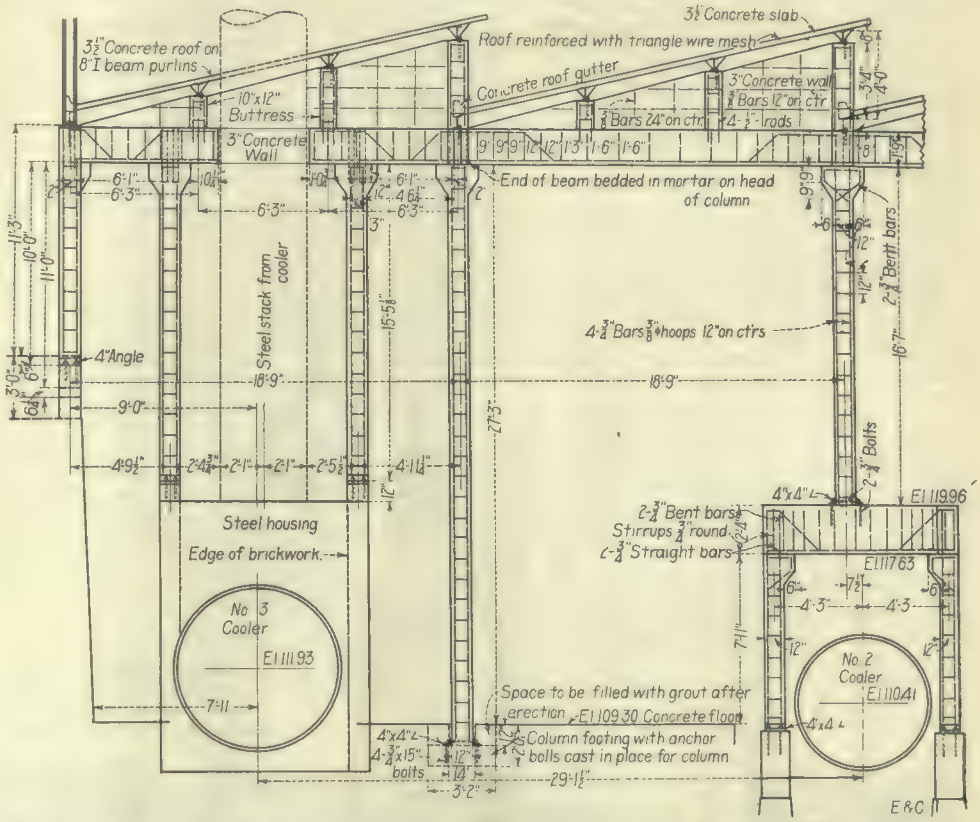


Fig. 1. Sectional Elevation of Mill Building at Victoria, B. C., Showing Types of Construction and Special Features at Coolers.

CASTING FLOOR AND HANDLING EQUIPMENT.

It was decided to cast the various units on a casting floor located outside of the building. This floor, which was about 30 ft. wide by 100 ft. long, was built of 2-in. tongue-and-groove dressed lumber. The floor was carefully leveled, and a special type of "telpher" track was built on each side of it for use in handling the long girders and columns (see Fig. 3). This track consisted of a 20-lb. rail spiked to timber stringers, the latter being supported by timber posts spaced 18 ft. on centers. A two-wheeled carriage, having grooved wheels overhung on a ball-bearing shaft, operated over

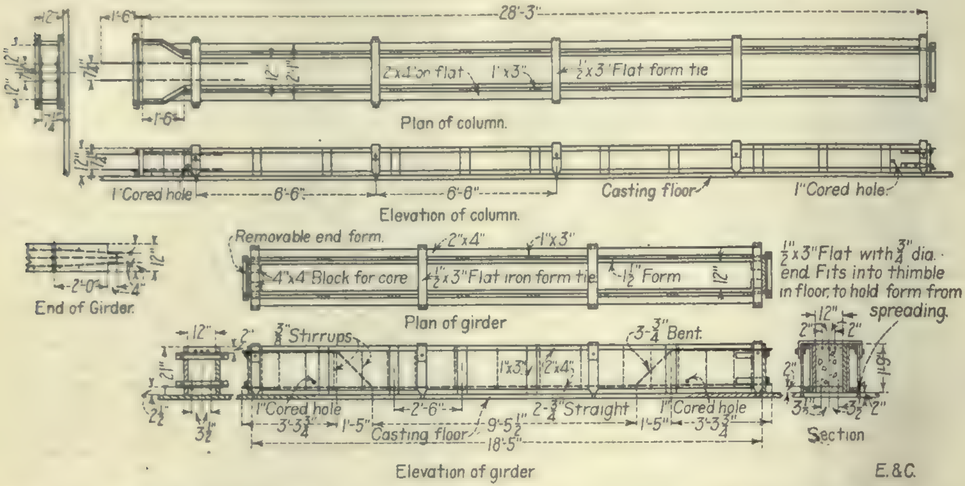


Fig. 2. Plans and Elevations of Typical Girders and Columns of Mill Building at Victoria, B. C.

the track. To this carriage there was attached a frame carrying a five-ton chain block. A 29-ft. length of 7½-in. H-section beam was used as a sling to support the concrete columns and girders and to provide means of attaching the chain block at each end. By lifting the units high enough to clear the other forms, using steel bars which were inserted in holes cored in the concrete members, the units were easily transferred to the storage yard. When the members were required the same methods were used to place them on a flat car which operated over a track, the latter crossing under the telpher track.

A ½-cu. yd. motor-driven "Ransome" mixer was located at one end of the casting floor, the mixer having been set high enough to discharge into concrete buggies which were operated over a runway laid on top of the unit forms.

GIRDERS, COLUMNS AND FORMS.

The girders are 12x21 ins. x 18 ft. 5 ins. long, each girder being reinforced with three ¾-in. bent bars, two ¾-in. straight bars, and with ⅜-in. stirrups. The columns are 12 ins. square and 28 ft. 3 ins. long, with an enlarged head to provide additional support to the girders. The ends of the reinforcing bars project 18 ins. beyond the head of each column, while the ends of the bars in the girders project 2 ins. at each end. Figure 2 gives details of the columns and girders. As will be noted by referring to these drawings, 1-in. holes were cored in the columns and girders for lifting purposes, while in the columns two ¾-in. bolts, threaded at both ends, were cast into the columns to provide means for attaching the 4x4-in. anchorage angles. The reinforcing steel for each member was made up, tied and placed as a unit. The forms were made readily collapsible, and were held in place by ½-in. x 3-in. iron flats, which engaged in holes in the floor, as shown in Fig. 2. This arrangement enabled the forms to be held in alignment and thus insured straight columns.

A 1:2:3 concrete mixture was used for the columns and girders. By casting the units in a horizontal position, careful tamping of the concrete was assured, and the finished units were found to be comparatively free from defects. The concrete was allowed to set for seven days, on the average, and the unit was then moved to the storage yard, where it remained until it was erected.

ERECTION FEATURES.

After the excavations were made for the column footings the concrete was poured up to a plane 1 ft. below grade. Four ¾-in. anchor bolts were then set for each column. The columns were then erected by means of a ginpole hand winch, as the site was too congested to permit the use of a derrick. The ginpole was also used to pick up the girder at its center and to set it on the tops of the columns. Before landing the girder in position a thin layer of mortar was spread over the head of the column to insure a uniform bearing, and a form was then placed around the joint enclosing the projecting column and girder reinforcement. The dove-tailed ends of the girders were then grouted with a wet 1:3 mortar.

After the girder had been set in place a collapsible form was set up on top of it, and the roof supports were poured in place. Figure 1 shows details of these supports, which consist of three 10 x 12-in. buttresses connected by a 3-in. reinforced concrete wall. Anchor bolts were set in the buttresses for attaching the 8-in. I-beam purlins which support the roof slab. The buttresses are bonded to the girder with ¾-in. dowels, which were grouted into holes cored in the girder.

The forms for the roof slab were made in sections and were supported on the bottom flanges of the I-beams. As shown in Fig. 1, the upper flange and the web of the I-beam were encased in concrete, only the bottom flange being left exposed. The concrete for the roof slab was mixed at the central plant located on the casting floor. The 1-cu. yd. "Koffel" side-dump cars were hauled by an electric winch to a tower located at the edge of the building. A second winch picked up bodily both the car and a section of the track, and lifted them about 35 ft. to the level of a track on the roof, where the concrete was dumped into a box and distributed by wheelbarrows (see Fig. 4).

The roof slab, which is 3½ ins. thick, was finished with a ½-in. layer of 1:2 mortar, troweled smooth. A concrete gutter was molded in place to provide adequate drainage.

The girder and column forms were used repeatedly, as were also the buttress and the collapsible roof-slab forms. Excellent results were obtained in this building by the use of unit construction, and it was estimated by the engineer in charge that the cost of the structure was only 70 per cent of that of a similar design built in place.

PERSONNEL.

The structure was designed and erected under the direction of D. C. Findlay, C. E., for the Vancouver Portland Cement Co., of Victoria, B. C. We are indebted to Mr. Findlay for the data on which this article is based.

Allowable Error in and Frequency of Testing Pennsylvania Water Meters.—The Public Service Commission of Pennsylvania has promulgated a set of rules and regulations pertaining to water utilities. The provisions as to allowable error and periodic tests of water meters are as follows:

Allowable Error.—No water meter shall be placed in service nor allowed to remain in service, which has an error in registration of more than four (4%) per cent when water is passing through it at approximately the following rates of flow:

Size of meter, ins.	Gals. per min.
	[illegible]
⅝	10
¾	20
1	30
1½	50
2	90
3	180
4	300
6	

Periodic Tests.—No utility furnishing metered water service shall allow a water meter to remain in service for a period longer than, or for a registration greater than, that specified in the following table, without checking it for accuracy, and readjusting it if found to be incorrect beyond the limits established above:

⅝-in. meter, 10 years or 100,000 cu. ft.
¾-in. meter, 8 years, or 150,000 cu. ft.
1 -in. meter, 6 years or 300,000 cu. ft.
All meters above 1-in., 4 years.

Fig. 3. View of Casting Yard for Building at Victoria, B. C., Showing Equipment for Transporting Units.

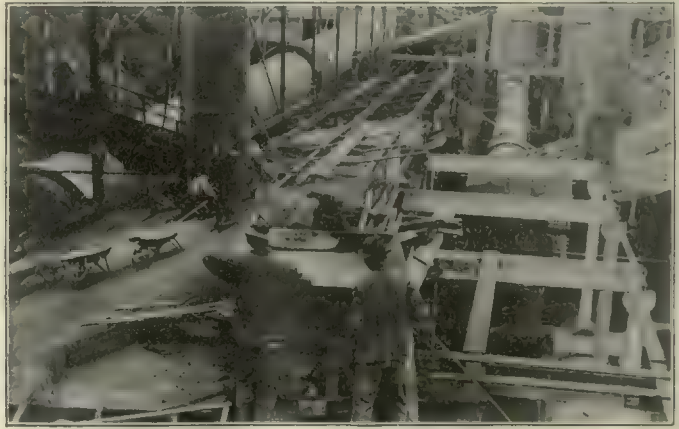


Fig. 4. View of Portion of Roof of Building at Victoria, B. C., Showing Erection Procedure.

ROADS AND STREETS

A Brief Outline of the Functions of the Planning Boards Installed in the Bureau of Highways and Street Cleaning, Philadelphia, Pa.

Contributed by Wm. H. Connell, Chief.

In order to facilitate the carrying on of the work in an orderly and systematic manner, planning boards have been installed in the office of the chief engineer, in each of the division engineers' offices, and in the seven district engineers' offices. The information contained on the boards indicates the proposed work and presents a picture of the operations coming under their jurisdiction.

The planning boards consist of a map indicating, in different colors, the character of all the pavements and unimproved streets throughout the city, mounted on a board and incased in a frame. The scale of the map is such as is necessary to contain the information desired in each specific case; for example, the scale of the District Engineer's map, which contains the locations of holes in the pavements, etc., is necessarily greater than that of the Chief Engineer's map, which does not show such detail.

The scheme is a very simple one, and is not difficult to operate. The status of contract and municipal repair work, bituminous surface treatments, etc., and the location of the repair gangs and all other information contained on the boards are indicated by pins of different colors, shapes and sizes. For example, the status of the contract work may be followed by noting the appearance and disappearance of the pins. When any paving, grading, repaving, resurfacing, etc., is completed, the limits of the work are colored with the coloring used on the standard map of the Bureau of Highways indicating the different characters of pavements and unimproved streets and roads. In the case of repair work, when the repairs are made the pins are removed; and the status of bituminous surface treatment and all other work (except that which is done in accordance with a fixed schedule), such as street cleaning, coming under the jurisdiction of the Bureau is indicated in a similar fashion.

The principal functions of these planning boards are first to enable the Chief Engineer to get a general idea of the status of the contract work (of which there are possibly 750 items a year) at any time, and also the work of the municipal forces, including repair work, bituminous surface treatments, etc., without being forced to consult the contract and municipal force record files, or without making it necessary to have a general conference with the division heads. In other words, the planning board in the office of the Chief Engineer will enable him at any time to get a general idea of the progress being made in the performance of all physical work coming under the jurisdiction of the Bureau, and thus assist him in planning the operations to the best advantage. The planning boards have been designed to contain the information that it would be desirable to picture in ready reference fashion for the Chief Engineer in charge of the organization, and the respective heads of the different functions of the organization. This means that only such information as is necessary to control the work is plotted on the respective boards; that contained on the Division Engineers' necessarily going into more detail than the Chief Engineer's, and likewise the District Engineers' going into more detail than the Division Engineers'.

On the planning boards of the District Engineers the location of each street requiring general repairs, and the location of each hole or depression in the pavements on other streets, are indicated, as is also the location and progress of the repair gangs as well as the location and progress of the contract work, and from the information contained on these planning boards the foremen's route sheets routing the order in which the repair work shall be done originate.

The planning boards of the Division Engineers contain sufficient information for them to control the work of the District Engineers without going through the files containing the contract record and municipal repair record cards, and those used in the District Engineers' offices enable the engineers in charge, by spending a few minutes every morning consulting their planning boards, to keep in touch with and thoroughly control all the operations coming under their jurisdiction down to patching less than a yard of pavement in an isolated locality.

These planning boards may be likened to a moving picture of the operation of the entire Bureau, going into sufficient detail in the respective offices of the Chief, Division and District Engineers to insure the carrying on of the work with a maximum of efficiency and the least possible friction and loss of time. No matter how thoroughly the operations of a highway department may be systematized, where the heads of the different units of the organization are dependent upon daily consultations and studies of the records on file to enable them to picture in their minds the progress of the work under their jurisdiction, there is always a certain amount of lost motion, which this new scheme for controlling highway work reduces to a minimum.

(As an indication of the information furnished by the map and the colored tacks used we give the following lists: A separate color is given to (1) unimproved roads, (2) asphalt, (3) asphalt block, (4) granolithic or concrete, (5) vitrified brick, (6) slag block, (7) granite block, (8) cobble or rubble, (9) macadam, (10) bituminous macadam, and (11) wood block. To indicate authorized work broken lines in colored ink are drawn along the street, separate colors indicating (1) grading, (2) asphalt, (3) vitrified block, (4) granite block, (5) wood block, (6) bituminous macadam, (7) waterbound macadam, (8) cement concrete. Colored classification tacks indicate, (1) grading, (2) paving, (3) repaving, (4) surfacing, (5) resurfacing, (6) extensive repairs by municipal forces, (7) dust-layer treatment, (8) bituminous surface treatment, (9) surface treatment urgent, (10) material ordered, (11) material delivered, (12) ordinance pending, (13) park, boulevard and special construction, (14) outstanding tickler. Status of work, tacks, each a separate color, indicate (1) work under contract, (2) work in progress by contract, (3) work in progress by municipal forces, (4) trouble marker. A set of general tacks indicate: main highway office; district highway offices; street cleaning districts; store yard; railway siding; dump; garbage disposal plant; rubbish disposal plant; stable, street cleaning and ash, rubbish and garbage collecting contractors; municipal asphalt plant; contractor's asphalt plant; asphalt patching gangs.—Editors.)

The Need, Preparation and Utility of Statistical Records in a Highway Department.

(Staff Abstract.)

A year ago it would have been impossible to have answered any one of a dozen essential questions with respect to any highway in New York without going to the original papers. Today, we are in possession of a set of cards upon which may be found a detailed account of the construction and cost of every road in this state built and accepted prior to January, 1914. The information referred to is shown in the case of each highway on two cards, a copy of each of which is herewith submitted. A glance at the itemized card (see Fig. 1) will show that all the essential facts in connection with the highway stand out strongly and are readily found by the one in charge of the system, or familiar with it. Among other items of information which this card gives may be enumerated the following: The number of the highway, the county in which it is located, the width of the pavement, the square yardage computed from actual quantities of materials paid for, the date of contract, the date upon which work was begun, the date of acceptance, the traffic in tons per day of 12 hours, based on actual tallies, the type of pavement, the thickness and kind of material used and the total cost.

Hy. No. 638. Name, GENEVA. County, ONTARIO.
Length, 1.01 miles, 5,333 feet; width, 14 and 16 feet, 8,388 sq. yds.
Cont. aw'd'd, Feb. 19, '10; wk. st'd, May, 1910; contract date of completion, Nov. 15, '10; contract completed, Aug., 1910.
Contractor, Fred A. Brotsch, Jr.; address, Rochester, N. Y.
Sub-soil, ...; traffic, 1,250 tons per 12 hrs.; type-pavement, bit. macadam.
Sub-base course, approved stone; depth, 6 in.; cost, 0.333 per sq. yd.
....
Base course, approved stone; depth, 4 in.; cost, $0.450 per sq. yd.
0.262 0.248
Surface course, app. stone; bit. mat. Stand. "A"-Barrett "T"; depth, 2 in.; cost, 0.510 per sq. yd.
Other contract items............................; cost, $2,411.85; unit cost, $0.960 per sq. yd.
....
Original contract cost, $10,746.20; Eng'rs est....$13,400.00; State appro....$6,212.50
Supple'l contr't cost, Less 269.67; Eng'rs est.... ....; County appro.. 6,212.50
$10,476.53
Eng. and adv. ch'gs, 1,948.47 Eng'rs est.... ....; Village appro... ....
Town appro..... ....
Total highway cost, $12,425.00; Eng'rs est., $13,400.00; Total appro., $12,425.00.
Total highway cost per mile, $12,300; pavement cost per mile, $7,980; maint. per mi. per yr., $90.00.
Total eng'ring cost per mile, $1,930; other item cost per mile, $2,390.
Total equivalent cost for 16-ft. pavement, $9,010.

Fig. 1.

To these items of information have been added other cost data which embrace the cost of supplemental contracts, if any, engineering charges, the cost of the pavement proper per square yard, together with the cost of each course in the pavement. This information has been reduced to a mileage basis; the total cost, the cost of pavement, the cost of engineering and the cost of other contract items, each being expressed on the card in terms of the mile as a unit. For purposes of comparison, the cost of the pavement has been computed for a standard 16-ft. width pavement in each case, and this also forms a feature of the card.

Accompanying the first card is a second which is known as the "narrative card." (See Fig. 2.) This is made up to read in narrative form and gives practically all the information heretofore outlined, but in a more consecutive and readable manner. For the executive officers of the Department, for other State officials, and for the layman generally, this card will be of great value as it will give them a complete story of the highway, including essential cost data in about 400 words.

It will be noted that there is added to this card the cost of maintenance—this cost being expressed not only in terms of dollars and cents, but likewise in terms of dollars per mile per year, and in terms of cents per square yard per year. The maintenance costs are likewise shown divided under the three divisions of general maintenance, repairs and reconstruction. To make this classification, the writer was obliged to adopt arbitrary definitions of these terms. To complete the story on this card, the cost of the patrol mile per year is given and in the same terms, the cost of engineering and inspection.

The writer has called attention to the fact that cards have been completed for all highways built and accepted to January, 1914. The history of the roads constructed in 1914 will not prove to be a difficult task, as the provisions of the contracts as now prepared are more clearly stated and are more definite as to the terms. Moreover, there are no maintenance costs to be computed. It was much more important to complete the old contracts and this is done.

Another work closely related to that described and now under way, is a tabulation of all the data shown on the cards. This is first done by arranging the highways in numerical order. On a single line in thirty different columns is shown every useful item of information respecting each highway in the State. Following this, a second tabulation, drawn from the first, gives special information respecting maintenance. This, in a particular manner calls attention to the changes in unit costs from year to year.

ONTARIO COUNTY. GENEVA ROAD. ROAD NO. 638.

This road is 1.01 miles long, is paved for width of 14 and 16 feet and has a paved surface of 8,388 square yards. The original contract was awarded to Fred A. Brotsch, Jr., on Feb. 19, 1910, at his bid price of $10,746.20. The total original cost of this highway, including supplementary agreements ($279.67 decrease), engineering and other charges, was $12,425.00. This is equivalent to an average cost of $12,300.00 per mile. The type of this construction was bituminous macadam. The base course was 3 inches thick of approved stone and the surface course was also 3 inches thick of approved stone and Bit. Mat. "A" (Standard) and "T" (Barrett). The cost of the top course, including binder, was $0.510 per square yard, or at the rate of $4,790.00 per mile of 16-ft. road. The cost of pavement as a whole was $0.96 per square yard, or at an average rate of $7,980.00 per mile. This is equivalent to an average rate of $9,010.00 per mile for a 16-ft. pavement. The difference between the pavement cost ($7,980.00) and the total contract cost per mile was due on the one hand to other contract items, including excavation, at an average cost of $2,390.00 per mile and on the other hand to engineering and advertising charges at the rate of $1,930.00 per mile.

The records of the Bureau of Maintenance and Repair to Dec. 31, 1913, show expenditures on this road amounting to $327.00, all for general maintenance.

These maintenance charges amount to $90.00 per mile per year or to $0.0111 per square yard per year for a period of 3½ years.

The cost of patrol was $74.00 per mile per year. There were no charges for engineering.

Fig. 2.

During the past year under the writer's direction, a traffic census was taken on many of the highways of the State and the results are also shown upon the tabulated sheets, and upon the cards as well.

Still another feature of the work now in progress in the Bureau, is the arrangement of tables showing the work of maintenance done during the year just completed. These tables when completed, will show the total moneys expended, the nature of the work done, the portion performed under contract, the amount expended for work other than repairs to the pavement proper, the condition of the pavement at the conclusion of the season and the recommendations for work to be done in the coming year. This table it is believed will afford a very simple means by which new unit costs can be computed by combining them with the figures already shown upon our completed cards.

THE OBJECT.

It may naturally be asked what is the object of a system of cards prepared as above described. If the answer is that mere interest demanded their preparation, then the writer would seriously question whether the money and time expended were worth while. He believes moreover, that the value of the work would not last even as a matter of interest. To be effective, to be lasting, the object must have greater merit. The real end sought is economy. If the cards or the histories as prepared do not effect economies in construction and maintenance, then failure must be confessed. It will be the fault of those controlling the destinies of the Highway Department in the future if savings are not made through the use of this data. A short study of the information now at hand and for the first time in form will indicate how some of these economies may be practiced, how methods may be improved and how waste may be prevented.

THE UTILITY.

It has been heretofore pointed out what specific kinds of information have been collected or reduced from known facts to working forms. In what manner can this information help the Department in the direction of greater economy and efficiency? Let us for example take the question of the selection of the type of road surfacing. What are the factors employed in its determination? The traffic passing over the highway is one. Another is the relative cost of different types of pavement. A third is the yearly cost of maintenance of the different kinds of road surfaces. It is clear that in order to make an accurate selection, data of the kind enumerated should be close at hand. Until this time, no such data was available in form to use. Because of this lack of knowledge, erroneous conclusions have been drawn and erroneous statements made. We have heard it repeatedly said that broken stone roads cost $1,000 per mile per year to maintain, and that in addition they must be rebuilt in the course of seven or eight years. Our records, now properly compiled for the first time, do not show this. One shows that twelve water-bound roads, twelve years old up to Jan. 1, 1914, have cost $0.0634 per square yard per year to maintain, which is equal to $640 per mile for a road of standard 16-ft. width. Another record shows that the average cost of maintaining 21 water-bound macadam roads, eleven years old, not including those above given, was at the rate of $525 per mile per year. Twelve additional roads ten years old cost $410 per mile per year. All of these roads received oil treatment at various times and the cost of this is included, as is also the cost of such reconstruction as was necessary.

It is not claimed that the roads above mentioned, numbering in all 45, are subjected to heavy travel, yet they were considered of sufficient importance to receive the early attention of State officials, and they are at any rate typical of the great majority of the highways of the State. Moreover, they are still in use and from this year's reports many of them are in good condition.

It is not the purpose to set up here an argument in favor of macadam roads, but rather to justify, if that be necessary, by an example taken quite at random the expense of arranging and tabulating data long of little use in the files of the Highway Department of this State. With the example cited before, and aside from the merits of different types of pavement, is it fair to make the assertion that macadam roads have outlived their usefulness, or that they cost $1,000 per mile to maintain, plus the cost of rebuilding? It does not appear business-like to make financial comparisons based upon mere guesswork when accurate data are at hand for the labor of digging it out. With the knowledge made available by these cards, misstatements of this kind will be made impossible in the future. Furthermore, in the selection of types of pavement we will be able to make comparisons of costs based upon records of our experiences.

As another example of the use to which these cards may be put, we may refer to the fact that an examination shows that the cost of what we have termed "other contract items" amount to approximately $4,500 per mile. This is the average of over one hundred separate highways and means that the State is spending that much money on every mile of road for excavation, embankment, retaining walls, culverts, etc. These features of road construction are looked upon by engineers as permanent. The pavement wears out or has to be kept in good condition at more or less expense. Grading and shaping the road, however, once done, or concrete culverts once built, are presumed to be done and built practically forever. Because of this it is contended that we should spare no expense in having these features of road construction done right at the very beginning. No one disputes this position. They should be done right, but it is believed that in many cases doing things right may be confused with doing them extravagantly.

At any rate in the preparation of the data which is the subject-matter of this report, care was taken to separate in each case the cost of "other contract items" so that if negligence, waste or extravagance in this direction was being practiced a means would be at hand whereby it could be detected. The result, as we have said, shows that the average cost per mile of these features of road construction amounted to forty-five hundred dollars.

The possibilities of a great saving in construction items of this kind may be imagined when we reflect that there are approximately 6,000 miles of state and county highways still to be built. If we assume that by a close scrutiny of the plans prepared for each new highway, a reduction of only 10 per cent in the cost of "other contract items" can be made, then an aggregate saving of over $2,500,000 for the mileage still to be built may be estimated. Is this too much to claim when it is recalled that the chief expenditure under this heading is for excavation, both earth and rock, and when we further reflect that we are too much inclined to refinement in the matter of grades, in the face of the fact that year by year the horse, as an industrial factor, is giving way to the motor. Nor should we forget that in our endeavors to limit our maximum grades to a point below what is absolutely required, we increase our costs not only by deepening our excavation, but by seeking alignments that materially add to the length of the road.

It is believed that a proper use of the information as now tabulated, combined with the will to effect a saving, will result in doing so, particularly along the lines indicated.

It has been repeatedly said that in a few years the highway problem in this State will be largely one of maintenance. It is time, therefore, that the most efficient methods of keeping the highways in first-class condition at all times and the costs for so doing should be thoroughly known. The work done in a statistical bureau will do much to assist in this. It can so arrange the mass of information of all kinds naturally developed by the great mileage of this State that there need be no question about the method or cost at the end of the next two years.

A still further benefit to be derived from the cards and sheets as already prepared, is that which will accrue to the executive or administrative head of the Department: He will be enabled at a glance to determine not only the cost of any particular feature of the work, but he will be enabled to make comparisons of costs in many different ways, and will personally be able to keep in touch with a great many things hitherto impossible. This, to my mind, is a very important thing, as most of the troubles in a Department of this kind are caused by the immensity of the district over which it has jurisdiction. Anything, therefore, that places the Commissioner in closer touch with what has been done or with what is going on, cannot but tend to greater efficiency.

THE FUTURE.

In reporting upon the progress of this work, the writer cannot but express the hope that it will be continued. He has pointed out the possibilities of great saving, suggested by the results of the work already done, but the actual saving can only be accomplished by continuous watching. If the work does proceed, there are many new features which can be added which will tend still further toward greater economy in highway construction. It is not necessary to outline these here. It is sufficient to say that the work as it has progressed has revealed new ways and means by which waste and extravagance may be checked and more efficient methods of construction and maintenance suggested.

ACKNOWLEDGMENT.

Extract from report of P. P. Farley, efficiency engineer, in Annual Report of New York State Commissioner of Highways for 1914.

The Design of Cross-Sections for Steep Grades on Public Highways.

Contributed by B. H. Pipemeier, Maintenance Engineer, Illinois State Highway Department, Springfield, Ill.

Improperly designed or located roads on steep grades often result in expensive upkeep.

It is admitted that the most important problem connected with the design of a modern highway is that of properly providing for all drainage. At least good drainage insures that the upkeep cost will be reduced to a minimum.

Yet in view of this well established principle of construction it is not uncommon to find many pavements in use where drainage has not been properly provided for. This is especially true on steep grades and on soils that wash badly.

Earth in some localities errodes more readily than in others, so necessarily needs more attention. The tendency in construction is to reduce the first cost of the road and in doing so often neglect important features of the pavement that make for more permanent and safer highways.

The writer has had an occasion to examine a very large number of pavements constructed on long, steep grades and on soils that errode very easily and it is evident that some form of cross-section that will confine the water on the pavement or within a paved gutter is usually necessary on long grades that exceed about five per cent, and particularly on soils that are inclined to wash badly.

A number of concrete and brick pavements with macadam, gravel and earth shoulders constructed on grades varying from four to ten per cent have been inspected and in nearly every case the side ditches soon become unnecessarily deep and the macadam, gravel or earth shoulders gullied out until the road becomes unsafe.

Occasionally a road is constructed on a tight soil which does not wash badly even on the steep grades. There are also times when circumstances permit the earth roads and ditches to sod rapidly and in such cases the formation of sod prevents excessive errosion for several years. However, in a majority of cases the entire road is loosened up during construction and before it becomes thoroughly compacted and set rains will cause trouble.

It is evident that a steep crown on a cross-section carries the surface water to the side ditches more rapidly and gives much better results on steep grades than the ordinary flat crown. The steep crown sheds the surface water quickly and more uniformly, which prevents a great many side gullies. But with the rapidly moving traffic it is not always safe to construct a crown that will permit this without endangering traffic during wet

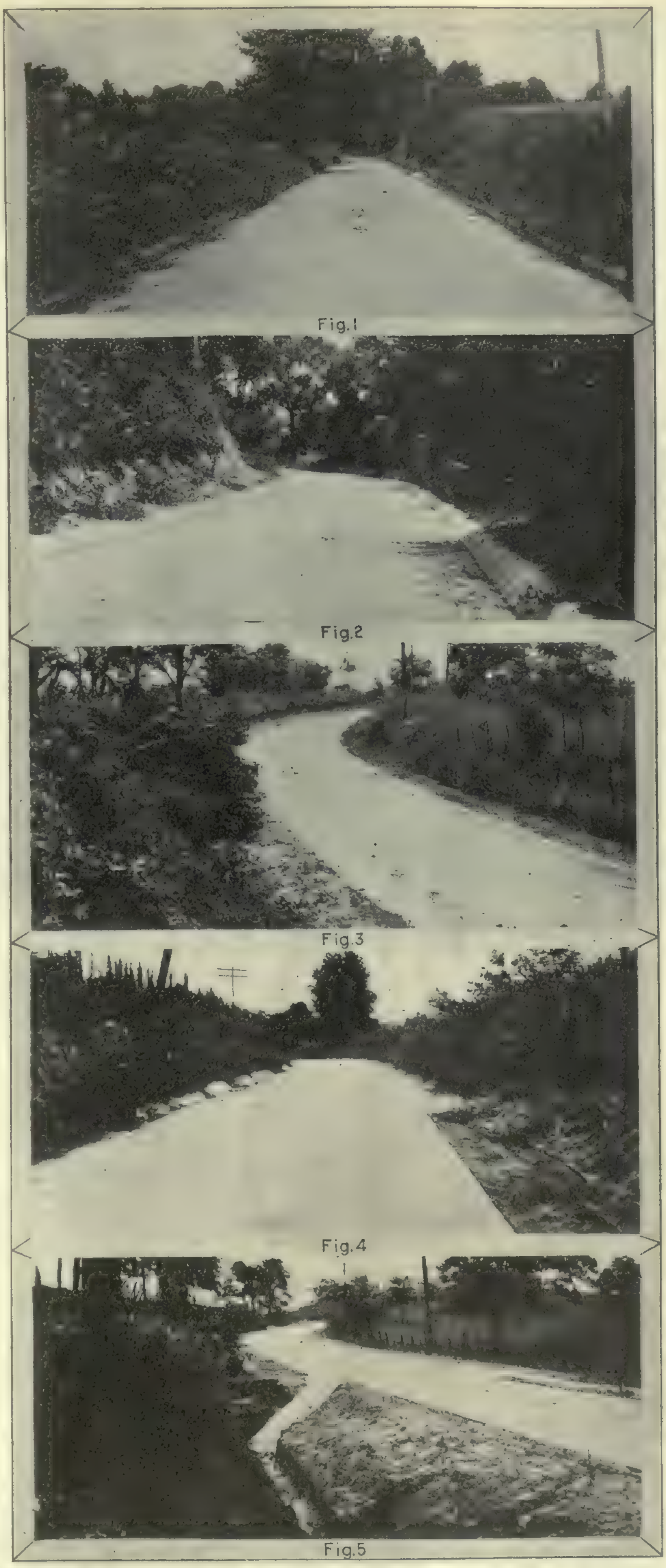


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

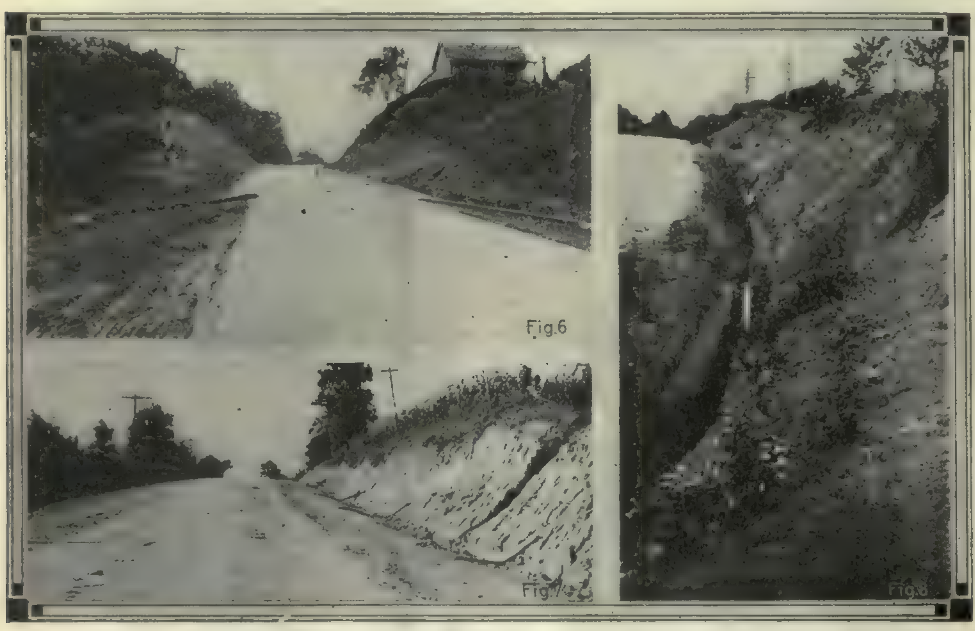
Views Showing Cross-Sections for Steep Grades on Roads.

Fig. 1. Eighteen-foot concrete pavement with vertical curb, on grade of 6 per cent. Built 1912. Fig. 2. Concrete pavement with sloping curb, constructed on sandy soil on grade of 6 per cent, 20 ft. between curbs. Fig. 3. Concrete pavement 20 ft. between curbs, constructed with sloping integral curb, on grade of 7 per cent. Soil very sandy. Fig. 4. Fifteen-foot concrete pavement, showing concrete gutters at top of hill. Soil very sandy. Gutters prevent wash and reduce upkeep cost to a minimum. Fig. 5. Open down spout conducting water from concrete gutters to ditches at foot of hill.

slippery weather. It is evident therefore, that some other form of section is necessary in many cases to provide for the surface water, and afford safety to traffic.

From the results of a very careful study of the various cross-sections in use on steep grades, the writer has concluded that some form of section shown in Figs. 1, 2, 3, or 4, where there is an integral curb or concrete gutter, in connection with the pavement, is the safest and most economical cross-section for a majority of roads on steep grades.

Where the pavement is constructed with a curb as shown in Fig. 1, it should in no case be less than about 18 ft., between curbs, and as much more as traffic may require. In this form of pavement the pavement proper acts as a gutter for carrying the water down the hill. The slight crown in the pavement forces the small volumes of water next to the curb and leaves the center of the pavement free of water. Excessive rain may of course fill the pavement to the top of the curb but such rains are of short duration and there is no inconvenience in the results.



Views Showing Cross-Sections for Steep Grades on Roads.

Fig. 6. Fifteen-foot brick pavement with concrete gutters through the cut. Wing walls constructed at end of gutters to turn water to side ditches. Gutters should have extended further down the grade before turning off. Fig. 7. Ten-foot brick pavement with 4-ft. macadam shoulders constructed on grade of 7 per cent. Concrete wing walls constructed across the side ditch at intervals of 30 ft. to prevent excessive wash. Fig. 8. An improved road constructed on sandy soil, 6 per cent grade. Side ditches provided with 10-in. tile, with catch-basins at intervals of 50 ft. Note tile and catch-basin about washed out.

The section of pavement shown in Fig. 2 has preference over that in Fig. 1. Where the integral curb slopes back at an angle of about 45° it presents a better appearance and is recognized as safer for traffic. Should a team become frightened on such a pavement and turn around very quickly the sloping curb permits the wheel to climb over the curb without turning over the vehicle or breaking the wheel. The vertical curb often prevents the wheel from climbing and the result is a break down.

From the top of the curb back to the embankment the earth slope should be about 4 to 1 for a distance of at least 4 ft. where possible. The side cut presents a good appearance and permits one to see around slight curves more readily and will also act as a table to catch any earth slides that may come down from the side cuts.

Where the above named sections are used there is no possible chance for the gutters to become clogged and serious damage done by washouts. This means a great deal on the average country highway as there is no opportunity to clean the gutters, catch basins, etc., on the country roads as there is on city streets. To reduce the up-keep cost to a minimum therefore, it is necessary to design a pavement or section so to say "Fool proof." In a majority of cases the small repairs that are necessary on the average country road often require a greater expense in getting someone on the job to do the work than the cost of doing the thing itself.

Where pavements are constructed with earth, macadam or gravel shoulders the tendency for heavily loaded teams is to pull one wheel to the side to help hold back the load in going down the grade. This practice in nearly every case will soon result in forming ruts, which will permit water to accumulate and make them larger and more serious.

A number of pavements have been examined where a large tile was embedded 2 or 3 ft. below the side ditches and catch-basins constructed at intervals to carry the surface water into the tile. This method of providing for surface and underground water is in first cost somewhat cheaper than other methods but there is always some unexpected heavy rain that is sure to clog the tile inlet with earth or debris of some kind and it refuses to carry the water and the result is that quite often the entire tile is washed out and a good portion of the earth shoulder washed away. Such construction should be avoided as it is sure to mean expensive upkeep for the road.

The writer has also examined many other devices for protecting the side road and ditches from washing. In Fig. 7 is shown curtain walls constructed at intervals of 20 to 50 ft., depending upon the grade of the ditch.

The curtain walls are of concrete and constructed so as to reach from the traveled portion of the road across the side ditch and into the side cut. They are constructed at such intervals and made of such depth that the bottom of one wall is level or below the top of the one next below it. The top of the walls are depressed so the water is confined to one place in following down the side ditch.

This method of preventing excessive wash is not always satisfactory. If the walls are properly constructed they prevent the side ditch from getting unnecessarily deep, but there is usually a very unsightly water-fall just below each cross-wall and in a great many cases rip-rap or some form of protection is necessary just below each wall to prevent serious washouts. While in first cost this method may be attractive, yet considering the results and the unsightly appearance, and danger to traffic it cannot always be recommended.

Where the water is confined between two curbs on the pavement there is no possible chance for excess wash, and the water upon reaching the bottom of the hill may be carried off to the side ditch as shown in Fig. 5. The side ditch at the bottom of the grade should have a natural slope for carrying the water so there will be no excessive washing result from turning the water in the side ditches. When conducting the water from the side gutters, at the bottom of the hill, to the side ditch the flume should deflect from the pavement at an angle of not to exceed about 30°. If a greater angle is used the water will refuse to make the turn on account of its velocity and some form of additional protection as shown in Fig. 6 is necessary to prevent the water from washing out the earth shoulder just beyond the end of the gutter.

Any abrupt water-fall, as shown in Fig. 5, should have the bank thoroughly protected with concrete or similar material to prevent the water from cutting back up the hill.

There has been some little objection offered to turning a concrete or brick pavement into a ditch and permit the surface water to be carried upon the surface of the pavement from the standpoint that ice will form in the winter months and the road become impassable. This objection is not serious in Illinois, as there are but very few days in the year that such a condition will exist.

Pavements as shown in Figs. 1, 2, 3 and 4 have been in use three and four winters and there has been practically no objections offered against them, but, on the contrary many very favorable comments.

The above investigation was made and this report is published with the approval of Wm. W. Marr, Chief State Highway Engineer of Illinois.

Advantages and Disadvantages of the Single Gutter Pavement.

(Staff Abstract.)

The present form of our streets and pavements was no doubt selected originally because the material of which the streets and roads were made was more or less porous, soft, spongy, and needed drainage. The natural thing to do was to throw up a ridge of earth or stone to drive upon.

The conditions today are greatly changed. A large portion of our city pavements and a goodly share of our country highways are being made of material such as asphalt, brick, creosoted block and concrete, which are practically impervious. The crowned street is no longer essential or necessary, the use of two gutters is an antiquated idea, and, if progress is to be made along this line, a form of street surface should be adopted which involves the use of a single gutter along the center line of the street. We are not advancing with the times if we stick to the old methods of highway construction.

The new form of pavement surface advocated consists of a concave surface. The proposed pavement should have low curbs not more than 6 ins. high. The surface of the street should have an even slope from the curb to the center line. This slope should not be over 0.2 ft. in 10 ft., or a 2 per cent grade. The low point should be in the center of the street, where curbs may be held at the same elevation, but where a warped surface is necessary the low point can be thrown to one side of the center, just as we now do with the crown of a street.

ADVANTAGES OF SINGLE GUTTER PAVEMENT.

Some of the principal advantages of such a pavement are as follows:

1. The capacity of the pavement to carry storm water is many times that of the pavement constructed in the old way.
2. It will keep the dirt and filth in the center of the street, where it was made and where it can be easily cleaned or washed away.
3. With this construction it will be easier and more convenient to establish street grades to conform to existing conditions than it is with the present method of street construction.
4. It will be more economical in the cost of catch basins and sewers, as one or possibly two catch basins will take the place of four or more.

5. No need of deep gutters with costly covers for sidewalks, which are an obstruction to the street.

6. Lower curbs or none at all in the residence sections, except such as might be formed of sod.

7. Greater convenience in driving up to the curb. No mess of water, filth, papers, cigar stubs, etc., to alight into from a carriage or auto.

8. More sanitary because storm water, or water from street washing, would be more concentrated and therefore wash the street cleaner.

9. The appearance of the street will be improved from the æsthetic point of view.

10. Less crown (or anti-crown in this case) will be needed.

11. The street will be more easily cleaned, as the debris will be concentrated in one windrow in place of two as now.

12. This form of street pavement will tend to divide traffic to right and left sides of the street.

13. Great advantage on boulevarded streets where four gutters are now necessary.

14. Where concrete is used as a paving material the tendency to crack along the center line will be reduced because the expansion of the pavement, due to temperature changes, will put compressive stresses in the pavement at the center line instead of tensile stresses as is now the case when the street is crowned at the center.

DISADVANTAGES OF SINGLE GUTTER PAVEMENT.

Some of the disadvantages to such a form of street are:

1. A narrow street with car tracks, the gutter would be between the rails, which would cause debris to accumulate in the wheel grooves. This objection could be eliminated on a wide street by making a low point each side of the car tracks.

2. During heavy storms the stream of water in the center of the street might be too deep to walk through.

3. Where the grade is slight and where there is freezing and thawing weather, water may collect in pools 4 to 6 ft. wide, freeze and make traffic in the center of the street difficult.

4. If pavement is made thick at the curb and thin at the center, fear has been expressed that the pavement would crack along the center line.

5. Fear has been expressed that rapidly moving vehicles at street intersections would tend to skid towards the center of the pavement instead of towards the curb, as would be the case of a crowned street. This contention would be true in case of vehicles turning around a corner to the right, but if the vehicle was going to the left the new form of surface would tend to keep the vehicle in the street and right side up, while with the crowned surface, as at present, the vehicle has a tendency to skid down the crown towards the curb and possibly overturn.

CONCLUSIONS.

Although some of these objections are well taken and would be found to exist in actual experience, yet many of them can be overcome and are no worse than conditions that are brought about by the use of the crowned surface of the street, as for instance, the flooding of gutters and sidewalks, due to insufficient capacity.

The idea of the single gutter pavement is not original with the author, as it has been used on alleys and driveways to good advantage for a long time; also, Mr. Harold Turner, Assistant Engineer and Surveyor of Surbitan, England, advocated this type of street six years ago. Mr. Fixmer, of the Board of Local Improvements of Chicago, has advocated a similar section for roads on side hills.

The capacity of this form of pavement to carry storm water is about 2⅔ times as great as the capacity of a street with the same width and curb height, having a crowned surface.

The cost of caring for storm water and street washing will be reduced. For comparison, take a street intersection, where four catch basins and eight gutter covers are necessary on a crowned street. The cost of construction would be about $226. The same intersection with single gutter would cost about $80 for one large catch basin with inlets, thus making a saving of $146 per street intersection.

There is no logical reason for separating the water and filth from a street into two parts and depositing it along the gutters. It seems better to leave the dirt and filth as it drops in the street in the center where it belongs, and wash it away with street flushers or the storm water.

ACKNOWLEDGMENT.

This discussion is the major portion of a paper by Mr. W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis., before the annual meeting of the Wisconsin League of Municipalities.

Bleeding and Swelling of Paving Blocks.

(Staff Abstract.)

Numerous theories have been advanced to account for the bleeding and swelling of paving blocks. In many cases these were unsupported by facts, and did not give rise to methods that prevented the trouble. Work was, therefore, started at the Forest Products Laboratory to determine, if possible, the cause of the difficulties and to devise methods of preventing them. The laboratory tests indicated that both bleeding and swelling might be greatly reduced by the adoption of suitable methods of treating and handling the blocks. Since these experiments were limited to two blocks in each test, they could not, taken by themselves, be considered conclusive.

RESULTS.

All of the results seem to indicate that bleeding is caused to a large extent by the expansion of air in the wood cells. Other contributing causes which no doubt aggravate bleeding are expansion of the preservative in the wood, external pressure exerted upon the blocks, excessive absorption of preservative by some of the blocks, and the use of rapid growth woods. Sapwood is also a factor, largely because of the excessive absorption of oil that it takes.

The following conclusions on swelling were drawn as a result of the tests:

(1) The rate of swelling was much slower in treated blocks than in untreated blocks. In all cases where the blocks were soaked in water, however, the *maximum* swelling finally obtained was at least two-thirds, and in most cases was only slightly less than that of untreated wood.

(2) Blocks treated with mixtures of carbon-free tar and creosote showed a slower rate of swelling as the per cent of tar was increased. The total amount of swelling was also less. At least 50 per cent, and in some cases 75 per cent, of tar was necessary, however, to markedly retard or reduce swelling.

(3) The presence of free carbon in the tar appeared to have no appreciable effect on the amount of swelling.

(4) The kind of tar used has some influence on the amount of swelling. The least amount swelling with a given mixture was obtained with the gas-house tar.

(5) The results indicate that preliminary vacuum has a tendency to reduce swelling.

(6) Increasing the absorption of oil above 10 pounds per cubic foot had but little influence in reducing swelling.

(7) The results obtained in the test made on the sand cushion were similar to those obtained in the soaking tests except that the total amount of swelling was less.

(8) No swelling was obtained in blocks treated in the green condition.

(9) It was possible to obtain the desired absorption by increasing the time and pressure of the treatment as the percentage of tar was increased.

(10) The penetration of preservative was more uneven as the percentage of tar in the mixture was increased.

(11) The decrease in swelling obtained by varying methods of treatment, or by using tar mixtures does not seem to be sufficient in itself to prevent expansion in street pavements. The use of green material was the most effective of the methods tested.

GENERAL CONCLUSION.

These tests seem to indicate that longleaf pine paving should be treated in the green condition after being well steamed. All blocks, even if thoroughly air-seasoned should be well steamed. While it is true that a preliminary and final vacuum greatly retarded bleeding and to some extent the swelling of air-seasoned wood, a preliminary vacuum will tend to make the absorption of oil too rapid during treatment, resulting in uneven penetration. A steaming period is, therefore, advisable to render the absorption less rapid and allow a longer and more intense pressure period to be applied. Furthermore, if seasoned blocks are steamed, they will take up moisture and expand and should be less liable to give trouble from swelling after laying in the street. For these reasons it would be preferable to treat green material when it is possible to obtain it.

If for any reason the blocks cannot be laid soon after treatment, they should be covered and perhaps wet down occasionally to prevent them from drying out. It is likely that if the blocks are wet when laid, expansion troubles will be much reduced, provided a good job of laying is done.

It would seem to be desirable to give a vacuum treatment after the steaming period and also after the oil has been removed from the cylinder. If tar mixtures are used, a final steam bath should succeed the final vacuum to remove carbon and dirt from the blocks.

Absorptions of over 16 pounds per cubic foot hardly seem necessary. Data are available which show that heavier absorptions do not greatly retard swelling and they tend to increase bleeding.

It seems very likely that the reasons why some pavements bleed while others do not may very often be traced to the method used in treatment. A plant treating green material would resort to a steaming and vacuum treatment with the result probably that the blocks would give no trouble. The same plant, perhaps, would later treat seasoned material without steaming it or giving it a vacuum treatment. This would be the simplest method of treating such timber as much time would be saved, and these operations would seem unnecessary.

These tests do not indicate that the use of tar mixtures will prevent swelling, although they tend to retard it. The least swelling was obtained with large amounts of gas-house tar having a high viscosity and specific gravity. Previous tests, however, have shown that such tar mixtures greatly retard penetration. The tar most suitable for mixing with creosote, when their penetrating qualities are considered, are those having the lowest per cent of free carbon, and possibly those having low specific gravities and viscosities. These tests indicate that such tars do not greatly retard swelling. It would seem, therefore, that the only justification for mixing tar in oils to be used for treating paving blocks is to lower its cost.

Furthermore, the tests indicate that increasing the absorption of oil above 10 lbs. per cubic foot does not tend to appreciably decrease swelling. It would seem, therefore, that in drawing up specifications for treating blocks, the waterproofing effect of the oil or treatment should not receive much consideration. The main points to be considered (aside from the selection of wood) should be to have sufficient oil of good grade to obtain a thorough penetration in order to avoid decay, and to specify a method of treatment that will not cause the blocks to bleed. The tests also indicate that swelling should be controlled principally by having the blocks in the green condition when laid in the street, and by taking special care with the filler and method of laying so that water will not penetrate to the bottom of the blocks.

Extracts from a paper by C. H. Teesdale before the American Wood Preservers' Association.

Perfect Condition of Fourteen-Year-Old Granite Block Paving.

(Staff Article.)

An exceedingly perfect condition of grouted granite block paving after fourteen years' service was disclosed by recent street railway track reconstruction at Worcester, Mass. The street was Main St., a view of which is given by Fig. 1; this street and Front St. were paved with grouted granite block during the period 1900-3-4. On Main St., which is specifically under consideration, the traffic is heavy, a count in January, 1915, showing daily the following number of vehicles: Automobiles, 10,677; motor trucks, 3,457; light horse vehicles, 1,787; horse trucks, 13,640. Figure 1 shows clearly the fine general appearance of the pavement after 14 years' service without expenditure during this time for maintenance due to wear.

The railway repair work noted above involved removing the granite block between rails and for a 2-ft. strip outside of the outer rails. The views, Figs. 2 to 7, show the work of removal and particularly the condition of the pavement which was taken out. A notation on each view is perhaps the best manner of indicating these conditions.

Figure 2 shows the pavement "toothed out" ready for the laying of the new blocks. The solidity of the slab of grouted blocks is apparent, as is also its even surface after 14 years' wear.

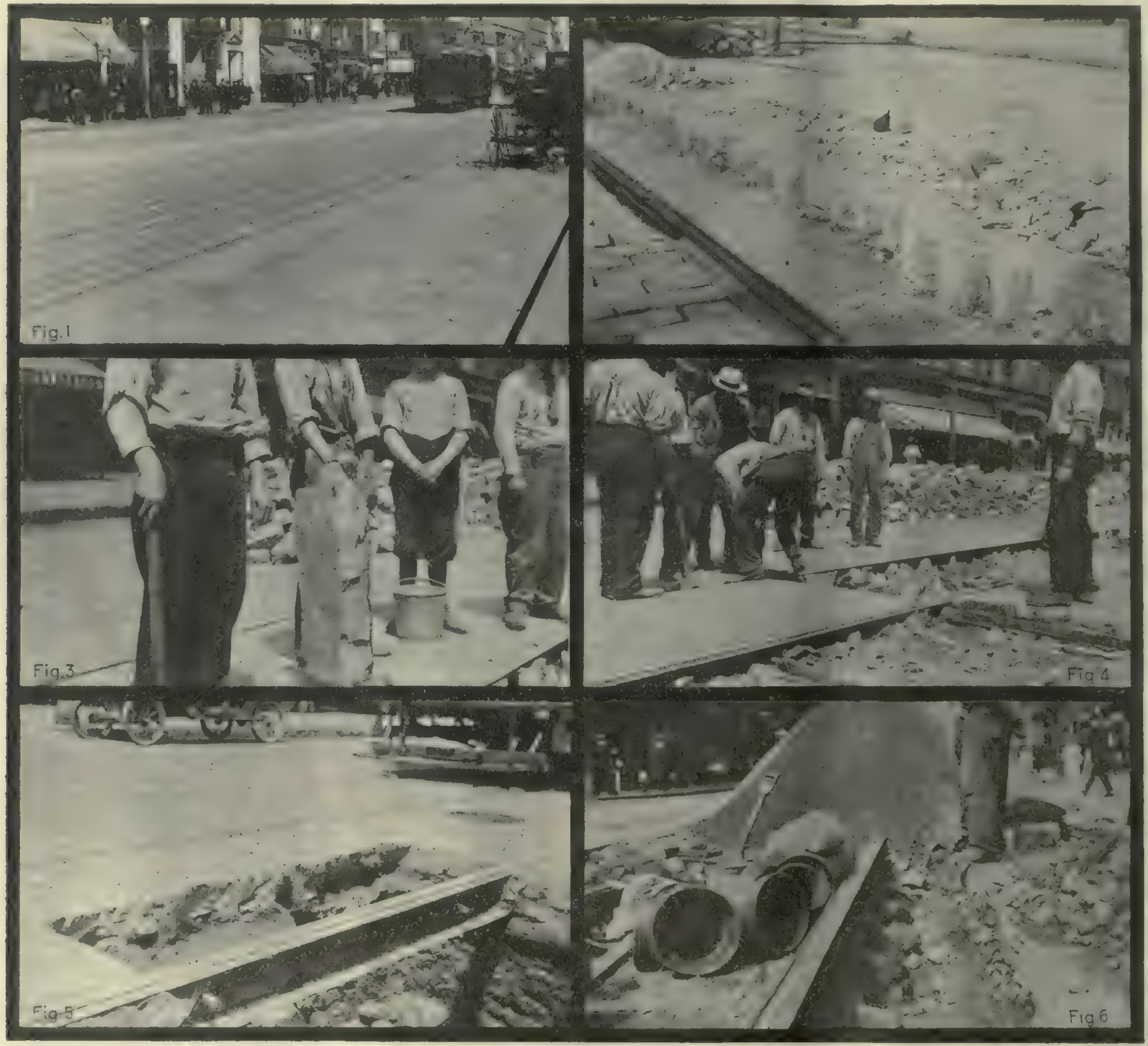
Figure 3 shows a 12-block slab lifted out in one piece. The grout penetration and joint bond are as nearly perfect as one could require.

Figure 4 shows the method of breaking out the blocks with sledge and pinch bar. Note great penetration under the cross-bar between rails; also note the salvaged blocks piled along the curb. Salvaged blocks perfectly good for relaying aggregated 70 per cent of the total number removed. In addition the blocks broken in removing were crushed for concrete by the street railway company, obtaining a saving of 80 cts. per ton over bought crushed stone.

Figure 5 shows cut in pavement indicating as does Fig. 1 the solidity and monolithic character of the grouted slab.

Figure 6 shows rotted ends of old ties leaving side support of rail to be provided almost wholly by the abutting granite block slab; this slab showed no cracks over the rotted tie ends.

The preceding data are compiled from information given by F. A. McClure, City Engineer, Worcester, Mass., and the Granite Paving Block Manufacturers Association, Boston, Mass.



Views Showing Condition of 14-year-old Granite Block Paving in Worcester, Mass.

Columns of Lincoln Memorial.—The substructure of the Lincoln memorial is now complete, and it is estimated that the building will be finished inside of two years. The marble columns of this structure will be the largest of their kind in the world. Each block of marble as it comes from the quarry weighs about 35 tons, and 12 of these huge blocks are required for each column. There will be 38 columns and each column will be 46 ft. high, weigh 192 tons when completed, and will be valued at $15,000. As the 38 columns will require 456 blocks of about 25 tons each, the total weight of marble will approximate 11,400 tons. This mass of marble is being shaped into columns at Marble, Colo.

A 512-Mile Road Improvement Project.—An extensive road improvement program is under consideration in Cochise County, Arizona. The county is contemplating a bond issue for the improvement of county roads. In connection with the project a Bond Issue Association has been formed with delegates from every part of the county. This association has outlined the roads to be constructed, which total in all 512 miles. At the present time J. C. Ryan, County Engineer, has parties in the field making surveys and estimates of the cost of building the roads as outlined. It is expected that the estimate will be completed and in the hands of the Association by Oct. 15, 1915. It is the intention to build graded roads of natural material providing for the necessary drainage, which in this county will be the largest item of expense.

GENERAL

Considerations of Sliding, Overturning, Crushing and Blow-Outs in Dam Design, by the Ohio River Board.

Based upon data supplied by available recorded tests and upon results of special percolation and upward water pressure tests conducted by it, the Ohio River Board has worked out a tentative practice in dam design. Some features of this practice, from a paper in "Professional Memoirs" (Jan.-Feb., 1915), by Capt. W. A. Mitchell, Corps of Engineers, U. S. A., are summarized here, as follows:

SLIDING.

If founded on piles, it is customary and natural to place the tops of the piles some 18 ins. into the concrete, so as to prevent sliding. Calculations are easily made, with the values in hand-books, to determine the shearing values of the piles. If the material is very soft, experiments should be made to determine the lateral bearing value of each pile; if not very soft, the lateral bearing value of each pile is sufficient and can be determined from the hand-books. See Fig. 1, showing the piles for fixed weir at Dam No. 43, Ohio River, where the material is sand, very fine but well packed.

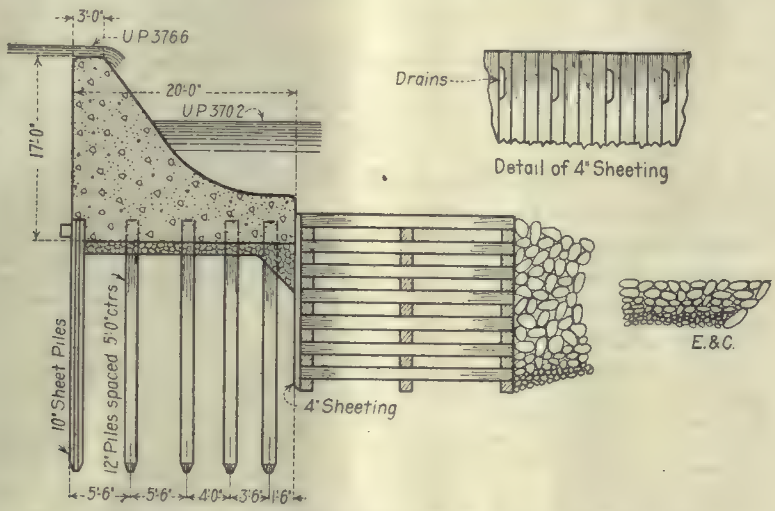


Fig. 1. Piles for Fixed Weir at Dam No. 43, Ohio River.

If the dam is founded on rock, it is claimed by many engineers that the adhesion of concrete to the rock will be sufficient, or at least of great value. Experiments do not prove this. Those made by Colonel Poe are strictly laboratory experiments. The experiments to show adhesion of concrete to concrete made by Professor Johnson at Harvard and Mr. Robinson in England gave remarkably high values in a laboratory; but those made by Colonel Shunk at Pittsburgh show that these values are entirely unreliable in actual construction. The Ohio River Board has decided to place no reliance on adhesion of concrete to concrete or to rock, and has fixed upon a key in all cases to prevent sliding. The depth of this key is placed at "never less than 3 ft.," in order to prevent possible shearing off of corners. See Fig. 2, showing design for fixed weir at Dam No. 39, Ohio River.

This key acts also as a cut-off wall and is consequently placed near the heel. If intended solely to prevent sliding, there would be no particular objection to placing it near the toe as advocated in ENGINEERING AND CONTRACTING (April 1, 1914, page 376), provided it has drains through it to prevent accumulation of upward water pressure.

OVERTURNING.

That there is always upward water pressure on sand and gravel foundations is evident from the experiments by Mr. Saville at Panama and from the experiments by Major Jervey at Wheeling. The experiments of Major Jervey also show that this pressure becomes equal to the full head of upper pool if there is no drainage into lower pool; but if there is such drainage, the pressure decreases from upper pool to lower pool, though it is not proven that the pressure decreases uniformly from full head of upper pool at heel to full head of lower pool at toe. It seems more probable that some head is lost on entrance into the material, and some on discharge from the material.

With such foundations as sand and gravel, the Ohio River Board has decided to provide drainage holes in sheet piles on lower edge of the concrete (or have no sheet piles at all); and to make design to withstand an upward water pressure over whole base of the dam varying in force from head due to upper pool at upstream edge to head due to lower pool at downstream edge. See Fig. 1, showing drain holes in sheeting on downstream side of design of fixed weir at Dam No. 43, Ohio River, where material was such as to render sheeting necessary.

With foundations on rock, the amount of upward water pressure is not so easily determined. It is evident, however, that there is such pressure. Experiments by Mr. Francis, by Colonel Hains, Colonel Shunk and Major Jervey show that water percolates through concrete and through joints between concrete and concrete or rock. Experiments as reported by Mr. Weidner, by test holes at Gatun Locks, and by Colonel Shunk and Major Jervey show that the water will rise in any test hole, and that roughly the final height of such rise varies about as its distance from lower pool relative to the distance between pools. These experiments show also that in some cases the water reaches final height in the hole very quickly, while in others it takes a very long time, thereby indicating that in general the water is present in very thin streams; and if efficient drains are introduced the upward water pressure beyond such efficient drains will be practically negligible in good rock. In this connection, it is well to note that the drains must be effective (must not be too small and must not be stopped). With rock foundations, the Ohio River Board in the general case uses the following values:

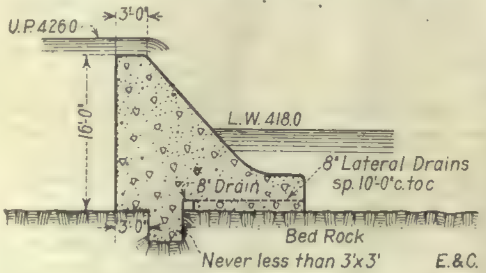


Fig. 2. Design for Fixed Weir at Dam No. 39, Ohio River.

(a) Upward water pressure varying from upper pool at up-stream edge to lower pool at drains.

(b) Pressure under 50 per cent of base for firm solid rock and under 100 per cent of base for weak rock.

(c) Drains in rock below key (see Fig. 2).

(d) Neglecting upward water pressure, center of pressure to fall within middle third; including upward water pressure, to fall far enough inside the toe so that the maximum compression shall not exceed 400 pounds per square inch for good rock or 70 pounds per square inch for poor or doubtful rock.

To overcome upward water pressure gravity sections are generally used, but sometimes steel rods with or without initial tension are used to anchor foundations to rock.

The system so often used of building a key, which is called a "cut-off wall," at or near the upper edge of a foundation is all right in theory. That of building also a "cut-off wall" at the lower edge of the wall is about the worst thing that could be done. The upper key cuts off a little water, although its principal value lies in the fact that the water can drain away below it faster than it can pass along the more difficult joint of the key itself. But if a second key is placed at the lower edge of the foundation and there are no drain holes through this key, this water accumulates under the center of the foundation, with much resultant upward pressure.

The key should not be too close to the upper edge of the foundation, as too free passage of water will create damage in poor rock; and real drains should be provided below it to the lower pool to provide better drainage than now provided by poor workmanship, which is useful in that it leaves a kind of drain along the joint between the concrete and the rock.

CRUSHING.

Dams fail by crushing of the rock foundation or by bearing down or rupture of the pile foundation. The force of this pressure depends upon all of the forces acting, which, of course, requires a determination of the value of the upward water pressure. This upward water pressure is particularly important in that it changes position of the center of pressure, generally moving it nearer the toe and, consequently, increasing the unit pressure at and near the toe.

Having determined the maximum unit pressure which is possible, the material must be examined or tested to determine its strength. If rock, laboratory tests are most satisfactory; but results of experiments elsewhere would be somewhat dependable. If sand, gravel, etc., a pile can be driven and weighted, or results of experiments elsewhere with similar material would be somewhat dependable.

BLOW-OUT.

When the water percolates through a dam with considerable speed and runs out on downstream side with considerable velocity (pressure), there is danger that the water will carry with it certain material lining the vein of its passage, thus increasing the size of the vein. This is progressive; the size of the vein continues to increase until a vast quantity of water rushes through, the vein becomes an enormous hole and the concrete monoliths above collapse from lack of support. This is what happened to the Stoney River Dam and to many dams in India.

That the percolation factor is too small is first seen by the appearance of "boils" on the downstream side. These are sometimes present for days in sand and earth dams; but if there is much alluvial soil present, there is short shift between the boil and the blowout.

On the other hand, if the boil does not carry material (is not muddy), it is probable that it is formed by the junction, near exit, of several veins through the dam, and destruction will not follow.

Quite often it is possible to build a wall around these boils, letting the water rise in this pool until the difference of pressure is so decreased that the velocity is not sufficient to carry away material and enlarge the veins.

Although, as stated, boils do not always cause destruction, their presence is an indication that prompt action is necessary.

There are no very definite experiments as to percolation factors needed to prevent blowout. Any number of experiments have been made in connection with filtration to determine amount of percolation through sand and other materials. The amount of such percolation is not of great value, except to determine the size of drains needed to carry away percolated water in order to prevent accumulation of head.

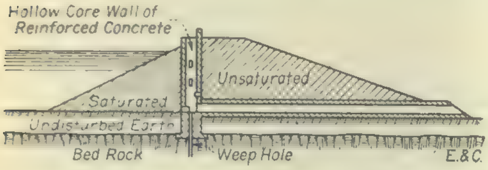


Fig. 3. Most Suitable Design to Prevent Blowouts in Earth Dams.

Percolation factors for safety against blowout have been assumed by Mr. Bligh; but he does not say on what they were based. Presumably, they were based on the fact that smaller factors were present in dams that failed; but this is not entirely conclusive, for in some cases it was evident that other causes contributed to the failure of the dams.

Experiment by Major Jervey shows that sand will blow out through a drain hole until the exposed surface of the sand is sufficiently large so that the velocity of water is not great enough to move the sand. Such first movement of sand is not a blow-out, and if gravel is first placed so that it will fill the space of such a crater, no sand will be blown out. Although it is evident that such a construction is safe, there is not sufficient data yet to determine exactly what is the percolation factor for safety.

For earth dams, the most suitable design is shown in Fig. 3, this being an Ambursen type. This is particularly suitable to eliminate blowouts and will not fail if the following conditions are fulfilled:

(a) If there are no large holes or cracks leading from saturated earth to inside of core wall, or from unsaturated earth to lateral drains.

(b) If length and resistance of line of travel through saturated earth, down around and under core wall (whether on rock or earth), through unsaturated earth, is such that the percolation factor is a safe one—that is, such that there will be no carrying of material and enlargement of veins.

(c) If the weight back of wall is sufficient to prevent displacement of the wall.

(d) If there is no overflow to wash away the rear unsaturated earth.

For rock foundations, a suitable design for safety against blow-out is shown in Fig. 2. In such dams it is only necessary to remember that rotten rock, hardpan, etc., can be carried away by rapid and continual percolation, and the beginnings of such drains must be far enough from the upper pool to prevent destructive percolation. The Ohio River Board has adopted a tentative distance of 5 ft. for ordinary shale, but this distance will vary with the material and depth of upper pool.

If the drain holes are placed too far from the upper pool, the upward water pressure will be considerably increased, and the dam will cost more.

Relative Strengths of Mortar and of Concrete Containing Ohio and Allegheny River Sands and Gravels and Relation Between Proportions of Aggregates and the Strength of Concrete.

(Staff Abstract.)

An interesting series of tests has recently been made in the materials laboratory of the Carnegie Institute of Technology, the purposes of which were: (1) to compare the strength of mortars and concretes made from sands and gravels available near Pittsburgh, Pa., and (2) to determine the effect on the strength of concrete of varying the relative volumes of sand and gravel, the volume of cement and the sum of the volumes of sand and gravel remaining the same. The program of tests and the methods of conducting them are quite similar to those used by the United States Geological Survey and described in Bulletin No. 329. The following data were abstracted from the results of these tests:

MATERIALS.

Cement.—The cement used consisted of a mixture of equal parts of Alpha, Crescent, Universal and Vulcanite purchased from dealers in Pittsburgh.

Aggregates.—Four sands were used, two from the Ohio River and two from the Allegheny River. The Ohio sands were designated *O* and *K*, and the Allegheny sands A_1 *and* A_2. Three gravels and a Ligonier limestone were investigated, the gravels being designated *O*, *K* and A_1, and the limestone *L*. Gravels *O* and *K* were obtained from the Ohio River and *A* from the Allegheny River. The physical properties of the aggregates are noted in Table I.

MAKING, CURING AND TESTING SPECIMENS.

Mortar Briquettes and Cubes.—All briquettes were mixed and molded as prescribed by the American Society of Civil Engineers. They were stored in the moist closet for 36 hours, then placed in water until tested. The same procedure was followed in making the cubes.

Concrete Cylinders.—The concrete materials were proportioned by volume, the cement being measured in a compact condition and the sand and gravel as delivered loose. A sack of cement weighing 94 lbs. net was taken equal to 1 cu. ft., in accordance with the Pittsburgh building ordinance. It was assumed (based on tests) that 1.2 cu. ft. of sand as delivered would give 1 cu. ft. of dry sand, and that 1.05 cu. ft. of gravel as delivered would dry to 1 cu. ft.

Temperatures.—The average temperature of the water in the storage tanks was 63.9° F. and that of the air in the testing laboratory 66.3° F.

RESULTS OF TESTS.

Cement.—The cement passed all requirements very satisfactorily.

Properties of Sand.—The most striking fact brought out in these tests was the greater fineness of the two sands from the Allegheny River as compared with the Ohio River sands. Although sand A_2 was purchased five months later than sand A_1, and was probably dredged from a different part of the Allegheny River, the mechanical analysis values are almost identical. Sand *O* is considerably coarser than sand *K*. The coal content of the sands, while not determined, appeared very small, but was greatest in A_2. It will be noted that the weight per cubic foot of sand A_1 is less and the percentage of voids greater than for sands *O* and *K*, this being due to the more favorable grading of sands *O* and *K*.

The specific gravity values agree quite closely and are a trifle less than the average value of 2.65 usually obtained.

Properties of Gravels.—All orders were placed for 1-in. gravel, but it was possible to secure this size only from the dealer furnishing *A* gravel. The *O* and *K* gravels were sold as 1½-in. and 1¼-in. gravel, respectively. The difference in the size of gravel is not so great proportionately as for the sands. The coarsest is the A_1 gravel; *O* is next and *K* is finest. The limestone is much coarser than any of the gravels. The Pittsburgh building ordinance limits the minimum size of gravel to material "which when dry is retained on a screen having ¼-in. mesh." Table I shows that the percentage of material held on a sieve having a diameter of 0.24 in. varied from 17.7 to 27.4 per cent. This material was therefore sand and not gravel.

There was little difference in the weight per cubic foot and percentage of voids of the gravels, but the Ligonier limestone, as might be expected because of the angular particles, gave a smaller weight per cubic foot and a greater percentage of voids. It will be noted that the specific gravity of the gravels was less than the limestone and also less than 2.66, the average value usually quoted for gravels.

TABLE I.—PHYSICAL PROPERTIES OF SANDS, GRAVELS AND STONE USED IN TESTS.

SAND

Material.	Weight per cu. ft. Dried.	Weight per cu. ft. Delv'd.	Percentage of voids.	Specific gravity. By void cylinder.	Specific gravity. By Le Chatelier flask.	Percentage of moisture.	Volume of delivered material. Volume of dry material.	Mechanical analysis. Percentage by weight passing Sieve No. 4	6	10	16	20	30	40	50	74	100
A1	91.1	77.3	43.9	2.61	2.63	6.02	1.25	100	98.8	93.9	90.6	88.5	83.3	57.3	34.6	7.3	3.6
A2	....	....	....	....	2.61	....	....	100	99.3	94.8	91.0	86.7	81.5	58.7	35.1	6.6	3.3
O	95.5	83.0	40.7	2.585	2.61	5.66	1.213	100	94.6	86.1	79.0	73.6	64	29.6	16.1	4.5	2.7
K	95.2	84.6	41.8	2.625	2.64	5.38	1.185	100	98	91.5	86.6	83	77.3	48.7	27	6.1	3.4
Ottawa	....	....	....	....	2.66	....	....	...	....	....	100.0	91	0.7	0.0	....	...	...

GRAVELS AND STONE

Material.	Weight per cu. ft. Dried.	Weight per cu. ft. Delv'd.	Percentage of voids.	Specific gravity.	Percentage of moisture.	Volume of delivered material. Volume of dry material.	Mechanical Analysis. Percentage by weight passing sieve having diameter in inches of— 0.10	0.153	0.18	0.24	0.31	0.43	0.69	1.00	1.50
A gravel	105.0	103.1	33.2	2.525	3.43	1.052	3.1	4.0	6.8	17.7	26.4	45.2	75.6	94.8	99.6
O gravel	108.8	106.2	32.2	2.575	2.44	1.048	3.3	5.4	7.9	21.2	33.6	53.3	76.6	91.3	99.5
K gravel	106.2	104.2	33.2	2.55	2.97	1.048	2.8	5.2	9.4	27.4	40.6	59.6	82.1	94.2	99.7
L stone	90.9	.....	45.4	2.665	....	.....	1.4	2.0	2.9	5.4	8.5	18.1	48.1	90	100

Strength of Briquettes.—As may be seen by referring to Table II, the 1:3 mortars made from sands *O* and *K* are stronger than those made from sands A_1 and A_2 at 7, 28 and 90 days. Sand *K* tests somewhat higher than sand *O* in three sets of specimens, but slightly lower in the two remaining sets. Ottawa sand mortar is the strongest at all ages. The ratio of strength of the 1:3 local sand mortar to Ottawa sand mortar varies from 54 to 88 per cent, averaging about 70 per cent for Allegheny sands and 80 per cent for Ohio sands. The requirement of "Committee C-2 on Concrete and Reinforced Concrete" regarding the strength of mortar made from fine aggregates is not met in the case of the local sands. The local building ordinance has the same strength specification for fine aggregates as Committee C-2.

TABLE II.—TENSILE STRENGTH OF MORTAR MADE OF VARIOUS SANDS.

Sand.	Ratio of cement to sand.	Water, per cent.	Tensile strength lbs. per sq. in.			Ratio of strength to Ottawa mortar.		
			7 days.	28 days.	90 days.	7 days.	28 days.	90 days.
Series No. 1								
Ottawa	1:3	9.25	204	330	328	....	....	....
			201	302	344	....	....	....
			204	332	...	....	....	....
			214	287	318	....	....	....
	Avge.	....	206	313	330	1.00	1.00	1.00
A_1	1:3	9.25	170	200	220	....	....	....
			180	193	222	....	....	....
			170	206	210	....	....	....
			178	190	219	....	....	....
	Avge.	....	175	197	218	0.85	0.63	0.66
O	1:3	9.25	189	235	245	....	....	....
			176	208	273	....	....	....
			176	227	255	....	....	....
			183	177	245	....	....	....
	Avge.	....	181	212	255	0.88	0.68	0.77
K	1:3	9.25	165	220	289	....	....	....
			196	228	251	....	....	....
			176	236	259	....	....	....
			175	235	275	....	....	....
	Avge.	....	178	230	269	0.86	0.73	0.82
Series No. 3—Same Consistency								
Ottawa	1:3	9.3	228	292	...	....	....	....
			220	300	...	....	....	....
			252	342	...	....	....	....
			212	295	...	....	....	....
	Avge.	....	228	307	...	1.00	1.00	....
A_1	1:3	15.0	154	215	...	....	....	....
			154	224	...	....	....	....
			137	240	...	....	....	....
			154	...	...	....	....	....
	Avge.	....	150	226	...	0.66	0.74	....
A_2	1:3	15.0	122	240	...	....	....	....
			120	235	...	....	....	....
			130	212	...	....	....	....
			...	230	...	....	....	....
	Avge.	....	124	229	...	0.54	0.75	....
O	1:3	13.0	198	240	...	....	....	....
			176	242	...	....	....	....
			192	260	...	....	....	....
			191	234	...	....	....	....
	Avge.	....	189	244	...	0.83	0.79	....
K	1:3	13.0	178	250	...	....	....	....
			174	255	...	....	....	....
			178	259	...	....	....	....
			170	...	...	....	....	....
	Avge.	....	175	255	...	0.77	0.83	....
Series No. 4								
Ottawa	1:2	10.5	361	514	560	....	....	....
			317	493	565	....	....	....
			362	467	537	....	....	....
			369	512	508	....	....	....
	Avge.	....	352	497	543	1.00	1.00	1.00
A_1	1:2	10.5	352	386	362	....	....	....
			346	357	409	....	....	....
			352	400	385	....	....	....
			350	394	395	....	....	....
	Avge.	....	350	384	388	0.99	0.77	0.71
O	1:2	10.5	360	430	550	....	....	....
			425	410	570	....	....	....
			369	388	470	....	....	....
			411	379	552	....	....	....
	Avge.	....	391	402	536	1.11	0.81	0.99
K	1:2	10.5	348	395	445	....	....	....
			368	409	488	....	....	....
			355	404	488	....	....	....
			394	422	493	....	....	....
	Avge.	.. .	366	408	479	1.04	0.82	0.88

Mortars made from the local sands were noticeably drier than the Ottawa sand mortar, and in order to obtain a consistency as wet as the Ottawa mortar it was necessary to increase the amount of water from 40 to 60 per cent, this amount being determined by the appearance of the mortar after mixing. All 1:2 briquettes were made with the same percentage of water. The briquettes were tested in a Riehle automatic cement machine of 1,000 lbs. capacity, the load being applied at the standard rate of 600 lbs. per minute (see Table II for strength of briquettes).

The results of the 1:2 briquettes (see Table II), while somewhat erratic, show the same general trend as regards the relative strength of the Ohio and Allegheny River sands. The ratio of strengths of the local 1:2 sand mortars to the 1:2 Ottawa sand mortar is higher than for the 1:3 mortars, varying from 71 to 111 per cent, with an average of 90 per cent. The ratio for sand A_1 is 82 per cent and for sands *O* and *K* is 94 per cent.

Strength of Cubes.—All values are tabulated in Table III. The values have the same general trend as those for the briquettes, the Allegheny mortars being weaker than the Ohio mortars, and the Ottawa mortars strongest, except in the 7-day specimens of series Nos. 6 and 7. However, the *O* sand gives higher results than *K* sand for all specimens, which was not the case for the briquettes. The ratio of strength of the local sand mortar to the Ottawa sand mortar varies from 51 to 109 per cent, the average values for A_1, A_2, *O* and *K* being 64, 53, 83 and 75 per cent respectively. This ratio for series No. 9, in which the same consistency is used, is from 10 to 14 per cent lower than series Nos. 6 and 7, in which the percentage of water was constant. Since the specimens of these three series were made by different operators, the cause of this variation cannot be definitely located.

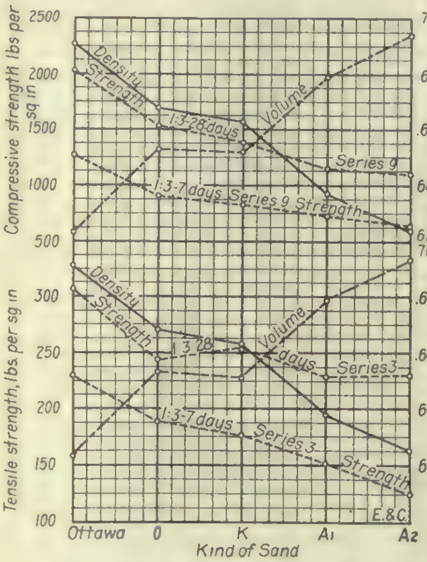


Fig. 1. Diagram Showing Relation Between Density of Mortar and Strength and Between Volume of Mortar and Strength.

The New York Board of Water Supply requires a strength of 1,000 and 1,300 lbs. per square inch at 28 days and 3 months respectively for 1:3, 2-in. cubes. It is evident that this requirement is easily met by all sands tested.

The relative strengths of the 1:2 cubes (see Table III) do not differ essentially from those obtained for the 1:3 cubes. The ratio of strength of A_1, *O* and *K* mortars to Ottawa mortar are 54, 79 and 70 per cent respectively, with individual value varying from 51 to 88 per cent.

Increase of Strength with Time.—Generally the rate of increase in strength for briquettes and cubes is greater at the earlier than at the later period, and the rate is usually the greatest for the Ottawa mortars and least for the Allegheny mortars.

Relation of Strength to Density and to Volume of Mortar.—In Fig. 1 are plotted curves showing the relation between strength and density, and between strength and volume of mortar, the mortar for all sands being of the same consistency. All briquettes and cubes were made of 1:3 proportions, and were broken at 7 and 28 days. It will be noted that the well-known law of strength increasing with density is verified, and since the volume of a mortar varies approximately in inverse proportion to its density, it follows that the strength increases as the volume of the mortar decreases.

This relation of strength to volume of a mortar suggests a convenient field method for determining the best sand. Cement and dry sand of the desired proportions are mixed with sufficient water and the volume of the mortar determined by measurement, as in a

TABLE III.—COMPRESSIVE STRENGTH OF MORTAR CUBES MADE OF VARIOUS SANDS.

Sand.	Ratio of cement to sand.	Water, per cent.	Compressive strength lbs. per sq. in.			Ratio of strength to Ottawa mortar.		
			7 days.	28 days.	90 days.	7 days.	28 days.	90 days.
Series No. 6								
Ottawa	1:3	9.25	1430	2375	2370	....	....	....
			1355	2260	2800	....	....	....
			1320	2020	3100	....	....	....
			1320	...	...	....	....	....
	Avge.	....	1356	2218	2757	1.00	1.00	1.00
A_1	1:3	9.25	1283	1330	1500	....	....	....
			998	1450	1600	....	....	....
			1213	1190	1685	....	....	....
			1070	1350	1840	....	....	....
	Avge.	....	1141	1330	1656	0.84	0.60	0.60
O	1:3	9.25	1620	1520	2350	....	....	....
			1360	1770	2360	....	....	....
			1500	1450	1930	....	....	....
			1455	1520	...	....	....	....
	Avge.	....	1484	1565	2213	1.09	0.71	0.80
K	1:3	9.25	1270	1630	...	....	....	....
			1070	1340	2015	....	....	....
			1180	1590	1810	....	....	....
			1500	1390	1825	....	....	....
	Avge.	....	1255	1488	1883	0.93	0.67	0.68
Series No. 7								
			7 days.	28 days.	83 days.	7 days.	28 days.	83 days.
Ottawa	1:3	9.25	1594	2850	3530	....	....	....
			1330	2380	3035	....	....	....
			1610	2970	3704	....	....	....
			1310	...	...	....	....	....
	Avge.	....	1461	2733	3423	1.00	1.00	1.00
A_1	1:3	9.25	1190	1840	1938	....	....	....
			1215	1710	1828	....	....	....
			1115	1760	1960	....	....	....
			1210	1480	2208	....	....	....
	Avge.	....	1183	1698	1984	0.81	0.62	0.58
O	1:3	9.25	1390	2440	2575	....	....	....
			1550	1960	3082	....	....	....
			1640	2560	2605	....	....	....
			1612	1875	2910	....	....	....
	Avge.	....	1548	2209	2793	1.06	0.81	0.82
K	1:3	9.25	1394	2100	2782	....	....	....
			1456	2025	2795	....	....	....
			1450	1750	2845	....	....	....
			1350	1850	2725	....	....	....
	Avge.	....	1413	1931	2787	0.97	0.71	0.81
Series No. 9—Same Consistency								
Ottawa	1:3	9.3	1250	1900	...	....	....	....
			1290	2080	...	....	....	....
			1240	...	...	....	....	....
			1295	2110	...	....	....	....
	Avge.	....	1269	2030	...	1.00	1.00	....
A_2	1:3	15.0	690	1075	...	....	....	....
			670	1130	...	....	....	....
			625	1087	...	....	....	....
			590	1050	...	....	....	....
	Avge.	...	644	1086	...	0.51	0.54	....
A_1	1:3	15.0	725	1150	...	....	....	....
			775	1123	...	....	....	....
			720	1150	...	....	....	....
			680	1138	...	....	....	....
	Avge.	....	725	1140	...	0.57	0.56	....
O	1:3	13.0	860	1520	...	....	....	....
			920	1565	...	....	....	....
			845	1533	...	....	....	....
			950	1505	...	....	....	....
	Avge.	....	894	1531	...	0.70	0.75	....
K	1:3	13.0	795	1410	...	....	....	....
			840	1812	...	....	....	....
			790	1339	...	....	....	....
			895	1472	...	....	....	....
	Avge.	....	830	1383	...	0.65	0.68	....
Series No. 10								
			7 days.	28 days.	90 days.	7 days.	28 days.	90 days.
Ottawa	1:2	10.5	2700	4890	...	....	....	....
			2760	5250	6120	....	....	....
			3090	4875	5780	....	....	....
	Avge.	....	2850	5004	5950	1.00	1.00	1.00
A_1	1:2	10.5	1850	2600	3260	....	....	....
			1450	2500	3027	....	....	....
			1487	2975	2985	....	....	....
			1430	2925	2900	....	....	....
	Avge.	....	1554	2750	3043	0.55	0.55	0.51
O	1:2	10.5	2560	3425	4460	....	....	....
			2330	3275	5140	....	....	....
			2670	3200	5320	....	....	....
			2480	3428	4400	....	....	....
	Avge.	....	2510	3332	4830	0.88	0.67	0.81
K	1:2	10.5	2290	3250	4040	....	....	....
			2220	3600	3940	....	....	....
			2120	3375	3730	....	....	....
			2090	3000	4720	....	....	....
	Avge.	....	2180	3306	4108	0.76	0.66	0.69

cylinder of convenient size. Similar measurements are made for the mortars of each sand under investigation, the consistency of the mortars and the weight of the cement and sand being the same. That sand which gives the mortar having the *least volume* will ordinarily be the most desirable material.

Concrete Tests.—(*a*) Specimens of series No. 1 were made in order to determine the comparative compressive strength of 1:2:4 concrete made of Allegheny River sand and gravel, Ohio River sand and gravel, Ligonier limestone and a fine aggregate composed of equal parts of sands A_1, *O* and *K*. It will be seen (Table IV) that the variation in strength at 28 days is very slight, the average being 1,492 lbs. per square inch, with a maximum variation from the average of about 5 per cent.

TABLE IV.—COMPRESSIVE STRENGTH OF CONCRETE MADE WITH VARIOUS MATERIALS AND PROPORTIONS OF AGGREGATES.

Sand.	Gravel or stone.	Proportions.	Compressive strength, lbs. per sq. in. 28 days.	90 days.
Series No. 1				
A_1........	A_1 gravel	1:2:4	1,600	2,270
			1,420	2,300
			1,430	2,330
Average			1,480	2,300
O........	O gravel	1:2:4	1,530	2,730
			1,610	2,700
			1,560	2,610
Average			1,570	2,680
K........	K gravel	1:2:4	1,570	2,510
			1,570	2,370
			1,250	2,410
Average			1,460	2,430
Equal parts of A_1, O, K	L stone	1:2:4	1,460	2,260
			1,410	2,230
			1,475	2,180
Average			1,450	2,220
Series No. 2				
K........	K	1:2:4	1,860	2,840
			1,830	2,670
			1,780	2,510
Average			1,820	2,670
K........	K	1:1½:4½	1,610	2,370
			1,750	2,230
			1,690	2,210
Average			1,680	2,270
K........	K	1:1:5	1,310	2,090
			1,280	2,210
			1,380	2,100
Average			1,320	2,130
K........	K	1:½:5½	1,440	2,080
			1,530	1,830
			1,740	2,050
Average			1,570	1,990
Series No. 3				
A_1........	A_1	1:2:4	1,360	2,440
			1,550	2,470
			1,330	2,460
Average			1,410	2,460
A_1........	A_1	1:1½:4½	1,260	2,180
			1,390	2,290
			1,520	2,300
Average			1,390	2,260
A_1........	A_1	1:1:5	1,040	1,670
			1,320	1,850
			1,170	1,830
Average			1,180	1,780
A_1........	A_1	1:½:5½	1,140	1,720
			1,185	1,780
			1,080	1,800
Average			1,135	1,770
Series No. 4				
O........	O	1:2:4	1,700	2,420
			1,420	2,320
			1,680	2,200
Average			1,600	2,310
O........	O	1:1½:4½	1,420	2,315
			1,310	2,560
			1,420	2,380
Average			1,380	2,420
O........	O	1:1:5	1,260	1,920
			1,420	1,830
			1,180	2,200
Average			1,290	1,980
O........	O	1:½:5½	1,220	1,930
			1,140	1,940
			1,140	2,060
Average			1,170	1,980

"Committee C-2 on Concrete" states that a 1:2:4 concrete cylinder 8 ins. in diameter and 16 ins. high should develop a compressive strength of 2,000 lbs. per square inch at 28 days. The local building ordinance specifies the same strength at 28 days for a specimen having similar dimensions and made of concrete in which the ratio of cement to the sum of the fine and coarse aggregates is 1:6.

The average strength obtained in these specimens is less than the required values quoted. This may be explained partly by the low average temperature of 63.5° during the 28-day period and by the greater slenderness of the 6x18-in. concrete specimen used as compared with the standard 8x16-in. specimen. However, it is doubtful whether these unfavorable conditions, if corrected, would result in increasing the strength to 2,000 lbs. per square inch.

At 90 days the variation in strength of series No. 1 was greater than at the earlier age, the average strength of all cylinders being 2,408 lbs. per square inch. The ratio of strength of the A_1, *K* and *L* to the *O* specimens, which were the strongest, was 86, 91 and 83 per cent respectively. The strength at this age shows the same general law as that for the 1:2 briquettes and cubes, although the variation is not proportionately so great, thus indicating that the sand is a more important factor than the gravel.

The gain in strength from the 28-day to the 90-day period was surprisingly high, values varying from 53 to 71 per cent, with an average of 61 per cent.

(*b*) The specimens of series Nos. 2, 3 and 4 were made with a view of ascertaining the effect of varying the relative volumes of sand and gravel in a mix of 1 volume of cement to 6 volumes of sand and gravel.

Because of the large amount of material in the gravel finer than ¼ in. it was thought that the standard proportions of 1:2:4 contained too much fine material and that therefore an increase in strength would result if the sand were decreased. Preliminary tests on Allegheny River materials in 1912 pointed to this conclusion. It is evident, however (see Table IV), that the 1:2:4 mix usually developed the greatest strength.

This may be explained in some small degree by the greater proportion of cement, based on weight, in the mixes having more sand. For example, in cylinders *K*, proportions 1:2:4, 18.5 lbs. of cement, 31.3 lbs. of sand and 79.9 lbs. of gravel were used. The proportion of cement based on the total weight of 129.7 lbs. is 14.3 per cent. For the 1:½:5½ specimens, 18.5 lbs. of cement, 7.5 lbs. of sand and 108.6 lbs. of gravel were required, a total weight of 136.3 lbs. with a cement content of 13.6 per cent. This decrease in the ratio of cement to the total weight of material used is due to the greater weight of the gravel as compared with the sand.

It is unfair to compare the strengths of concrete made of different materials in these three series, because of the various curing conditions. A comparison can be made only of the various mixes of concrete made from the same materials.

In conclusion the writer desires that the results obtained for the materials from the Allegheny and Ohio Rivers should not be interpreted as typical of those rivers, for it is known that the quality of the materials in any river varies with the location of the materials in the river. However, it may be stated that if local sands show the same difference in fineness as was exhibited by the sands discussed in this paper, then a considerable difference in the strengths of their mortars and concretes may ordinarily be expected.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by F. M. McCullough, assistant professor of materials, Carnegie Institute of Technology, in the May Proceedings of the Engineers' Society of Western Pennsylvania.

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A Simple Method of Preventing Clogging of Perforated Air Pipe in Air Lift Systems.

(Staff Abstract.)

It is a common procedure to perforate the lower portion of the air pipe in air lift pumping systems. These perforations sometimes clog with scale or precipitated matter, thereby impairing the usefulness of the entire installation and necessitating the removal of the air pipe for renewal or cleaning. A method of overcoming, or rather of preventing, the occurrence of this difficulty is briefly described as follows: A section of pipe is added to the air pipe below the perforations, and the lower end of it is left open. This construction enables any scale or dirt to escape downward through the open end of the tube while the air, following the line of least resistance, escapes through the perforations.

Even in the event that the perforations do become clogged, after long service, the air can still escape at the lower end. The lift would still operate, but the gage at the top of the well will then show by its reading that the perforations are clogged. The air pipe can then be "pulled" and cleaned.

ACKNOWLEDGMENT.

This construction is described in a recent issue of "Power," by Mr. E. M. Ivens.

Alaskan Lumber.—The two national forests of Alaska contain about 78 billion feet of merchantable timber and it is estimated by the Forest Service that more than 800 million feet could be cut every year forever without lessening the forests' productivity.

The Lighter Side of Engineering and Contracting

The Award.

SKINNER MULVEY begs leave to announce the result of the story-telling contest conducted in this department during the months of July and August. After long deliberation he has decided that the prize should be awarded to the contributor who told the story about the colored tunnel-mucker who directed that *he* be notified in case of accident. That story was printed in the Lighter Side for August 11. Will W. L. R. H., of Pittsburgh, Pa., winner of the Grand Prix, please write and state whether he elects to have his winnings in the form of cigars or of pipe tobacco?

The famous muleteer desires to express his thanks to all who have sent in stories. He especially appreciates the fact that readers of all ages and conditions have responded to his invitation to Smoke Up. The first wheeze in last week's issue was contributed by one of the oldest and best-known consulting highwaymen in the United States. One anecdote was written out by a typhoid convalescent—before writing anything else, after an illness of weeks, he took his pen in hand to write out a story for this page. No better gage of the interest in this department could be desired.

Probably all of you have attended contract lettings in the smaller cities. If so you have seen the fat mayor stand up and pat his capon-lined belly and have heard him preface the award by saying: "Well, boys, we are sorry we haven't contracts for all of you." Just so, Mulvey regrets that he is unable to give prizes to all contributors. However, he announces the renewal of the offer: for the best story received during September or October he will give a $5 box of cigars or the equivalent value in pipe tobacco. Again, gentlemen, Smoke Up!

When Not in Rome—

ONE day last week, while superintending the erection of a new furnace at the Dallas plant, W. L. McCulloch, Chief Engineer of the Oregon Power Co., found a brick mason back of the building, sitting comfortably in a wheelbarrow. To the engineer's remonstrance the mason calmly replied: "Oh, well, Rome was not built in a day." "No, and I wasn't superintending that job, either," responded the engineer. Work was resumed at once.

Best Railroad Story Since "Casey Jones."

MRS. BRIDGET CARR, who had her twelfth child in arms, met her friend Mrs. Norah Mulvaney and at once the blarney was on: "Arrah now Bridget," said Norah, "an' there ye arr wid another little Carr in yer arms." "Another it is, Mrs. Mulvaney," replied her friend, "an' it's me that's hopin' 'tis the caboose."

Early Autumn Styles for Contractors' Foremen.

OVERALLS for business wear will remain in vogue at least another season, the most popular shades being sky blue and army brown. There are strong indications that reinforced seats are on the wane. The tendency is plainly to revert to the old style single ply effect even though it is less resistant to wear.

One regrets that conservatism retards adopting brighter colors for overalls. There is an innate attractiveness, an appeal to the esthetic in the more brilliant hues. Then, too, they often have practical advantages. Leaf green, for example, is so inconspicuous in the woods and among the tall grass that a foreman clad in overalls of this color may readily come unobserved upon one or more of his gang who are prolonging their vacation beyond all reason. However leaf green is not insisted upon for evening wear. After 6 p. m. it should be *de rigeur* to don more sedate colors. Dark maroon pants are a welcome change when worn with a black velvet waistcoat and a chic Stetson hat in one of the mouse grays that are so deservedly popular.

Now, a word about the proper buttons to select for overalls. Nothing shows the taste of the well dressed foreman more clearly than the buttons he chooses. 'Tis a little thing—a button—but much depends on it. The small tin saucers that have served so well for many years are going out. On this point, at least, there can be no question, yet many will regret the change. There was so much that was eminently sensible about the tin saucer type of overall button. You will recall how readily you could find one if lost, in the bunk house, even without lighting a match. You had merely to walk around in your bare feet until you felt the sharp circular edges of the tin button pressing deeply into the skin. Then you lifted your foot and removed the button. Also, the old tin button would never split, as do the more beautiful but fragile celluloid substitutes that you must use this fall.

A word of caution right here as to the new celluloid buttons for overalls. Considerately handled they are a constant delight. They never rust. They may be had in colors to match the pants, or they may be had in colors that vividly contrast with the pants—just as your personal taste dictates. They depreciate slowly, at least if not brought too near a fire. But avoid scratching a match upon or even near a celluloid button, for celluloid is made, as you may not know, of gun-cotton dipped in nitroglycerine and then kiln-dried. Clearly some caution should be exercised by those who adopt this year's styles in overalls and celluloid buttons.

The Specialist's Bequest.

HAPPILY the age of severe specialization is passing if not past. While it was at its height a German professor of Greek lay on his death-bed and addressed his seven sons in these words: "My children, I have made a very great mistake in my life. I aspired to understand and study the whole dative case in Greek. Now, I have no worldly possessions to leave you by will; I have accumulated nothing in my life but knowledge, yet I am going to leave to each one of you one aspect—each of you a different aspect of the dative case to study."

Applied Science.

A VERY studious young man graduated from an engineering college and then took the post-graduate course. After treading the halls of learning for about two decades he fared forth into the cold world in pursuit of the nimble sheckle. His first engagement was with a contractor and he was given the job of inventorying the plant and livestock in winter quarters. He was unable to differentiate between horses and mules without recourse to the measurement of the length of their ears with a foot rule.

Help Wanted.

IN a recent examination of the applicants for the position of foreman of garbage handlers held by the Chicago city civil service commission, the following question was among those asked: "What would you do in case a fire broke out in (a) the dryer, (b) the fan and (c) the dust collector?" One applicant answered: "(a) Call for help, (b) call for help, (c) summon help."

Compensation of Life Among the Lowly.

TWO colored laborers were punctuating their conversation with pick-blows on the hardpan in a trench. Said one: "Is Sam married?" "I reckon not," said the other, "I see him goin' to work ev'ry mawnin."

Skinner Mulvey says: I expect t' be kep' pretty busy fer si'v'ral years now. The war crisis don't cris any more and it begins to look like either Woodrow or Elihu. They are both good friends of mine.

CURRENT NEWS

The Doings of the Week. To offset the important development of last week regarding Germany's attitude as to submarine warfare is the recent torpedoing of the Hesperian and the reported connection of the German and Austrian ambassadors with strike plots in this country. Should these conditions be satisfactorily adjusted, and we hope they will, the business outlook will continue with an upward tendency. The steel industry is good. This is shown by the quarterly report to be issued the latter part of this month by the U. S. Steel Corporation, which, it is said, will announce greater earnings and orders than for any similar period during the past year. The corporation's plants at Gary, South Chicago and Joliet are working to capacity, which is true of the majority of independent plants throughout the country. Another encouraging outlook is contained in the report of R. G. Dun & Co. regarding the country's business mortality during August. Commercial failures are still above the average, but last month there were 344 fewer defaults than in July. Several of the railroads have placed orders for new equipment, including engines, box cars and passenger coaches, while a few have been in the market for rails. In the construction field, aside from the Southern, little activity has been shown by the railroads. This company, however, is spending a lot of money for betterments, doubletracking and line extensions. A considerable amount of road work is being carried on at the present time. Several states are actively engaged in this class of work, the leaders being New York, California, Washington, Ohio and Illinois. Of these Washington and Illinois, as well as Pennsylvania, have placed calls for bids, while New York, Washington and Alabama have awarded contracts. In the municipal line street paving leads, being closely followed by sewer, waterworks and building construction. The Iron Age prices for finished iron and steel and for sheets, nails and wire for the week ending Sept. 1 were as follows:

Finished Iron and Steel.	Sept. 1.	Aug. 25.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.459	1.459
Iron bars, Pittsburgh	1.35	1.30
Iron bars, Chicago	1.25	1.25
Steel bars, Pittsburgh	1.30	1.30
Steel bars, New York	1.519	1.519
Tank plates, Pittsburgh	1.30	1.30
Tank plates, New York	1.519	1.469
Beams, etc., Pittsburgh	1.35	1.30
Beams, etc., New York	1.519	1.519
Skelp, grooved steel, P'gh	1.30	1.30
Skelp, sheared steel, P'gh	1.35	1.35
Steel hoops, Pittsburgh	1.35	1.35
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	1.90	1.90
Galv. sheets, No. 28, P'gh	3.60	3.40
Wire nails, Pittsburgh	1.65	1.65
Cut nails, Pittsburgh	1.60	1.60
Fence wire, base, P'gh	1.50	1.50
Barb wire, galv., P'gh	2.50	2.40

For structural material f. o. b. Pittsburgh The Iron Age prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.35c.

Railways.—Prospective railroad construction was light during the past week. A few electric lines were organized and several steam roads have surveys under way for extensions and new lines. Perhaps the most interesting piece of news was the announcement of the reception of bids on Friday by the Southern Railway for 26 miles of double tracking from Greenville, S. C., to Easley to Central, S. C. This company also has another job coming up which will involve very heavy construction, the doubletracking of its line between Charlotte and Spartonsburg. A contract was let during the week by the Public Service Commission for the First District of New York City for station finish on the Jerome Ave. and White Plains Ave. rapid transit lines. This work was secured by the Altoria Realty & Construction Co., the lowest bidder, for $860,637. The Johnson-Gifford Co. will erect steel for additional tracks on the Broadway elevated railroad in Brooklyn for the New York Municipal Railway Corp., the contract price being $400,442.

Roads and Streets.—As usual a large amount of road work and street paving made its appearance during the week. Ohio wants bids until Sept. 10 for 11 new contracts and one repair job; Pennsylvania until Sept. 15 on two roads totaling nearly 7 miles in length, and Illinois on two small jobs. The State Road Commission of Utah is also calling for bids, the amount being about 40 miles between Knolls and Wendover. Allegheny County, Pennsylvania, has asked bids on about 7 miles of brick and macadam roads. Some contracts let are 20 miles of work on the National Park and Inland Empire highways in the state of Washington; 24 new construction and 9 repair contracts in New York; 40 street paving jobs let by the city of Chicago; bitulithic road on the Pacific highway leading out of Tacoma, Wash., which went to the Washington Paving Co. for $79,375; Third St. paving contract in Xenia, O., to Andrews Paving Co., Middletown, $42,850; approximately $475,000 worth of paving in Philadelphia, and state rural highway out of Aitkin, Minn., to Small & Olson of that city for $43,390.

Bridges. — A considerable amount of bridge work came to the front during the week. Perhaps the largest job was that secured by the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., for reinforced concrete structure over the Arkansas River, the price being $158,000. Other contracts were El Monte bridge over San Gabriel near Bassett, Cal., to Mesmer & Rice for $93,000; bridges and culverts out of Terrell, Tex., to W. W. Fuller, Bonham, for $26,814; four bridges in connection with state road work in Maine, and one over Grand Trunk at College Ave., Grand Rapids, Mich. Several fair-sized jobs are up for bids, including about 5 steel and reinforced concrete bridges for the Illinois State Highway Commission and 5 steel spans for the County Commissioners at Roundup, Mont.

Drainage and Irrigation.—There were few drainage jobs that reached the call for bids stage during the past week, the largest being three contracts for the county at Slayton, Minn., ditches Nos. 10, 40 and 43, aggregating about 400,000 ft. of tile work. Two irrigation projects are up for consideration. One, the Cowhead irrigation and power enterprise, calls for about $600,000 worth of work in the Surprise Valley, California, and the other, the Horse Heaven District, Prosser, Wash., is up for hearing Sept. 11.

Waterworks.—A number of small municipal waterworks are being advertised this week. These include complete plants for Oberlin, O., for Fromberg, Wash., and for Brewster, O., as well as Manchester, N. Y. Covington, Ky., is also taking bids on a job that calls for a duplicate main across the Licking River. Prospective work worthy of consideration is the proposed system for Aberdeen, Wash., which is to consist of two dams and a 22-mile pipe line; also about $600,000 worth of work proposed at Everett, Wash.

Sewerage.—Few large contracts appeared in this line during the week. However, several prospects were mentioned. An east end trunk sewer is planned at Alton, Ill., a complete system at New Iberia, La., sanitary and storm systems at New Baltimore, Mich., new system at Plattsburg, Mo., main intercepting sewers at Cushing, Okla., and storm sewers at Minot, N. Dak. A contract was let at Christopher, Ill., for a system to cost about $50,000, and at Madison, Wis., for improvements to present sewerage system to cost about $65,665.

Conclusive. For many moons this generation of engineers has been seeking a sign of the return of prosperity. First it was hoped that the tariff ghost was laid, for a time at least, by the falling off in imports and the counterbalancing war tax on some of life's little unnecessaries. Then hope sprung from the government crop reports. Finally the rising market in steel stocks, heretofore an unerring harbinger of good times in the construction field, was thought to herald the near approach of jobs for the engineer. However, the war order industries drew heavily on steel and rendered that material only one of industry's barometers, and the long-expected boom failed to materialize. All of these tests were inferential, of course. Now comes a fact which renders further speculation along this line superfluous. We are crediby informed that an engineers' employment agency hereabouts, which has been established for over 20 years, has placed more engineers during the past three weeks than during the two years preceding that period. Not even the coming on of autumn should be allowed to take the edge off this announcement. We haven't had any summer to speak of—perhaps we shall have an open winter.

American Builders' Week at the Panama-Pacific International Exposition.

The week of October 18-23, 1915, has been fixed as "American Builders' Week" at the Panama-Pacific International Exposition. San Francisco was chosen as the place of meeting by the National Association of Builders' Exchanges in response to the invitation of the builders of San Francisco and the officials of the Exposition Company. The following topics have been selected for addresses and papers to be delivered during the Congress:

"Organization as Applied to Construction Work" (Major-General Geo. W. Goethals has been invited to address the Congress on this subject); "The American Builder," by R. Clipston Sturgis, President American Institute of Architects; "The Engineering Contractor," by Halbert P. Gillette, author of "Cost Data," Editor-in-Chief of "Engineering and Contracting" and founder of American Society of Engineering Contractors; "National Organization in the Building Industry—Its Need," by H. L. Lewman, President National Association of Builders' Exchanges; "The Building Business as a Factor in the Commercial Life of the Country," by Charles W. Gindele, President of the Building Construction Employers' Association of Chicago; "The Efficient Conduct of Building Operations"; "Bonding the Builder—Its Origin and Present Effect Upon Building Contracts"; "Opening Bids in Public as Essential to Proper Business Conditions," by Geo. W. Kalham, Chief of Architecture, P. P. I. E.; and "Men Who Build, and Their Legal Responsibilities," by John L. McNab, formerly U. S. District Attorney.

An urgent request is made that contractors and builders visit the Exposition at this time and take part in the Congress. Additional information may be obtained by addressing the Publicity Committee, American Builders' Week, care General Contractors' Association, 110 Jessie St., San Francisco, Calif.

New Tidewater-Virginia Railway.

At the present time probably more different railway developments are being projected in eastern Virginia than in any of the other eastern or southern states. In the last few months numerous companies have been organized for the construction of steam or electric railway lines. Much of the construction is intended for the development of the so-called tidewater counties and for the northern neck section.

One of the larger of the new lines is known as the Norfolk, Washington & New York Ry. This road will be 159 miles in length and will extend from the outskirts of Washington, D. C., to Newport News, Va. This line has been under consideration for some time. The surveys have been made and over 65 per cent of the right of way secured. This route extends through many counties not touched by any railway. Starting at the boundaries of the District of Columbia it follows down the eastern side of the Potomac River through Charles County, Maryland, crossing the Potomac near Metomkin Point. It then runs through King George and Westmoreland Counties and crosses over the Rappahannock River. From this point it runs about parallel to the river until Saluda is reached. It crosses a small stream here and then extends south to Gloucester Point. The York River will be bridged and the line proceed through Elizabeth City County and Hampton County to Newport News. Connections are to be made with the Chesapeake & Ohio at Newport News and with the Baltimore &Ohio and Pennsylvania railroads at Washington.

Two branches are proposed for the Norfolk, Washington & New York Ry. One of these would start at a point near Leedstown, Va., and would extend through Westmoreland, Richmond, Lancaster and Northumberland counties to Fairport Harbor on Chesapeake Bay. The other branch is proposed to extend from Tappahannock to Newcastle on the Pamunkey River, where a connection would be made with the Richmond & Rappahannock River R. R., which would be extended to that point.

Channing M. Ward, C. E., Richmond, Va., is president of the Norfolk, Washington & New York Ry. Frank S. Gannon, 2 Rector st., New York City, formerly Vice President and General Manager of the Southern Ry., is associated with Mr. Ward.

Another line projected for eastern Virginia is the Richmond, Rappahannock & Northern Ry. This company was chartered a short time ago. It has two parties in the field at the present surveying the route, and it is expected that the engineer's report will be made shortly, after which the promoters will take up with contractors the matter of building the road.

This company proposes a line from West Point to Urbanna, with a probable extension eastward through Middlesex County. It will connect at West Point with the Southern Ry. and also will connect with the boat line at that place. It is probable the road will extend into Gloucester County and across the Rappahannock River into the Northern Neck. This route extends through level country and there will be no tunnels, very few bridges and a small amount of trestle. There also probably will not be much rock work. Warner Moore, Richmond, Va., of Warner Moore & Co., owners of the Shockoe Mills, is President of the Richmond, Rappahannock & Northern Ry. Charles L. Ruffin is Chief Engineer. The railway has its general office in the American National Bank Bldg., Richmond, Va.

In connection with the above railway it is interesting to note that the Richmond & Rappahannock River Ry., now operating 26 miles of line, is understood to propose extending its road to Urbanna. This company was reported in June as planning a $500,000 bond issue for this work and other extensions.

A considerable amount of electric railway construction in the vicinity of Petersburg, Va., is planned. The Petersburg & Appomattox Ry Co., proposing an electric railway between Petersburg and Hopewell and City Point, is reported to have awarded the construction contract to the Vaughn Construction Co., Richmond, Va. This line is said not to involve much heavy grading. It will cost about $200,000. The Petersburg & James River Ry. also is projecting a railway from Petersburg to Hopewell.

Minnesota Tile Drainage, 414,000 Lin. Ft., Estimated Cost $144,000.

Drainage work estimated to cost over $144,000 and requiring nearly 414,000 lin. ft. of tile is being advertised for bids by the County Auditor of Murray County, Minnesota. The improvements call for the construction of Judicial Ditches Nos. 10 and 11 and County Ditches Nos. 40, 42 and 43; also two laterals for the latter ditch. The tile is to be first grade hard burned clay or of equal quality. The average hauls for the various jobs are about as follows: Judicial Ditch No. 10, 4 miles from Slayton; Judicial Ditch No. 11, 4 miles from Dundee; County Ditch 40, 2 miles from Fulda; County Ditch 42, 3 miles from Lime Creek; County Ditch 43, 3 miles from Lime Creek. Some details of the work are given in Table I.

TABLE I.—TILE DRAIN LETTING AT SLAYTON, MINN.

Tile.	Judicial Ditch 10.	Judicial Ditch 11.	County Ditch 40.	County Ditch 42.	County Ditch 43.	Lateral A, Co. Ditch 43.	Lateral B, Co. Ditch 43.
6-in., lin ft.	21,500	15,300	5,800	4,100	700	15,500	2,800
7-in., lin ft.	31,100	17,800	.....	4,500	8,800	7,500	5,900
8-in., lin. ft.	23,400	11,600	9,400	19,000	10,000	3,300	4,500
9-in., lin. ft.	4,400	1,900	1,700	4,400	4,300	4,100	900
10-in., lin. ft.	12,500	1,400	1,400	3,200	9,800	2,500	2,800
12-in., lin. ft.	12,800	7,000	4,800	5,400	3,500	4,200	400
14-in., lin. ft.	6,600	5,700	1,800	1,700	1,100	2,600	800
15-in., lin. ft.	7,000	4,100	.....	.....	500	1,300	.....
16-in., lin. ft.	5,300	3,560	2,300	4,100	600	1,900	.....
18-in., lin. ft.	3,100	510	3,083	2,300	500	3,600	.....
20-in., lin. ft.	4,200	.....	4,700	1,300	2,100	1,500	2,665
22-in., lin. ft.	6,500	.....	.....	1,600	200	.....	.....
24-in., lin. ft.	3,200	.....	.....	.....	700*	.....	.....
26-in., lin. ft.	1,900	.....	.....	5,300	2,100	800	.....
28-in., lin. ft.	600	.....	.....	.....	1,800	.....	.....
30-in., lin. ft.	2,300	.....	.....	.....	.....	2,200	.....
32-in., lin. ft.	.....	.....	.....	1,000	.....	.....	.....
Open ditch, cu. yds.	87,130	151	1,441	1,139	7,285	.....	.....
Estimated cost	$53,443	$12,481	$10,658	$23,651	$21,798	$17,499	$4,686

*Also 800 ft., 25-in.; also 700 ft., 34-in.

Bids for Judicial Ditches Nos. 10 and 11 will be received by E. V. O'Brien, County Auditor, Slayton, Minn., on Sept. 22. Bids for the other ditches will be opened Sept. 21.

The $15,000,000 Union Depot Project, Cleveland, O.—The $15,000,000 Union Station development at Cleveland, O., has been brought a step nearer the actual construction stage. Officials of the city and the New York Central lines and Pennsylvania R. R. are stated to have agreed on the main details of the ordinance and it is believed the necessary legislation will be submitted to the voters at the November election. Under the ordinance the city cedes to the railroads the Bath and property between the river and W. 9th st. in return for lake frontage between East 12th st. and East 18th st. It is thought that actual work can be started July 1, 1916; the date for completion must be not later than July 1, 1919. It is estimated the total expenditure for site, station, new bridges over the river and track layouts will be between $15,000,000 and $17,000,000.

A 32,000,000-ft. Lumber Order.—One of the largest lumber contracts let for some years was awarded a few days ago by the Public Service Commission of the First District, New York City. The contract calls for approximately 32,000,000 ft. of lumber and ties for use in the construction of the dual system of rapid transit of New York City. The specifications call for about 17,000,000 ft. of yellow pine and 15,000,00 ft. of ties, approximately 500,000 pieces. The contractor has the option of furnishing white oak or yellow pine ties. The contract was awarded to the D. K. Jeffries Lumber Co., Pullman Bldg., Chicago, Ill., at about $1,250,000. This company also received a contract two months ago from the New York Public Service Commission for 8,000,000 ft. of yellow pine. It also has a contract for furnishing 200,000 white oak ties for railroad improvements in France.

Louisiana Levee Work.

The Red River, Atchafalaya & Bayou Boeuf Levee District of Alexandria, La., opens bids Sept. 10 on a 590,000 cu. yd. levee letting. Of the total 300,000 cu. yds. are in the Alto to Crooked Bayou Levee in the Parishes of Avoyelles and St. Landry, the work being located on the right bank of the Atchafalaya River, the upper end being about 7 miles below Simmsport and the lower end about 13 miles above Melville, La. The length of line to be treated is about 7 miles. The work may be visited best by team or automobile from Melville, La., on main branch of the Texas & Pacific Ry.

About 150,000 cu. yds. of earth are required for the Simmsport to Deer Range Levee in the Parish of Avoyelles. This is located on the right bank of the Atchafalaya River and is principally riverside enlargement. Special treatment, however, will be required at certain points. The length of line is 2½ miles. This work can be reached from Simmsport on the Avoyelles Branch of the Texas & Pacific Ry., or by automobile from Melville on Texas & Pacific Ry.

For the White Place to Wilson Point Levee about 140,000 cu. yds. of work are required. This is in the Parish of Rapides on the right bank of the Red River, about 12 miles below Alexandria, La., and is in general riverside enlargement. The distance between the upper and lower limits of the work is about 8 miles. The length of line to be treated within this limit is about 5½ miles. The work may be visited best by team or automobile from Alexandria, La.

The width of crown required for the levees will be 8 ft.; side slopes 3 and 3 to 1; increase in grade (net) about 2 ft.; width of berm 30 ft. Cash payments will be made. Work must be started on or before Oct. 1 and be completed on or before May 1, 1916.

Howard B. Gist, Alexandria, La., is Secretary of the District.

Flood Prevention Works in Ohio.—Steps are being taken for the formation of several districts under the new Ohio Conservancy Law for the construction of works for the prevention of damage by floods. The Upper Scioto Drainage & Conservancy District was established recently and has engaged the Morgan Engineering Co., Memphis, Tenn., and Dayton, O., to handle the engineering work. Proceedings are now pending in the common pleas courts of Hardin and Allen counties for the establishment of the Ottawa River Drainage and Conservancy District. The Miami Conservancy District, for which the Morgan Engineering Co. also is the engineers, is well advanced with its preliminaries. If the various districts, now established or in prospect, carry out their plans, Ohio during the next two or three years will offer an abundance of work in the earthmoving and concrete lines.

LARGE MINNESOTA DITCH JOB.

Beltrami County Ditch Work to Cost $262,030.

A ditch job, estimated to cost $262,000, is being advertised for bids by the Commissioners of Beltrami County, Minnesota. The improvement is known as Judicial Ditch No. 30. The nearest point to the work from the railway is Bandette, Minn., which is 16 miles north of the nearest outlet. Kelliher, Minn., is 35 miles from the nearest source of the ditch.

The total length of the ditch will be 165.64 miles and in its construction the excavated material will be placed on one side to form a foundation for a roadbed. The berm will be at least 6 ft. The work includes leveling and dragging this material to form a road alongside the ditch. Of the 165.64 miles of ditch 156.58 miles will have a 3-ft. base, 8.65 miles a 4-ft. base, 0.05 mile a 6-ft. base, 0.22 mile an 8-ft. base and 0.17 mile a 14-ft. base.

The work requires 1,656,560 cu. yds. of excavation, estimated to cost 13 cts. per cubic yard. The southerly portion of the ditch covering about 100 miles is floater work and cannot be done dry with a dry land machine. The balance is dry land work, or can be carried out with a dry land machine.

The floater work lies about 5 miles north of Red Lake and is lightly timbered with a scrubby growth of spruce and tamarac. In places it is absolutely open. The soundings are from 9 ft. to 15 ft. in depth and the cuttings from 5 ft. to 8 ft. deep. The fall per mile does not exceed 3 ft. On the dry land work the soundings generally are 4 ft. in depth, a portion runs through high land. The dry land work includes all outlets. The timber generally is heavier than on the floater work and is very heavy near the outlets and at Rapid River.

Data on some features of the work follows:

Ditch, 166.64 miles; est. cost per mile, $1,301.

Roadway, 165.65 miles; est. cost per mile, $283.

Average excavation per mile of ditch, 9,999 cu. yds.

Clearing, 1,325 acres; est. cost per acre, $7.52.

Grubbing, 181.27 acres; est. cost per acre, $28.28.

Road leveling, est. cost per mile, $59.67.

Road dragging, est. cost per trip, $1.

The estimated cost of the improvement is as follows:

Clearing	$ 9,973
Grubbing	5,127
Excavation	215,352
Road leveling	9,987
Dragging	3,303
Culverts	4,811
Bridges	13,530

In all 43 culverts and 40 pile and timber bridges will be required. This work is not included in the present contract. Bids will be considered for clearing, grubbing and roadwork separate from the excavation.

The clearing will cover a strip 60 ft. wide. For creeks a strip 10 ft. wide on each bank will be cleared. Grubbing will cover a strip 44 ft. wide along the course of the ditch. All material excavated from the ditch, except stone, stumps, roots and rubbish, will be spread along in grubbed strip in a uniform and compact manner. The top earth of the ditch will form a foundation and the bottom material will be used as a surface to the roadway.

Bids for the construction of Judicial Ditch No. 30 will be received until 10 a. m., Sept. 13, by the County Auditor, Bemidji, Minn. W. M. Everts, Bemidji, Minn., is Engineer.

The Hudson Bay Ry.—Good progress has been made with the construction of the railroad which is being built to furnish a rail outlet from the grain provinces of Saskatchewan and Manitoba directly to Hudson Bay. The line is now graded to a point within 25 miles of the bay and the steel laid half way from Le Pas where the road leaves the Canadian Northern system. If present progress is continued the line will be completed next year by which time the terminal work at the north of the Nelson will be well under way. J. D. McArthur, Winnipeg, Man., is the contractor.

PERSONALS

William B. Bamford, M. Am. Soc. C. E., has been elected to fill a vacancy on the Belmar, N. J., borough council. He last spring refused the nomination for mayor under a proposed commission government. Mr. Bamford is also president of the trustees of the free public library and other public bodies.

Paul D. Fuquay, of the staff of the city engineer of Dayton, Ohio, has been placed in direct supervision of the construction of the three new bridges contemplated in that city. Mr. Fuquay will have charge of the plans which are being detailed to govern the construction of the Fifth St. bridge, the Webster St., and the Keowee St. bridges.

Mr. Howard S. Reed, Assoc. Mem. Am. Soc. C. E., who for the past eleven years has been with the United States Geological Survey and the United States Reclamation Service, having been in charge of the operation and maintenance of the Salt River (Roosevelt) irrigation project in Arizona for the past six years, announces that he will engage in the general practice of Engineering at Phoenix, with offices in the Noll Bldg. Special attention will be given to the design, construction and valuation of water works systems, to the design, construction and operation of irrigation systems, and to the making of engineering reports. He will also represent the Builders' Iron Foundry of Providence, R. I.

Mr. Joseph Weidel was recently appointed Valuation Engineer of the entire Atchison, Topeka and Santa Fe Railway System and controlled roads. He began his professional work in 1895 as a draftsman in New York City. In 1899 he was assayer for the Buck Exploration Co. at Durango, Mexico. In 1900-02 he served in various capacities for the Santa Fe Railway in Colorado, New Mexico and Kansas. In 1903 he was division engineer of the Mexican Central Railway in the states of Coahuila and Vera Cruz. He was an assistant engineer with the Santa Fe in 1904-05. In 1906 he was construction engineer for the Hally and Swink Railway in Colorado. He then returned to the Santa Fe, serving for one year as engineer on construction of the Raton Tunnel at Trinidad, Colo., and for two years as office engineer at Topeka, Kans. In 1912-13 he had charge of the construction of the Pecos and Northern Texas Railway from Lubbock, Texas, to Texico, N. Mex. In 1914 he again became an assistant engineer with the Santa Fe.

Mr. William C. Coffin has severed his connection with the Jones and Laughlin Steel Co. to become Vice President of the Knox Pressed and Welded Steel Co. of Pittsburgh, Pa. Mr. Coffin was Vice President of the Riter-Conley Manufacturing Company from 1898 to 1908, and since then has been Structural Engineer of the Jones and Laughlin Steel Co. Mr. Coffin's new position will also include the duties of General Sales Manager and he will devote his entire time to his new connection. With the acquisition of Mr. Coffin the officers of the Knox Pressed and Welded Steel Co. now are Luther L. Knox, President; William C. Coffin, Vice President and Sales Manager; Irvin F. Lehman, Secretary and Treasurer. The approaching completion of the new Knox plant was the deciding factor that brought Mr. Coffin to that company. The new plant will be given over to riveted and welded steel plate work, while the company's present plant at Farrell, Pa., will be continued in the manufacture of the Knox Patented Water-Cooled Devices for Open Hearth and Heating Furnaces.

OBITUARIES

Dexter Brackett, Chief Engineer of the Metropolitan Water and Sewerage Board of Massachusetts, died on August 26. Mr. Brackett was born in Newton, Mass., 63 years ago. He had been connected with the Metropolitan Board since its creation in 1895, his first position with that organization being engineer of the distribution department. He became chief engineer on Feb. 1, 1907. He was a member of the American Society of Civil Engineers and was a past president of both the New England Water Works Association and the Boston Society of Civil Engineers. He was one of the most widely known of American water works engineers.

John H. Warder, for the past 15 years Secretary of the Western Society of Engineers, died at his home in Chicago on Aug. 30, 1915. He was born in Cincinnati Jan. 21, 1846, and was, therefore, nearly 70 years of age at the time of his death. The work for which Mr. Warder will always be remembered was performed in the discharge of his duties as Secretary and Librarian of the Western Society of Engineers at the permanent headquarters of the Society in the Monadnock Block, Chicago.

His application for membership in the Society was dated Sept. 20, 1898. At the time of joining the Society he was Assistant Engineer for the Chicago Bureau of Sewers and had charge of sewer construction work. He remained in the service of the city until he became Secretary of the Society on Jan. 10, 1901.

Mr. Warder graduated from the Polytechnic College of Philadelphia in 1867 with the degree of Mechanical Engineer. From then until his election to the secretaryship of the Society he was engaged in the practice of his profession. One of his first engagements was with the Cincinnati Southern Railway System. He also spent considerable time in bridge inspection work at the Phoenix Iron Works and at the several bridge works in Chicago. He served as inspector on the construction of bridges in various cities, including Detroit, Pittsburgh, Edgemoor, Minn.; Athens, Pa., and Elmira and Rochester, N. Y. He worked for a time in the bridge department of the Chicago, Milwaukee and St. Paul Railway. He also designed electric light and power plants in the vicinity of Chicago. He planned the water works for Pullman, Ill., a Chicago suburb, in 1893.

As Secretary, Mr. Warder edited the Journal of the Western Society of Engineers and was always the chief worker among the Society members to get them to read profession papers before the Society. His broad knowledge of engineering science and engineering literature enabled him to take a leading part in the discussion of such papers. The literature of engineering was enriched by his labors.

A Motorcycle Street Sweeper.—One of the latest American novelties is a motorcycle street sweeper, described in *Motor Cycle*. It is mounted on a side-car chassis of peculiar design, and in front of the sweeping mechanism is a steel brush that loosens the dirt so that the broom may easily remove it. The broom is lowered by means of a handle to the left of the driver's seat, and when the broom is in contact with the pavement it engages the actuating mechanism connected to the side-car wheel, which causes the broom to rotate. Raising the broom throws the mechanism out of gear. It is designed to be used on streets paved with asphalt or wood blocks.

$15,000,000 Union Station Project, St. Paul, Minn.—It looks now as though construction work on the new $15,000,000 union station project at St. Paul, Minn., would be held up for a year. The U. S. War Department is understood to have refused to approve the changes in the river channel proposed by the Union Depot Co. and sanctioned by the City Council. Bids on the work were taken some weeks ago but were held in abeyance awaiting approval of the plans by the Governments engineers. These plans are now said to have been referred back to the special board of engineers with suggestions for certain alterations.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

Volume XLIV. CHICAGO, ILL., SEPTEMBER 15, 1915. Number 11.

The Value of High Pressure Steam Tests of Cement.

Twenty-five years ago, as nearly as he can calculate without undesired exertion, the editor became much interested in "accelerated tests" for hydraulic cement. He has grown less interested every year since. At about the time indicated, Mr. William Maclay was propounding and defending his hot water test of cement. Controversy waxed hot. Previously Michaelis, Erdmenger, Faija and others abroad, had proposed various sorts of cooking processes for determining over night the liability of a cement to "blow," and afterward there came a host of other advocates of the searching value of fire as a determinant of cement quality. The processes advocated ranged from the very mild hot water test to grilling a fresh briquette in a Bunsen burner. To assert that the cement manufacturers fought these innovations puts the condition too mildly; they smothered the enemy with asphyxiating gases and scientifically nicked the ends of their cartridges to mushroom on impact. Having checked the first onset the "industry" settled down to normal trench fighting, and for years only occasional minor sallies indicated the existence of the embattled fronts.

Two main facts contributed to continued quietude. Cement became to be made far better than it once was. Better control of raw materials, finer grinding, superior calcination, and other improvements did much to eradicate the "free lime" scare and the "magnesia" roorback. Complaints of "blowing" cement were rare. The second fact was that a rather general study of "accelerated" tests was undertaken by laboratories and by individual experts without a theory to defend. As time went on, all things contributing, the opinion of the "accelerated test" settled down to the little homily that "no distinctly unsound cement can escape detection but also that such tests label as unsound many cements which time proves to be entirely all right." With the coming about of this in-conclusion the present writer and, he imagines, most cement users lost any very deep concern in the accelerated-test-for-cement propaganda. However the snake was only scotched.

Two years ago, about, the old idea of marvelous quality belonging to heat as a crime detector for Portland cement was revivified. This time it was a high pressure steam test, with refinements, that was proposed. To the older observers of accelerated test history the method seemed not greatly different in general to that proposed by Erdmenger some 35 years ago, but this thought may be passed. The new test gained converts and a large amount of the very finest sort of publicity. A pamphlet dated no later than Aug. 18, 1915, at the Bureau of Standards, is evidence of the deep impression of this publicity on the cement technological consciousness of the engineering profession. This pamphlet is very interesting. It not only arrives at some very definite conclusions of the value of the new heat test, but it awakens old fond memories by its familiar ring. One cannot forbear to quote:

> 1. The high-pressure steam test should be made on all cements that are incorporated in cement, mortar, or concrete products that are to be cured in steam at pressures above atmospheric.
>
> 2. The high-pressure steam test may be of value as forecasting the behavior of neat cement or a very rich mortar when exposed under normal conditions in dry air, but it will not forecast the behavior of cements in concretes as normally exposed.
>
> 3. The cement passing the high-pressure steam test is not superior in cementing quality, as determined from the compressive strength of concretes, to cement that fails to pass this test.
>
> 4. The cement passing the high-pressure steam test does not make more permanent or durable concrete than cement which meets the requirements of the standard specification but fails to pass this test.
>
> 5. Cement failing to pass the standard specification atmospheric steam test but meeting the other requirements of the standard specification shows in some instances a normal strength in concrete.
>
> 6. For practical work under normal conditions of construction, the results of this investigation fail to show that the high-pressure steam test is of value as a means of determining the ultimate soundness of concrete.

Solely because of our recollection of former times in the history of accelerated tests we know that these conclusions will not be accepted by any real heat test disciple. We also announce that we are firm in the decision to be absolutely unfair by refusing to publish any answer to or refutation of these conclusions. Once in former more energetic and curious years we read all the volume of discussion aroused by similar laboratory investigations of heat test claims and any possible repetition of the task looms too formidable to be encouraged.

The Plumber's Day in Court.

Probably no other legitimate craft has been assailed as often as the plumbers'. Newspaper writers have, for years, made a target of the plumber. He has been charged with unequalled time-killing propensities and for charges beyond all reason. Many of these articles were obviously intended to be funny, but there was usually a serious theme running through them. Plumbers and plumbers' journals have taken cognizance of newspaper jokes at the plumbers' expense and have protested against this form of newspaper humor, holding it to be harmful to the best interests of the craft. However, that there was much truth in the charges so made against plumbers can scarcely be doubted by anyone who has had much to do with these artisans. Probably the general public considers the plumber's charges exorbitant and doubts that he finishes his work as expeditiously as he could were he so minded.

With his air-tight organizations the plumber has come to be looked upon as a first-class illustration of the tyranny of which organized labor is capable. The editors have many times heard it stated that it is easier to gain access to the most exclusive social set in Chicago than it is to take up plumbing work in this city. It is stated that a man must be a blood-relative of a Chicago union plumber or he cannot hope to become a member of the union. Without membership in the union he cannot engage in plumbing, so it is believed that the local union is practically a closed corporation. This belief, being held by many people, has made the plumber unpopular locally, and, for one reason or another, he is rather unpopular generally.

It must not be supposed, however, that all the criticisms aimed at the plumber emanate from newspaper jokesmiths or from the incompletely informed public. The matter is more serious that that. Speaking before the Indiana Sanitary and Water Supply Association, Prof. Earle B. Phelps, of the federal government's health service, called the present time "The Age of Sanitation." He said: "The man who fixes your water pipes styles himself a Sanitary Engineer and charges you accordingly." Much more direct and specific criticisms of plumbers were made by Wm. C. Groeniger, State Inspector of Plumbing for the Ohio State Board of Health, in an address delivered before the 1914 annual convention of Ohio State Master Plumbers Association at Cincinnati. Among other things Mr. Groeniger said:

> Plumbers will install cheap and defective material knowing that it will have to be replaced in the very near future and they will spend days figuring how they are going to skin a job. * * *
>
> Thirty-three and one-third per cent of the plumbers of the state of Ohio do not require law to compel them to install work in accordance with good practice. Sixty-six and two-thirds per cent want law for the other fellow but not for themselves.

Such statements as these from such a source, cannot be disposed of lightly.

The work of the plumber is of immediate concern to engineers interested in the installation and operation of water supply and sewerage systems. In sewerage, "engineering" usually extends to the street side of the curb while "plumbing" extends from the curb to and into the house and the house fixtures. The same is sometimes true in water systems, though water departments usually retain more direct control of the installation of house pipes and fixtures than is the case with sewer departments. Regardless of how this work is handled, engineering suffers where plumbers' charges are too high. Many a householder balks on installing water and sewerage facilities in his house because of his reluctance to lay himself liable to plumbers' charges. This delays the proper extension of water and sewer systems in cities which are incompletely served by these utilities. The same thing dissuades some small towns from installing water and sewer systems—the householder is naturally reluctant to embark on an enterprise which will ultimately make it necessary for him to give the combination of his safe to a plumber.

That water department officials do not feel very kindly towards plumbers as a class was clearly shown in a discussion on "The Control of Plumbers and Plumbing" at the latest annual convention of the American Water Works Association. One water works superintendent said: "The plumber is the poorest mechanic we have." This view was assented to by others and it was agreed that plumbers are the source of a good deal of trouble to water department officials. For example, one superintendent said that plumbers made him a great deal of trouble by coaching water-takers to object to the amount of water bills. Thus the plumber says: "Your bill is too high. So much water could not pass through the meter." Such misinformation tears down the good will the water department is constantly striving to build up.

In view of all this it is interesting to note, as reported in the daily press, that suit will be begun soon by the federal government to obtain the complete dissolution of the National Association of Master Plumbers, which comprises among its members practically all of the larger plumbers in the United States and a great many of the smaller ones. Briefly, the suit will charge the plumbers' association with fixing prices in restraint of trade, in violation of the Sherman anti-trust law, and will ask an injunction to prevent meetings for further price fixing and the dissolution of the Association.

Believing, as we do, that the high-handed methods resorted to by plumbers has been made possible only by the strength of their organization, and that these methods have been harmful to the cause of sanitation, we hope that the government will win its suit. Regardless of the results of the suit, leaders of thought among plumbers should note the general displeasure with which the public, engineers, and city and government officials, view the course which plumbers have too long pursued.

WATER WORKS

Some Design Features of the Montebello Water Filters, Baltimore, Md.

(Staff Article.)

The Montebello filters of the Baltimore water works were formally opened on Sept. 13, 1915. Mr. Robert L. Clemmitt, President of the Water Board, presided at the exercises. The following addresses were delivered: Baltimore's New Improvements, by Mayor James H. Preston; Historical Sketch of Baltimore's Water Works, by Richard Bernard, member of the Water Board; Relation of Water Supply to Public Health, by Granville R. Jones, Professor of Sanitary Engineering, Johns Hopkins University; Tuning Up the Filtration Plant, by James W. Armstrong, Engineer of Filtration; How the Five-Million-Dollar Loan Was Spent, by Ezra B. Whitman, Consulting Engineer. The formal exercises were opened and closed with music by the Municipal Band. Following the program the filter plant was inspected. We present herewith a description of the design features of this plant.

The water purification plant consists of a low-lift pumping station, the filtration plant proper, including the head house, the coagulating basins and filters and the filtered water reservoirs.

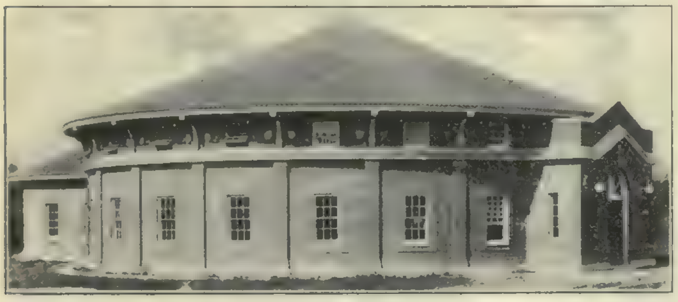


Fig. 1. View of the Low-Lift Pumping Station of the Montebello Water Purification Plant, Baltimore, Md.

This building is 81 ft. in diameter and contains four centrifugal pumps having an aggregate capacity of 160,000,000 gals. per day. The pumps rest upon the floor 22 ft. below the ground level and are operated by electric motors, power for which is transmitted from McCalls Ferry, 40 miles away, at 13,200 volts. It is transformed to 550 volts for operating the motors.

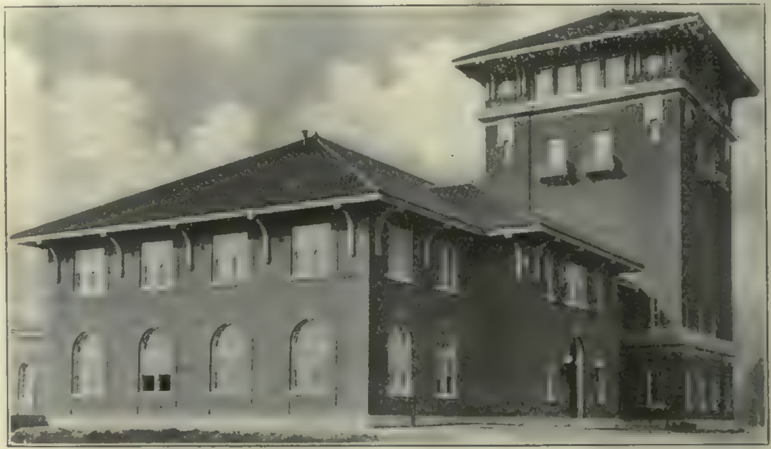


Fig. 2. View of Head House of Montebello Water Filters, Baltimore, Md.

This building contains the offices and laboratory. It is the place where all the chemicals are stored, mixed and controlled. The tower contains the freight and bucket elevators and 15 storage bins which have a capacity of two carloads each.

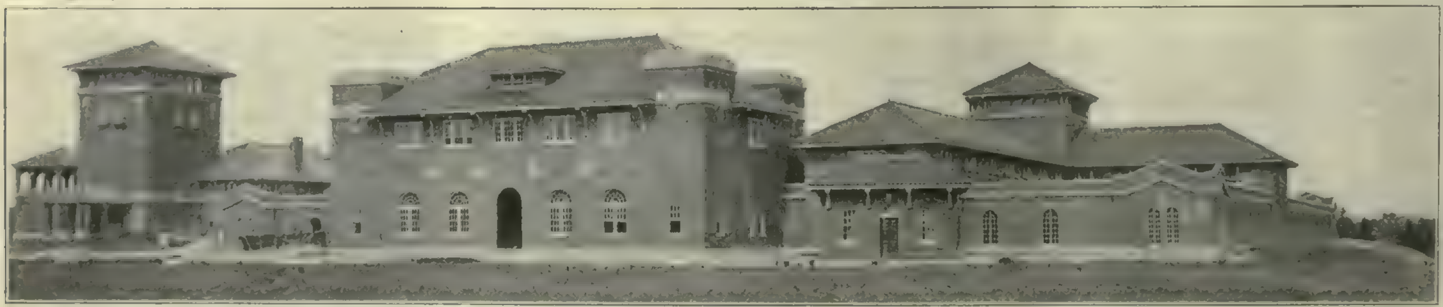


Fig. 3. General View of the Montebello Filtration Plant, Baltimore, Md., Looking East.

This view was taken from the center of the filtered water reservoir. Beginning at the left the structures are as follows: Aerator gate house, head house, wash water building and filter building, with a small inlet gate house in front of the filter building.

LOW-LIFT PUMPING STATION.

The low-lift pumping station is shown in Fig. 1. The old Loch Raven-Montebello water tunnel, which brought water from the Gunpowder River to the city, was tapped by a vertical shaft and the suction from the low-lift centrifugal pump extend down into this shaft. The pumps are arranged around this shaft and the pumping station building is circular in form.

Four centrifugal pumps have been installed having an aggregate capacity of 160,000,000 gals. per day. One has a capacity of 50,000,000 gals., two 40,000,000 gals. each, and one 30,000,000 gals. The capacities were thus varied so that the pumps can be operated at their rated speeds and still supply water in the varying amounts required to meet the fluctuating demand. The lowest daily consumption is about 70,000,000 gals.

The choice between electric and steam pumping was made on account of cost considerations. An advantage of the circular form of pumping station is that with it a simple arrangement can be made for handling the machinery by means of a radial hand operated revolving crane. The pumping station and shaft are so arranged that water can be delivered to the filtration plant or by-passed to the tunnel leading to Lake Montebello, one of the old units of the Baltimore water works. A 60-in. sluice gate is provided in the shaft by means of which the water can be permitted to flow by gravity directly into Lake Montebello, as it did formerly, if the remote contingency of an enforced shut-down of the filtration plant should arise.

THE FILTRATION PLANT.

Head House.—The head house is shown in Fig. 2, and a general view of the plant is shown in Fig. 3. The water, after leaving the low-lift pumping station, passes through an 8-ft. conduit into a Venturi meter and from there passes through chambers in the conduit to be used in case aeration is found to be necessary. This 8-ft. conduit extends to the head house where its section is changed to a rectangle 10 ft. 2 ins. wide by 5 ft. high. Before the water reaches the mixing basin it passes through a stilling chamber which is provided for the purpose of taking care of any quick changes in the operation of the pumps.

Lime and iron are used as coagulants and the filtered water is chlorinated. The lime, as delivered, is dumped on a mezzanine floor in the basement of the building. From there it is passed through a crusher into the bucket elevator and is lifted into the tower whence it is spouted to the storage bins. There are 15 storage bins, each about 9 ft. square inside and 23 ft. deep. It is withdrawn from the bottom of the bins into trolley buckets, which hold about 800 lbs. each. These buckets are suspended from an overhead I-beam which passes over the mixing tanks. The buckets are suspended by roller bearing trolleys and can easily be pushed by one man.

The lime is discharged from the trolley buckets into concrete mixers, which have been especially adapted for the handling of lime. From the concrete mixers the lime is discharged into steel troughs which lead to the solution tanks, of which there are three, each 14 ft. in diameter by 14 ft. deep. As the lime tends to settle very rapidly, it will be kept in suspension by means of propeller blades operated at 750 r. p. m. by motors placed below the tank. From the solution tank the lime flows directly to the chemical controllers and after passing through the controllers is applied to the water at the point where it enters the mixing basin.

The sulphate of iron is handled in the same manner as the lime, except that it is not passed through the crusher. It is dissolved in concrete boxes to which the water is applied through a pipe grid supported on the floor of the boxes. The solution is stored in four concrete tanks, each measuring 12 by 9 ft. inside by 16 ft. deep. The sulphate of iron is piped to the mixing basin, where it can be added at various points along the center passage as it may be deemed most advisable to apply it.

A view of the chemical laboratory is shown in Fig. 4.

Mixing Basin.—The water enters the mixing basin from the stilling chamber of the head house. This mixing chamber is covered with groined arches, and it is divided into passages 8 ft. wide by wooden baffles. It is 120 ft. by 192 ft. 6 ins. in plan. The time of passage of water through the mixing basin, based upon the rated capacity of 128,000,000 gals. per day, is about 31 minutes. The velocity of the flow through the channels between the baffles at this rate is about 1 ft. per minute. The wooden baffles are not continued throughout the entire basin, but provide only for about 16 minutes' mixing. At the middle point of the mixing basin two 72x72-in. gates are provided to take the water into the intermediate passage of the center conduit, and this intermediate passage delivers the water into the coagulating basins. This is the ordinary course of the water when turbid. Arrangements are made for passing directly from the mixing basin to the filters when the raw water is fairly clear and the amount of chemicals being used is small, thus dispensing with the use of the coagulating basins.

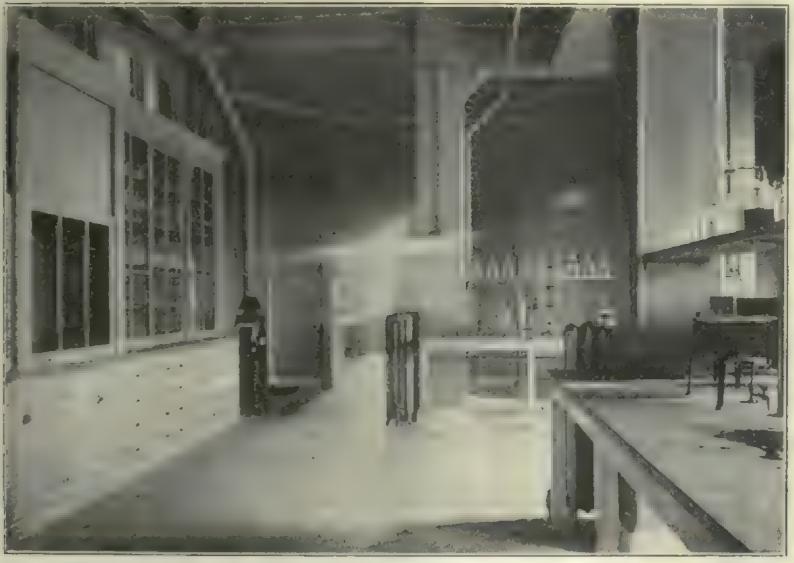


Fig. 4. View of the Chemical Laboratory in the Head House of the Montebello Filters, Baltimore, Md.

This laboratory has a tile floor and is finished in an ivory colored enamel paint, and all the tables and benches are made of Alberene. It is equipped with a gas machine and automatic refrigerating plant.

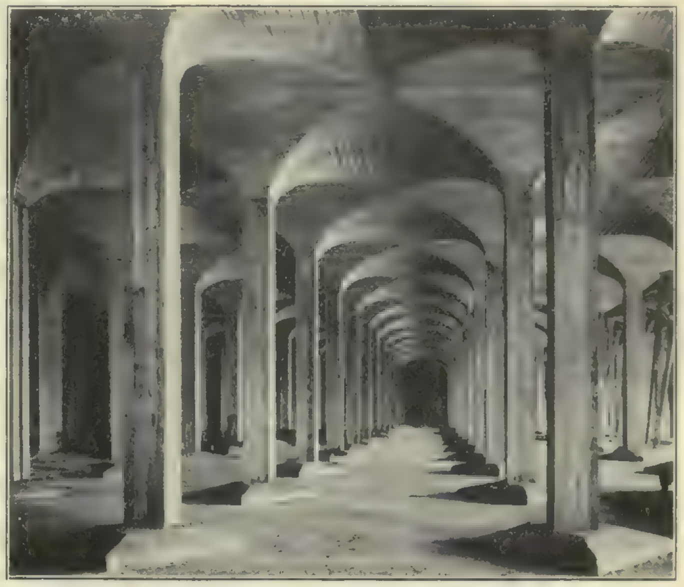


Fig. 5. Interior View of the Filtered Water Reservoirs of the Baltimore Water Purification Plant.

The columns supporting the groined arches are spaced 15 ft. center to center and the arches have a rise of 3 ft. The capacity of the two reservoirs is 15,300,000 gals.

The floor of the mixing basin is laid on a 0.66 per cent grade toward the center passage. When the chemical sludge accumulates in this basin to such an amount as to increase the velocity of the water it is removed by flushing to the gutter along the center passage wall. This gutter drains to four sumps. Then, by means of 18-in. sluice gates, this sludge is flushed to the main drain or the lower conduit of the center passage.

Coagulating Basins.—The two coagulating basins are each 233x324 ft. in plan. The water enters these basins from the intermediate conduit of the center passage near the bottom of the coagulating basins through five 48x48-in. sluice gates. The water, after entering the basins, passes along their long dimension and around the end of the concrete baffle wall and runs back to the center passage where it passes over a 4-in. skimming wier and is drawn off into the upper conduit of the center passage by means of five 54x54-in. sluice gates.

The coagulating basins are practically divided into two compartments by the reinforced concrete baffle wall passing down the center of the basin from the center passage, dividing each one of these two basins in half.

There are gutters which slope toward the center passage, and the floors are so laid that they slope to these gutters from all directions. When the coagulating basins become so filled with sludge that it becomes necessary to clean them, the water is drained from them. At the wall near the upper end of these gutters a 12-in. gate valve is located which carries raw water from the head house before the chemical is added to the point at the upper end of the gutters. The 12-in. gate valves above mentioned are then opened and the raw water flowing from this gate valve is used to carry the deposited sludge down the gutter and into the main drain under the center passage through the 18-in. sluice gate built in a sump at the end of the gutter. In order to flush the slude to this main gutter, hose connections are provided from 4-in. cast-iron water pipes, which are connected with the regular city mains under a pressure of about 40 lbs. Three 60x72-in. sluice gates are provided in the division wall between the two coagulating basins at a point near the center passage. The two coagulating basins can be used in series if it is desirable to operate them in that way by opening these sluice gates. The time of passage of water through each one of the coagulating basins, based on the rated capacity of 128,000,000 gals. for the plant, is approximately 1½ hours, and, with the two coagulating basins in use, either in series or parallel, it would therefore require three hours for the passage of the water through them.

Filters.—There are 32 filter units each 53 ft. 6 ins. by 30 ft. 6 ins. by 9 ft., inside measurement. These are the typical rapid sand filter boxes with which our readers are familiar. The depth of sand and gravel in the filter is approximately 4 ft.

FILTERED WATER RESERVOIRS.

The rate controllers on each filter take care of all ordinary fluctuations in the use of water by the city. In order to take care of any sudden demands, however, it is necessary to have a reservoir of from three to four hours' capacity, considering the average daily consumption for the entire city. Therefore, two reservoirs, each having a capacity of about seven and one-half million gallons, were built to receive the filtered water from the filtration plant.

One of the characteristics of filtered water is that if exposed to the sunlight, algae very quickly grow in this clear water and produce tastes and odors which are most disagreeable. In order to obviate this it is necessary to cover filtered water reservoirs and the two reservoirs at Lake Montebello are covered with a groined arch construction as shown in Fig. 5. The clear water basins under the filters hold an additional 2,500,000 gals.

The water after passing through the filtered water reservoirs is delivered into a 9-ft. conduit, which carries the water to the gate house at Lake Clifton, where it enters the main distributing pipes leading to the city.

ACKNOWLEDGMENT.

For the photographs and a portion of the information here given we are indebted to James W. Armstrong, Engineer of the Filtration Division. The remainder of the information is drawn from the latest annual report of the Baltimore Water Board.

Cost of Chemicals Used in Treating Water.—The following data showing the quantity of water softened and purified at the Columbus, O., water softening and purification works, for the years 1909-1914, and giving the quantities and costs of chemicals used, are taken from the latest annual report of C. P. Hoover, chemist in charge:

Year.	Rate of consumption. Million gallons per 24 hours.	Lime		Soda ash		Alum		Bleach	
		Tons.	Cost per ton.	Tons.	Cost per ton.	Tons.	Cost per ton.	Tons.	Cost per ton.
1909	14.3	2,467	$5.75	1,402	$17.50	624	$19.00	..	......
1910	15.5	3,081	5.80	2,164	17.50	423	18.00	..	......
1911	15.6	3,860	5.42	1,776	17.50	590	17.50	..	......
1912	17.5	3,296	5.27	1,583	15.20	895	17.15	22	$27.80
1913	18.3	3,629	5,17	2,895	12.88	711	17.10	17	27.80
1914	18.4	4.650	5.27	3,540	13.30	880	16.75	14	29.20

Methods and Cost of Shaft Sinking at the Astoria Tunnel, New York City.

(Staff Abstract.)

The Astoria tunnel was constructed from two vertical shafts, respectively 276.5 ft. and 242 ft. deep, through rock. This tunnel carries gas mains from Astoria on Long Island and under Long Island Sound to about the east foot of 132nd St. in Bronx Borough, New York City. The distance between the two shafts, or the length of the tunnel, is 4,662 ft. The construction period was 1910-12. This article relates to the shaft construction alone.

GENERAL.

The dimensions of the two shafts were as follows:

	Astoria.	Bronx.
External diameter earth, ft..	42	30
External diameter rock, ft..	38½	28½
Internal diameter, ft........	34½	26
Depth, ft.	276½	242

At the Bronx shaft there was a depth of about 13 ft. of boulders, bank sand and gravel over the ledge rock. The depth of overburden at the Astoria shaft was about 50 ft., of which 40 ft. were below mean sea level, and the material was sand, gravel and boulders, carrying water. The ledge rock was medium hard gneiss.

SHAFT SINKING IN EARTH.

The sinking of the Astoria shaft began on Sept. 12, 1910. Steel sheet-piling of United States Steel Co. section was used for the exterior sheeting through the earth section, for a depth of 52 ft., and was braced with 16-sided timber frames, 4 ft. apart, strapped at the joints with steel plates, to which were attached turnbuckle tie-rods extending across the shaft for use in maintaining the circular form. The dump trestle having been constructed to circular form at a height of 15 ft. above the ground, and the excavation being removed to 8 ft. below the ground, a frame was prepared to the correct circular form, plumbed accurately below the trestle form, and served as a guide for driving the sheet-piling. The piling was cut in two lengths for the total depth, with joints staggered, and was driven with an Arnott 2,000-lb. steam pile-hammer suspended from a derrick.

Excavation was removed as the sheet-piling was driven, in order to avoid any distortion by over-driving against boulders or rock. Having sunk the shaft to rock level, excavation was carried down into the rock about 4 ft. below the point of the piling, and concrete was placed to half the ultimate thickness for the full depth of the excavation, in order to secure the sheet-piling and timber frames from injury during the further extension of the shaft construction.

TABLE I.—PROGRESS IN SHAFT CONSTRUCTION, ASTORIA TUNNEL.

	Actual cubic yards.		Working days of 24 hours each.		Daily average in actual cubic yards.	
	Astoria shaft.	Bronx shaft.	Astoria shaft.	Bronx shaft.	Astoria shaft.	Bronx shaft.
Excavating earth................	2,687	367	16.8	2.9	159.7	126.6
Excavating rock.................	11,542	5,939	123.4	97.9	93.5	60.7
Placing concrete................	3,178	1,621	37.2	23.3	85.5	69.6
Total construction...........	.....	.....	177.4	124.1	.....	.....

At the Bronx shaft, the shallow depth of the overlying soil and material, as well as its character, made it unnecessary to use steel sheet-piling. Wooden sheeting of 4-in. tongued and grooved stuff, supported by 12-sided timber frames, 4 ft. apart, was used through the 13 ft. of earth to rock level; the permanent lining inside this sheeting was concreted on reaching the rock floor.

SHAFT SINKING IN ROCK.

Shaft sinking in rock was carried out by the ordinary methods, the usual practice being to line up with concrete every 30 ft., as the rock was of treacherous character, and the introduction of the lining insured the employes against accidents.

For hoisting and removing the rock excavated from the shafts, and to avoid the danger of using a swinging bucket operated from the boom of a derrick, the permanent head-frame to be equipped later for the use of elevator cages, was erected, with overhead hoisting sheaves and the regular elevator hoisting engines. One of these elevator wells was then fitted with guide-framing below the landing, and at the level of the landing a broad-gage track crossed the elevator opening, with trap-doors fitted to insure safety. The spoil buckets were hoisted through this trap and landed on a flatcar run through the elevator opening before the hoisting rope was detached.

Water entered from numerous rock joints at various points in sinking the shafts, but not in such volume as to retard the progress of the work, except by the time lost in the removal by the derrick of the pumps and hose when blasting. This shaft water was readily handled in each shaft by one 350-gal. per minute steam-driven pump.

Two water rings were placed in each shaft as the sinking proceeded, in order to intercept the water seepage and prevent it from pouring on the men working below. Each ring was simply a 6-in. wooden shelf with gutter board sheathed with zinc, and a 3-in. pipe extending to the shaft bottom for drainage. Later, these leaks were stopped by grouting, while the driving of the tunnel was in progress.

TABLE II.—UNIT COSTS OF SHAFT CONSTRUCTION—NORMAL CONDITIONS.

	Cost Per Actual Cubic Yard.			
	Rock excavation (Gneiss).		Concrete Lining.	
Items.	Astoria Shaft.	Bronx Shaft.	Astoria Shaft.	Bronx Shaft.
General supervision	$0.114	$0.120	$0.130	$0.120
Engineering expense	0.193	0.204	0.221	0.205
Field office administration........	0.808	0.853	0.922	0.855
Plant and equipment, installation and maintenance..........	0.346	0.365	0.396	0.366
Plant and equipment, 60% of purchase value..............	0.867	0.915	0.990	0.917
General surface labor and supplies..............	0.354	0.373	0.451	0.375
Drilling and blasting	1.971	1.571	1.083	1.283
Mucking	1.652	1.797	....	....
Disposal, surface transportation................	0.484	1.592	....	....
Disposal, scow line and towing................	0.149	0.101	....	....
Power and plant running................	1.625	1.343	....	....
Making and sharpening steels, and repairing machines........	0.420	0.376	....	....
Lighting	0.157	0.171	0.134	0.161
Extending lines (air, pump, etc.)................	0.173	0.124	0.100	0.098
Pumping	0.301	0.439	0.234	0.207
Contingencies	0.817	0.879	1.113	1.078
Forms and platforms, making, setting and removing........	....	....	2.389	1.902
Use and waste of lumber................	....	....	0.300	0.294
Handling materials	....	....	0.519	0.341
Sand	....	....	0.264	0.424
Cement	....	....	1.898	1.807
Stone	....	....	0.836	0.806
Mixing concrete	....	....	0.784	0.779
Transportation	....	....	0.055	0.000
Placing concrete	....	....	1.342	1.650
Cleaning up	....	....	0.045	0.091
Totals	$10.431	$11.223	$14.206	$13.759

At the bottom of the Astoria shaft the design provided for an enlargement, about 41 ft. high, 34½ ft. wide, and extending some 19 ft. beyond the neat shaft lines. This was to be used ultimately as an operating chamber for the distribution of gas, but it, as well as the short length of 100 ft. of tunnel in the direction of the future Manhattan shaft at 111th St., was utilized, during the construction of the tunnel, as a pump chamber and storeroom. This enlargement extended 16 ft. below the tunnel invert, and, in addition, contained a 5-ft. circular sump 8 ft. deep, so that ample provision was afforded for the accumulation of the expected water flows and for settling any solid matter carried with the water.

As the tunnel drained southward toward Astoria, a similar sump was not required in the Bronx shaft, but ample precautions were taken by the construction of a rectangular sump, 21 ft. long, 12 ft. wide, and 8½ ft. deep.

The following tabulation presents the unit quantities relating to the shaft sinking in rock:

Drilling and blasting.	Astoria. shaft.	Bronx shaft.
Feet drilled per actual cubic yard	3.9	3.3
Linear feet of drill steel used per cubic yard	0.174	0.172
Pounds of 60 per cent Forcite used per cubic yard............	1.2	1.1

PROGRESS AND COST.

The progress made in construction is indicated by Table I. Table II shows the itemized unit costs of the two shafts exclusive of the earth excavation which cost as follows:

Item.	Astoria.	Bronx.
Per cubic yard	$ 7.05	$ 2.67
Per lineal foot	365.81	75.39

ACKNOWLEDGMENT.

Extracted and partly rewritten from a paper by J. Vipond Davies in Proceedings American Society of Civil Engineers, vol. XLI, p. 1405, August, 1915.

How to Make Good Joints in Cast Iron Water Mains With Leadite.

(Staff Article.)

While leadite is being used successfully by many water works men it is admittedly true that a good many have given it up after experimenting with it and are still using lead. Leadite failures appear to come from improper manipulation of the material—sometimes this is due to a lack of understanding and sometimes it is intentional on the part of calkers and other workmen who fear that they will lose their jobs if lead is supplemented by leadite.

The first experimental joints made by the author with leadite, about nine years ago, did not prove satisfactory. Later trials gave better results, so a service test was then made on a line of about 70 lengths of 6-in. pipe under light pressure. All but three joints were tight and those were easily repaired. Gradually we extended the use of leadite to joints under higher pressures and to larger pipe, and in two or three years practically abandoned lead. The result of our experience has been most satisfactory. We have used it on pipe from 4 to 30 ins. in diameter and under pressures up to 210 lbs. to the square inch.

Leadite comes in the form of a fine black powder. About one-half of it is sulphur, the other half is apparently a finely ground quartz with probably some lamp black to give it its color. Where melted and cast it becomes a black, hard, dense, vitreous mass. Anyone who is familiar with the two substances, lead and sulphur, will realize at once that they have very different characteristics. Lead has a specific gravity of about 11.4. Sulphur's specific gravity is about 2.0. In other words, a cubic foot of lead weights, in round numbers, 710 lbs., while a cubic foot of sulphur weighs 125 lbs. Lead melts at about 612° F.; sulphur at about 240° F. Lead is ductile and soft, sulphur is brittle and hard. Lead will flow under a continued pressure of about 500 lbs. per square inch; sulphur has a compressive strength of several thousand pounds per square inch. Lead expands one part in 63,012 for each increase of temperature of 1° F.; sulphur expands one part in 28,066; and cast iron expands one part in 162,000. It will thus be seen that lead expands about 2½ times as much as cast iron, and sulphur nearly 6 times as much as cast iron. In making leadite this tendency of sulphur to excessive expansion and contraction as compared with cast iron has to be overcome by the material which is mixed with it. This seems to have been accomplished successfully. Leadite has a strength in compression of about 7,000 lbs. per square inch and weighs about 138 lbs. per cubic foot.

IMPORTANCE OF STIRRING LEADITE.

In using leadite, it is melted in a pot in the same manner as lead, but since it melts at a much lower temperature it is melted more easily. A small fire is required but the leadite should be stirred frequently from the minute it begins to melt until it is put into the ladle ready to pour the joint. Failure to do this has been the cause of many of the unsatisfactory results obtained. As the leadite melts it froths and foams and then unless removed from the fire it suddenly becomes thick and pasty. This indicates that the temperature has been raised to too high a point and is the signal to remove the kettle from the fire. *Keep stirring.* As the temperature is reduced the leadite becomes like a thin black oil with a peculiar gloss, free from froth and foam, and it is then ready to be poured into the joint.

YARNING AND POURING.

The joint is yarned in the usual way, except that the yarn does not need to be driven quite so hard as it does for a lead joint which is to be calked. Any ordinary jointer will do, either a clay roll or a rubber band, but on account of leadite being so much lighter in weight than lead, in order to fill the top of the joint, the gate must be 8 to 10 ins. high. This is made by forming a hollow clay cylinder with an internal diameter of about 1 in. and the leadite is poured into the joint with moderate rapidity until the gate is full to the top. Pouring should be continued as the molten mass in the center of the gate shrinks and settles. The clay roll or jointer may be removed as soon as the joint is hard but it is well to leave the gate until the joint has thoroughly cooled. When the gate is broken off, care should be taken that none of the leadite in the top of the joint is cracked or broken. The gate can be thrown into the kettle and remelted.

When leadite joints have been properly made, a large percent of them when tested should be found to be practically tight. There may be a small amount of seepage and in a very few cases even an appreciable leakage indicated by water dropping from the joint or small spray. Practically all of these will take up tight within 24 hours and such as do not become tight are readily made so by cutting out the portion which is leaking and re-running with leadite, or in case there is too much water the portion of the joint which has been cut out can be filled with lead wool. If more than one or two per cent of the joints made show leakage after 24 hours, it is an indication that the joints were not properly made. In a line of 12, 10 and 8-in. pipe, five miles long, laid under my supervision several years ago and tested in the open trench, there was but one leaking joint. This was repaired by cutting out part of the joint and re-running.

ONE ADVANTAGE OF LEAD OVER LEADITE.

Lead has but one advantage over leadite; namely, that after having been run the joints can be calked. The calking adds materially to the expense of the joint, but there will be occasionally in a city street a joint immediately under some pipe or otherwise inaccessible, where it may be advisable to use lead so that in case of the joint being disturbed and leaking in the future it can be readily repaired by calking, whereas if it was leadite it might be necessary to run a new joint or to cut out part of it and replace with lead wool.

ADVANTAGES OF LEADITE OVER LEAD.

In practically all other respects leadite has the advantage over lead. Leadite costs about 10 cts. per pound, lead about 5 cts., but leadite weighs about one-fifth as much as lead and hence its cost per unit of volume is about two-fifths that of lead. Leadite requires no calking and this, as will be shown later, is a material saving, not only in the cost of labor of calking but in the digging of large bell holes, in addition to which is the saving in cost of inspection in order to insure well calked joints. There is the further saving in the maintenance of the ditch and bell hole during the time that the joint is being calked and inspected. This is an important item in bad ground or in wet trenches.

In a case where there is limited room for calking, leadite has marked advantage over lead. Some years ago I had a 30-in. pipe burst, the bell of which was very close to a concrete wall. It was barely possible to yarn and run the joint with leadite. Had we been compelled to use lead it would have required hours of time to have cut out sufficient concrete to have permitted the calking of the joint. It was imperative that the pipe be repaired quickly as a large community depended upon the line for its supply, and the use of leadite saved us from a water famine.

Leadite has another advantage over lead in the fact that it is so much lighter and hence more easily carried to the joint, especially in a deep ditch; also that a sufficient amount can be carried in one ladle so that a large joint can be made at one pouring, whereas with lead two or three ladles must be used. When lead is at a temperature suitable for pouring it oxidizes rapidly and in spite of the utmost care the oxide and dross which gathers on the surface will sometimes be poured into the joint. There is no trouble of this kind with leadite.

Since lead has practically no elasticity, any movement of pipe laid with lead or any continued shock or vibration to the pipe tends to loosen the lead in the joints or in many cases to squeeze it out altogether. Leadite being elastic, is not so affected. I have known cases of side hill slips moving a line of pipe laid with lead and generally the first indication of trouble is a flood caused by the blowing out of a part or the whole of a joint. With leadite joints, however, while the leadite may be more or less crushed and may leak slightly, the joints do not blow out. This is a very important advantage as side hill slips generally cause damage to adjoining property and one finds it difficult to convince those who have suffered damage, or the court, that the slip caused the leak and not the leak the slip. The extent of the slip is likely to be much greater if there is material leakage from the joints after the pipe has been moved and the liability for damage is thereby increased.

As stated above, a leadite joint resists repeated shock. In one case a 20-in. cast iron pipe laid with lead passed under a main line of a railroad on which the traffic was very heavy. For years it had been necessary periodically to uncover that pipe and recalk the joints. About ten years ago the lead in these joints was replaced with leadite and I am advised that there has not been a leak in them since.

Considering the brittle nature of leadite, it is surprising what a leadite joint will stand in the way of movement without serious damage. This has been illustrated in my own experience several times by side hill slips, and in one case where it was necessary to lower a line of 8-in. pipe for a distance of nearly 300 ft. and to a maximum depth of about 2 ft. The pipe had been laid with leadite and it was not supposed that it could be lowered without damage to most of the joints, which would probably require them to be remade. It was decided, however, to try the experiment and the pipe was lowered and to our surprise the joints remained tight.

Since leadite melts at such a low temperature, there is no danger of an explosion should it be necessary to run a wet joint. Where water is encountered a joint can be made by leaving an opening at the bottom of the joint out of which the water can run. An experienced man will then run the joint quickly and in most cases will make a good job. If, however, the joint still leaks it is an easy matter to cut the leadite out where necessary and calk with lead wool. Sometimes a kettle of melted leadite will catch fire and of course the fumes of the burning sulphur are extremely disagreeable. Usually the fire can be smothered by throwing on quickly some of the cold powdered leadite. If this does not succeed, however, a pail of water will accomplish the desired end. Those who have seen water poured on to melted lead will be inclined to doubt this statement, but when we consider the low temperature at which the leadite melts it is evident that there is no danger of an explosion.

Among leadite's good qualities is the fact that it offers a high resistance to the flow of electricity, thereby reducing materially the danger of damage by electrolysis. A few years ago the United States Bureau of Standards made a test near Pittsburgh of two lines of pipe about half a mile long laid parallel in the same street. Both of these lines were crossed by a single track trolley line and conveyed electricity from the trolley line back to a net work of trolley lines in the city. One was a 16-in. cast iron gas pipe laid with lead joints, the other was a 12-in. cast iron water line laid with leadite joints. I do not have the exact figures at hand, but the amount of current passing through the 12-in. water pipe was only a very small fraction of that which was passing through the 16-in gas pipe.

COST DATA.

Most important of leadite's good qualities is the saving effected by its use compared with lead. Roughly speaking, on the ordinary sizes of pipe and under average conditions, this amounts to at least one-half of the cost of lead joints. In my own experience, since leadite was a new material and our pressures unusually high, I have made leadite joints with a depth of from 2⅛ to 2½ ins., whereas with lead the joints would be made from 1¾ to 2 ins. in depth. Used in this way we find on the average that the amount of leadite and lead required for joints of different sizes are as shown in Table I.

TABLE I.—THE AVERAGE QUANTITIES OF LEADITE AND LEAD REQUIRED FOR JOINTS OF THE VARIOUS SIZES OF CAST IRON PIPE.

Diam. of pipe. Ins.	Leadite. Pounds.	Lead. Pounds.
4	2	7
6	3	10
8	4	13
10	5	17
12	6	21
14	7	25
16	8	29
20	10	37
24	12	45
30	15	57
36	18	69

On this basis, assuming the cost of leadite at 10 cts. per pound and lead at 5 cts., lead costs from 1¾ to nearly twice as much as leadite.

Labor costs vary according to the length of pipe laid and the difficulties encountered, but we have found on the average the labor in making leadite joints, including the melting of the material, the preparation and placing of the roll, yarning and pouring the joint, is one-half of the corresponding cost of making lead joints, including the calking, this without making any allowance for the extra cost of inspecting lead joints or for digging bell holes large enough for calking. As an example of what can be done under good conditions, we have had three men yarn, melt and pour 95 joints of 8-in. pipe in one day at a total cost for labor of $6.60, or a cost of 7 cts. per joint. The total cost including leadite was $49, or an average cost per foot of pipe of 4.3 cts. In this case the saving is well over 50 per cent of the cost of making the same joints with lead.

CONCLUSION.

The use of leadite has passed the experimental stage. The excellent results obtained with it, the ease with which it is used, and especially its economy, have been demonstrated. The only question remaining is that of its durability. There seems, however, to be no reason to suppose that it will be less durable than lead. In fact in these days of stray electric currents, it is likely to prove more durable. It would seem to be a material especially well suited for the small water works where it is difficult to secure the services of a calker. Any intelligent laborer can use it with a little instruction and experience. On most work the elimination of the calker —that bane of existence to the superintendent and engineer—would be worth while if it was the only advantage to be obtained.

ACKNOWLEDGMENT.

From paper before annual convention of New England Water Works Association, by Mr. W. C. Hawley, chief engineer and general superintendent Pennsylvania Water Co., Wilkinsburg, Pa.

Methods Employed in the Reforestation of the Croton Watersheds.

(Staff Abstract.)

The first attempt toward watershed reforestation by the Department of Water Supply, Gas and Electricity of the city of New York was made in the spring of 1912. Some of the experiences since gained in this work are here described.

The watershed constituting the source of water supply for the city of New York covers a territory, partially extending into the State of Connecticut, of 362 square miles. Within this and confined to the counties of Westchester and Putnam, the city has acquired and now owns some 22,000 acres, wherein is contained numerous storage reservoirs, lakes and ponds, together with existing streams and other natural sources of water. For the purpose of this article, the land comprising the Catskill domain is not considered. The large quantity of land in excess of that occupied or required for storage purposes, dams and other structural features, afford ample means for safeguarding the surface of the land, the streams, etc., against pollution and other undesirable contingencies and this was, in fact, the primary object of its acquisition. The property comprises divergent localities which form sites and protected areas for reservoirs and otherwise follow and circumscribe numerous streams. There are, therefore, very considerable areas of land upon which to outline and carry on formal forest renewal as a permanent feature of the landscape or for ultimate commercial purposes. In certain localities many trees have been planted on ground within and near the several villages in the watershed and about the dam sites, where conditions permit, and in long stretches adjacent to the public roads. These trees, some of them three years old, are very promising in their growth, reaching a height of 5 ft. or more.

We have used three and four-year-old transplants consisting of White and Scotch pines and spruce, secured from the State Conservation Commission. The cost of the plants for the first two years averaged $4.25 per 1,000, but this spring they were supplied for but 50 cts. per 1,000, the city however, in both cases, paying the expressage.

Close planting is generally recommended for reforesting work, the object being to secure straight stems and reduction in knot wood growth. The plants are certain to grow in open ground, that is by the removal of other surface vegetation. In preparing for planting, we removed the grass and other growth, for a space equal to about 2 sq. ft., at the same time the hole was excavated for planting. Incidentally this served as an additional safe-guard against fire.

The work of planting proceeds as follows: The tree sites having been prepared for the reception of the tree, two men constituting a planting gang go upon the ground, one ready to plant, the other carrying a number of plants in a pail in which a sufficient amount of water is supplied to keep the roots of the plants moistened. From this pail the plant is passed to the man who is to plant the tree. The cost of this proceeding has been 1 ct. per tree, and it has so far proven reasonably satisfactory, since our loss during the three years' experience has been within 15 per cent.

Considering the cost of such work as ordinarily carried on the figures indicate the attainment of considerable labor efficiency, and indicate the handling and planting of from 1,000 to 1,200 plants, according to size, per day by a team of two men. This is considered an average day's work.

The plants at first being cheap it is assumed, apparently, that comparatively superficial work of planting will ensure the growth of a substantial compensating percentage, and therefore it is not worth while to deal interestedly with the individual plant. As to the possibility of properly placing 1,000 to 1,200 plants per day by two men, I have my doubts. In some of these localities, where this kind of enterprise is contemplated, there is a decided handicap facing the plant at the outset in the meagre supply of soil for root covering support. I believe it would pay at a slight increase of cost per thousand, to supply additionally a small quantity of good soil to each plant. It may be impossible to follow out this plan at present, but it is to be borne in mind that any plant whose body structure shows strength and characteristic development and whose roots are full and fibrous, even at the early stage at which the stock is supplied, if properly planted and thereafter given a fair chance, will replace in value a half dozen weakly or otherwise fairly grown ones which have suffered some impairing injury.

However small the plant may be, in placing it permanently in the ground, the excavation should be ample to allow a full spread of the roots. A small supply of good soil conveniently handy to the planter, will enable him to make his work good at little loss of time.

Spring is regarded as the most favorable season for planting, though where a large number of plants are to be disposed of, the work may be successfully renewed in the fall months, until frost. Spring planting has the advantage of preceding the growing season, during which the plant becomes established in the ground. The effect of drouth in the beginning is the most discouraging experience of the young plant, at which time an artificial supply of water if possible is the one thing needful.

Evergreens seem to adapt themselves to most discouraging conditions. The white pine, often growing vigorously in light sandy soil, will respond to good soil in the growth and substance of its timber. It is not adapted to wet ground. On poor soil the Scotch pine, while less attractive in form and habit and not so valuable commercially, grows hardily, being aided in its efforts to thrive under somewhat adverse conditions by its longer penetrating root. In its native country it is regarded as we regard the white pine. Of the spruce, the Norway spruce is to be preferred to the native, and will do best in fairly good soil. It grows, too, better than most cone-bearing trees, in moist ground, and may be used to advantage for under-planting in existing woods. It is, in fact, noted for its hardiness and its adaptability to almost any soil.

The list of trees at present supplied by the state seems to be somewhat restricted. This may have been and is still due to the great demand for plants. It is certain, however, that if variety, sometimes quite desirable, is sought there are in addition to the above named not a few trees that may be used, especially where the less formal and the more desultory manner of planting is possible. The hemlock is a beautiful tree and should not be ignored, despite the fact it is less valuable than most wood, but still profitably available for rough work.

The larch, too, notable for its fine standing timber, is hardy. It grows well in any fairly good soil. Other species of evergreen, including the juniper, of a rather dwarfish tendency of growth in conjunction with stocky low growing underwood, are excellent for the formation of thicket and for the borders of stream and pool, being fine harbor for birds, also, which are to be cared for.

In the matter of tree planting for shade and the ornamentation of our public roads where conditions are consistent, as indeed they mostly may be found, if the engineer in particular will give attention at the outset to so desirable an item of the project of road building as is tree planting, it will be an agreeable duty to see if possible that it is provided as a part of the specifications that trees shall be placed in properly spaced locations, and seasonably planted. Under these conditions, the engineer will experience pleasure in having launched an enterprise which will retain a very effective feature and remain a growing asset in the value of the trees. This can be secured at an almost negligible increase of cost per foot of the whole undertaking.

ACKNOWLEDGMENT.

The foregoing information is from a paper before the annual convention of the New England Water Works Association by Mr. T. C. Culyer, of Purdy Station, N. Y., Engineer in charge of Watersheds and Aqueducts of the New York Bureau of Water Supply.

ROADS AND STREETS

A Method of Reconstruction of Old Macadam Roads.

Contributed by D. Tucker Brown, Civil Engineer, Chapel Hill, N. C.

Throughout the United States during the past half century or more a great many miles of roads have been constructed. The types of construction have been various—brick, concrete, bituminous macadam, waterbound macadam, gravel, sand-clay, and earth, all may be found in the miles of improved roads.

Many miles of water-bound macadam have been built. It was thought at one time that this was the most economical type of construction, but with the advent of the automobile, and subsequent thereto, the deterioration of such roads has been very rapid and has increased materially within the past decade when the motor vehicle has come into such general use.

In some sections organized and well directed maintenance has allayed and prevented the destruction of many miles, but unfortunately there are few counties or states in the South where any attention at all is paid to maintenance; the only work that is done on the roads is spasmodic and directed by someone unqualified and ignorant of the essentials of construction, repair and maintenance of roads.

In about 1903 Guilford County, North Carolina, voted $300,000 for the construction of roads, and built with it about 50 miles of well graded, well drained and well surfaced macadam roads.

During the period on which the roads have been in use maintenance has been badly neglected, and deterioration, although apparently slow at first, is now becoming so rapid that the very foundations of the roads are in danger of being destroyed, leaving nothing but grading as evidence of the one time magnificent system of macadam roads.

This spring (1915) I was employed by the Commissioners of Guilford County for the purpose of solving for them the problem of saving at least a part of the old roads, not by inaugurating a system of maintenance—for it was too late for that—but by reconstructing their old roads in view to bringing them back to a standard at which they can be maintained.

The old roads, in most instances, were metaled 12 ft., and the one to which I refer specifically was that width. It is a link in the capitol to capitol highway, between Washington and Atlanta, and helped to win for Guilford County a $1,000 prize offered by the *Atlanta Journal* for the best piece of road between Atlanta and Washington. This road, the reconstruction of which I shall describe, runs south from Greensboro, N. C., and for a distance of two miles parallels the tracks of the North Carolina Public Service Corporation, as shown in Fig. 1. Upon my recommendation it was decided by the Board of Commissioners to widen the road to 18 ft., cover the foundation with a 2-in. course of Warrenite, using Texaco asphalt of the proper specification as a binder.

It is not necessary for me to describe the details of the surface construction.

The principal problem which arose was how best to save the old macadam and utilize as much of it as possible in the construction of a base for a wider road than the original.

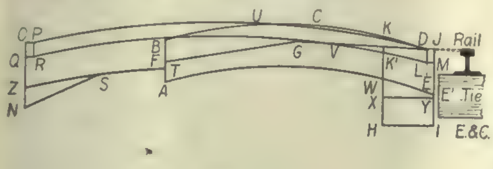


Fig. 1.

I recommended adhering to the old established grades, which were very good indeed, and widening the old base with a narrow strip of concrete 4 ins. in depth on the side next the car tracks, and a wider strip on the other side.

By reference to Fig. 1 the section of the original road was probably as shown in sectional area *A B C D E*, but when reconstruction began, this section was as *A F G D E*.

It is interesting to note not only the amount of wear, but the distribution of it. The section of road away from the car line seems to have had double the amount of traffic as the section adjacent to the car line. The old macadam, in a great many places, had worn down to the No. 1, or large size stone, and especially was this the case on the half of road furthest from the car line; with the above exception, however, it was in first class condition and showed no sign of failing under the weight of a 10-ton roller.

I concluded, after thoroughly testing, that the old macadam, if properly held in place and kept free from water, would make an excellent foundation, and after being satisfied myself of this, proceeded with the construction as follows:

Twenty-one inches from the car line rail I excavated a ditch, averaging 2½ ft. wide and 1½ ft. deep of the cross section of this ditch (referring to Fig. 1), section *W K J E'* was stone (old macadam), and *W E' I H* was earth.

The largest stone taken out of the ditch section was transferred to section *X Y H I*, and the smaller ones were used for concrete.

The object of the large stone was to prevent the seepage of water under the old macadam and to release any that might find its way to the sub-grade through the surface. This stone was tamped rigidly in place, and after being dampened thoroughly was covered with a 1:3:6 mixture of concrete as shown in section *K' L M Y X*. Some of the mortar from this concrete percolated the voids of the large stone below, but the concrete mixture was kept dry enough to prevent the interstices between the large stone being completely filled.

On the side away from the car line earth was taken out as shown by section *Q R B T S N*; the edge *B A* of the old macadam was swept and washed clean as was its surface *F G*.

Section *Q R B T S N* was then filled with 1:3:6 concrete, and this concrete was allowed to extend over the surface of the old macadam filling part of section *B F G*, but it did not extend far enough so as to decrease its thickness sufficiently to prevent it from withstanding the action of the roller.

After the concrete had been laid to grade on either side of the road, section of old macadam, *V K K'*, was picked off, and the small depressions and uneven spots in the old macadam, including that part of section *B F G* that was not filled with concrete, were filled with a binder consisting of 1-in. stone, sand, and about 10 per cent by weight of bitumen.

A header 2 ins. by 4 ins. of 1:2 mortar was floated on the base concrete before it had taken its initial set, see sections *O P Q R* and *D J L M*.

The base was then left to stand about six days, when it was ready for the wearing surface of 2 ins. of Warrenite.

A Foote 10 cu. ft. traction mixer with paving chute was used, and the material was distributed along the old macadam.

Convicts were the only labor used (with the exception of one or two skilled men) and their work proved highly satisfactory.

As much as 1,200 sq. yds. were laid in a day, and the cost of grading, laying base and material was about 35 cts. per square yard, figuring convict labor at $1.25 per day per man.

It is also interesting to note that a large part of the concrete base was laid with burnt shale instead of stone.

The Pomona Terra Cotta Company gave the county all of their refuse, such as broken shale pipe, etc., and I recommended using it in the base, giving as my opinion that it would do as well if not better than stone. I have been thoroughly convinced of its merits, and find that it makes a very hard tough concrete, and the mortar seems to adhere to it much more satisfactorily than it does to the stone.

I believe the pipe and tile companies would do well to investigate the use of their waste products in concrete construction.

The total mileage of Government experimental road at present under construction is 465 miles, according to a recent statement from the U. S. Department of Agriculture. These roads are situated in 28 counties of 13 states and are being built under the supervision of the department under authorization of the 1912 law which appropriated for the Post Office Department $500,000 to be expended in an experiment to test the value of improved rural carrier routes.

Means for Traffic Regulation in Detroit.

(Staff Abstract.)

A circular area one mile in diameter in the central portion of the city of Detroit, Mich., is under special restrictions as regards traffic movement. The means adopted because of their detail are interesting.

One is painting on the street pavement safety zones, crosswalks, automobile parking spaces, and the angle that the machines shall make with the curb while standing on the streets. At all the important crossings white lines extend from curb to curb, inclosing spaces which are usually of the same width as the sidewalks. Pedestrians know that they can walk between these lines in safety, provided they themselves are moving in the same direction that the traffic is following for the moment. All traffic on the cross street must halt behind the painted lines until such time as the traffic officer gives the signal to proceed. The public is not allowed to make diagonal crossings at the more important corners, but must follow the safety lines. Extra officers are on duty at these points, during certain hours of the day, to assist the regular traffic officer in directing the people in the use of the safety zones. It is expected that an ordinance will soon be introduced, making it a misdemeanor for pedestrians to cross the streets within the mile circle previously mentioned, except between the painted safety lines.

The usual method of parking an automobile consists in running the car close to the curb and parallel with it. This system requires extra space between cars in order that the drivers may get back into the street without moving the cars immediately in front or behind. Notwithstanding the disadvantages of this system it seems to be the only one feasible for narrow streets. In the wide streets of Detroit the angle system of parking cars prevails, however. Lines are painted on the street to indicate the angle (usually 45°) that the car must make with the curb, and also to indicate the limits of the parking space. This permits the maximum number of cars to be parked in a given space, with the least danger and inconvenience to the driver when he takes his car out.

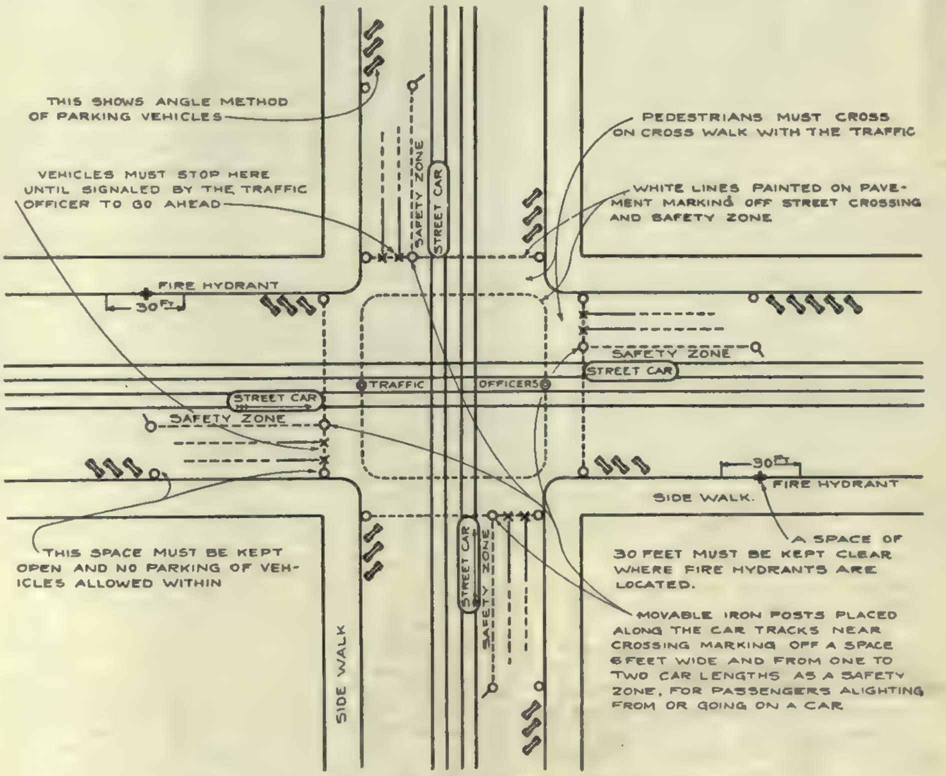

THIS SHOWS ANGLE METHOD OF PARKING VEHICLES
VEHICLES MUST STOP HERE UNTIL SIGNALED BY THE TRAFFIC OFFICER TO GO AHEAD
PEDESTRIANS MUST CROSS ON CROSS WALK WITH THE TRAFFIC
WHITE LINES PAINTED ON PAVEMENT MARKING OFF STREET CROSSING AND SAFETY ZONE
SAFETY ZONE
STREET CAR
FIRE HYDRANT
30 FT.
SAFETY ZONE
STREET CAR
TRAFFIC
OFFICERS
STREET CAR
SAFETY ZONE
30 FT.
FIRE HYDRANT
SIDE WALK.
THIS SPACE MUST BE KEPT OPEN AND NO PARKING OF VEHICLES ALLOWED WITHIN
A SPACE OF 30 FEET MUST BE KEPT CLEAR WHERE FIRE HYDRANTS ARE LOCATED.
STREET CAR
SAFETY ZONE
MOVABLE IRON POSTS PLACED ALONG THE CAR TRACKS NEAR CROSSING MARKING OFF A SPACE 6 FEET WIDE AND FROM ONE TO TWO CAR LENGTHS AS A SAFETY ZONE, FOR PASSENGERS ALIGHTING FROM OR GOING ON A CAR
SIDE WALK

Fig. 1. General Plan of a Detroit Street Crossing.

(This shows the details of a crossing where two double-track street car lines intersect. The dotted lines correspond to the white lines on the pavement.)

The troublesome problem of the left-hand turn has been solved by requiring all vehicles desiring to turn to the left at a cross street to assume a position in the middle of the street, and at a signal from the officer these vehicles proceed to make the turn before the cross traffic starts.

The problem of evolving a safe procedure for the public in boarding and leaving trolley cars, and at the same time interfering as little as possible with vehicular traffic, is not easy of solution. In a few cities a regulation is in force requiring all vehicular traffic to halt in the rear of a standing trolley car until the car proceeds. This, while insuring the safety of trolley-car passengers in boarding and leaving cars, has brought about a noticeable temporary congestion of traffic at certain points. In most of our larger cities this regulation could not well be enforced, and some compromise must therefore be adopted. In Detroit all trolley cars stop on the near side of cross streets, and at these points safety zones are marked, extending 6 ft. from the outer edge of the lower car step. Although trolley-car passengers are safe while in this space, there are times when it is extremely hazardous to approach or leave the safety zone. When traffic is at a standstill in the direction in which the car is headed, persons can pass freely between the curb and the safety zone; but when traffic is resumed the cars nearest the cross street go on, and others come up and stop to discharge or receive passengers. In the meantime, vehicular traffic is passing in a steady stream between the safety zone and the curb, so that anyone who has not reached the safety zone, but still desires to board a trolley car, must thread his way between the passing automobiles and teams. Likewise, those who wish to transfer at this point must dodge to the curb, or stand in the safety zone with a chance of losing a car. To those who understand the American propensity for "taking a chance," and our equally-marked aversion to losing a car (even if we have to run and board it while it is in motion), there is little doubt as to the procedure followed in the majority of cases.

Residents of Detroit soon become familiar with the traffic ordinances, but for the purpose of instructing the stranger, and as a reminder to the forgetful, various signs are used by the traffic department. Throughout the city signs reading "DANGER: CAR LINE" are posted on the side streets about one hundred feet from the street intersections—the number of arrows on the sign indicating whether the car line is single-tracked or double-tracked. Other signs indicate parking spaces, method of parking, crosswalks, and restricted areas. Most of the signs are located on the sidewalks, close to the curb—the purpose being to keep the street as free from obstructions as possible. A considerable number of those designating safety zones, however, are shown upon circular plates set nearly flush with the surface of the street, as illustrated in Fig. 4.

Automobiles are allowed to pass standing trolley cars wherever the space between the safety zone and the curb permits. In a narrow street a vehicle that cannot pass a trolley car without encroaching on the six-foot safety zone must stop behind the car, because the whole space between the track and the curb is then considered a safety zone while a street car is stationary, and must be respected accordingly.

Traffic officers avoid, as much as possible, the making of arrests and the issuing of court summonses, their chief mission being to direct traffic and educate the public in street safety. Instead of spending their time in making arrests, the officers make note of the ordinance violations. These are checked on a printed tag, which is attached to the car as a warning to the driver. Persistent refusal to comply with the ordinances receives, of course, the more drastic action of arrest and court summons. A police school is maintained for the purpose of instructing men in their duties as officers, particularly those who are to become traffic officers. These men, trained to look after the safety of the public in addition to fulfilling their other duties, are carrying on an educative campaign which bids fair to make the streets of Detroit among the safest in our country.

The preceding description is condensed from an article in the "Travelers' Standard," published by the Travelers' Insurance Co., Hartford, Conn.

The Cost of Loading Bricks Into a Box Car By Means of a Portable Belt Conveyor.

Contributed by A. C. Haskell, 15 William St., New York.

The following observations were made at a large brick manufactory in New Jersey, where common bricks were being loaded into a box car by means of a portable belt conveyor:

The car was on a siding and the bricks were (a) in piles about 30 ft. away; and (b) brought in on small flat cars on an industrial track parallel to and 40 ft. from the siding.

The conveyor was mounted on two wheels of about 4 ft. diameter and was driven by a small motor supported on the frame work. The belt was 20 ins. wide, 20 ft. long and had a speed of 240 ft. per minute. The lower end was 1½ ft. above the ground and the upper end 2 ft. above the car floor and extending about a foot within the car.

One man (1) (Fig. 1) stood at the foot of the conveyor and received bricks, four at a time, passed to him by two others (2) and (3) alternately, from the piles. (1) placed them on the conveyor and (4) and (5), standing in the car at the door, one on either side of the belt, took them off and passed them to (6) and (7) and to (8) and (9) who piled them in the car (Fig. 2).

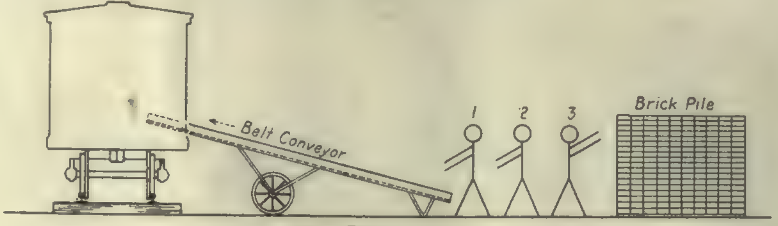


Fig. 1

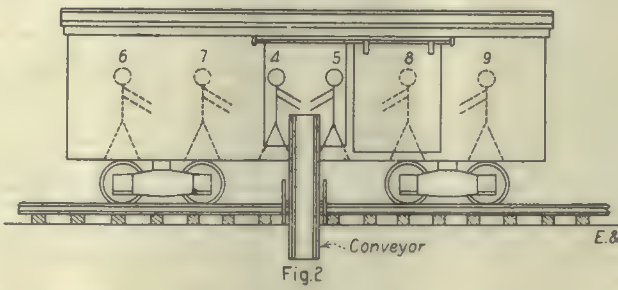


Fig. 2

From the flat Koppel cars which were run in as mentioned above, the bricks were loaded onto wheelbarrows, wheeled to the foot of the conveyor and stacked on four at a time.

The work was very fast and every unit was busy all the time. The only improvement that might have been suggested was that the bricks be placed with more uniformity on the conveyor. Sometimes they were put on in batches of four so close to one another that (4) and (5) could not get them off and they would pile up on the car floor. The foreman should have seen that the bricks were placed on the belt at equal intervals and with such frequency that the men in the car could just handle them.

The following time study was made when loading from the piles:

100 bricks were loaded in 1.07 mins.
102 bricks were loaded in 1.13 mins.
103 bricks were loaded in 1.17 mins.
100 bricks were loaded in 1.30 mins.

405 bricks were loaded in 4.67 mins.

On this basis in an 8-hour day. $\frac{405 \times 480}{4.67}$ = 41,600 bricks would be loaded, which is between three and four car loads. Allowing 45 minutes for shifting the conveyor, etc., the total would be reduced to 37,700.

9 men at $1.75	$15.75
1 foreman at $3.50	3.50
Conveyor at $0.50	0.50
	$19.75

or $19.75 / 37.7 = 52.4 cts. / thousand.

Therefore to load a car with 12,000 bricks, which is about the average, would cost $6.30.

The following time study was made when they were unloading bricks from the flat Koppel cars with wheelbarrows and transporting them to the conveyor:

	Waiting at loading point. Min.	Loading barrow. Min.	Transporting loaded to conveyor. Min.	Unloading at conveyor. Min.	Transporting empty. Min.	
	0.07	0.72	0.12	1.30	0.13	
	0.28	0.70	0.10	1.73	0.08	
	0.07	1.08	0.10	1.65	0.10	
	0.17	1.55	0.12	0.90	0.07	
	0.00	0.67	0.58*	0.78	0.25	
	0.00	0.67	0.22	0.88	0.17	
	0.00	0.82	0.27	1.48	0.26	Total
Av'ge	0.08	0.89	0.22	1.25	0.13	2.57

*Includes delay en route.

The average number of men loading was two, and the average number of bricks loaded was 73. The distance of travel to the foot of the conveyor was 30 ft.

Average speed loaded = 30/0.22 = 136 ft. per minute.

Average speed empty = 30/0.13 = 230 ft. per minute.

On the above basis the total number of bricks handled per day by the three wheelbarrows would be:

$$\frac{480}{2.57} \times 3 \times 73 = 40{,}900$$

Allowing, as before, for time to shift, the number would be 37,000:

2 men loading at $1.75	$ 3.50
3 men transporting at $1.75	5.25
9 men at conveyor at $1.75	15.75
1 foreman at $3.50	3.50
Conveyor at $0.50	0.50
	$28.50

Or at a cost of $28.50/37.0 = 77.2 cts. per thousand, or at the rate of $9.25 per carload.

Route Map of Maryland.—A route map of Maryland showing the principal through roads of the state and connections to points outside has recently been issued by the State Roads Commission. The map is printed on a sheet 28 by 22 ins., folded and enclosed in covers 4 by 6½ ins.—a convenient pocket size. The map shows the state in outline, with the principal cities and towns marked in and with the roads shown in heavy and light black lines, the former indicating improved roads and the latter unimproved roads.

A Demonstration of Gravel Road Construction Using Motor Truck and Road Grader.

Contributed by R. L. Morrison, Professor of Highway Engineering, Agricultural and Mechanical College of Texas.

An interesting feature of the joint meeting of the Texas Good Roads Association, the County Judges and Commissioners' Association, and the Rural Letter Carriers' Association, which was held at the Agricultural and Mechanical College of Texas on Aug. 5 and 6, was the construction of a gravel driveway on the college campus by the White Motor Co. with their White Good Roads truck and White Automatic Dump truck and an Austin Bros. grader. The capacity of the trucks was 4.1 cu. yds. The section of driveway built during the meeting is 515 ft. long, and 125.3 cu. yds. of gravel were used in surfacing. The haul was exactly one mile. The cost of the work was as follows:

Grading:	
Man handling grader 2 hrs. and 50 mins. at 25 cts. per hr.	$ 0.71
Truck driver, 2 hrs. and 50 mins. at 37½ cts. per hr.	1.06
Foreman, 2 hrs. and 50 mins. at 37½ cts. per hr.	1.06
5.22 gals. gasoline at 14 cts. per gal.	0.73
0.50 gals. lubricating oil at 70 cts. per gal.	0.35
Total	$ 3.91
Rolling Sub-grade:	
Truck driver, 45 mins. at 37½ cts. per hr.	$ 0.28
Foreman, 45 mins. at 37½ cts. per hr.	0.28
1.38 gals. gasoline at 14 cts. per gal.	0.19
0.14 gal. lubricating oil at 70 cts. per gal.	0.10
Total	$ 0.82
Loading Gravel:	
Truck driver, 11 hrs. and 35 mins. at 37½ cts. per hr.	$ 4.35
Foreman, 5 hrs. and 30 mins. at 37½ cts. per hr.	2.06
Labor, 105 hrs. at 18¾ cts. per hr.	19.69
Total	$26.10
Hauling and dumping gravel:	
Truck driver, 11 hrs. and 30 mins. at 37½ cts. per hr.	$ 4.30
Foreman, 2 hrs. and 25 mins. at 37½ cts. per hr.	0.91
29.12 gals. gasoline at 14 cts. per gal.	4.08
4.31 gals. lubricating oil at 70 cts. per gal.	3.01
Total	$12.30
Spreading gravel:	
Labor, 14 hrs. and 20 mins. at 18¾ cts. per hr.	$ 2.69
Foreman, 3 hrs. at 37½ cts. per hr.	1.13
Total	$ 3.82
Rolling gravel:	
Truck driver, 4 hrs. and 30 mins. at 37½ cts. per hr.	$ 1.69
Foreman, 4 hrs. and 30 mins. at 37½ cts. per hr.	1.69
8.28 gals. gasoline at 14 cts. per gal.	1.16
0.70 gal. lubricating oil at 70 cts. per gal.	0.56
Total	$ 5.10
Grand total	52.05

SUMMARY.

	Cost for 515 ft.	Cost per cu. yd.
Grading	$ 3.91	$0.031
Rolling sub-grade	0.82	0.006
Loading gravel	26.10	0.208
Hauling and dumping gravel	12.30	0.098
Spreading gravel	3.82	0.031
Rolling gravel	5.10	0.041
Total	$52.05	$0.415

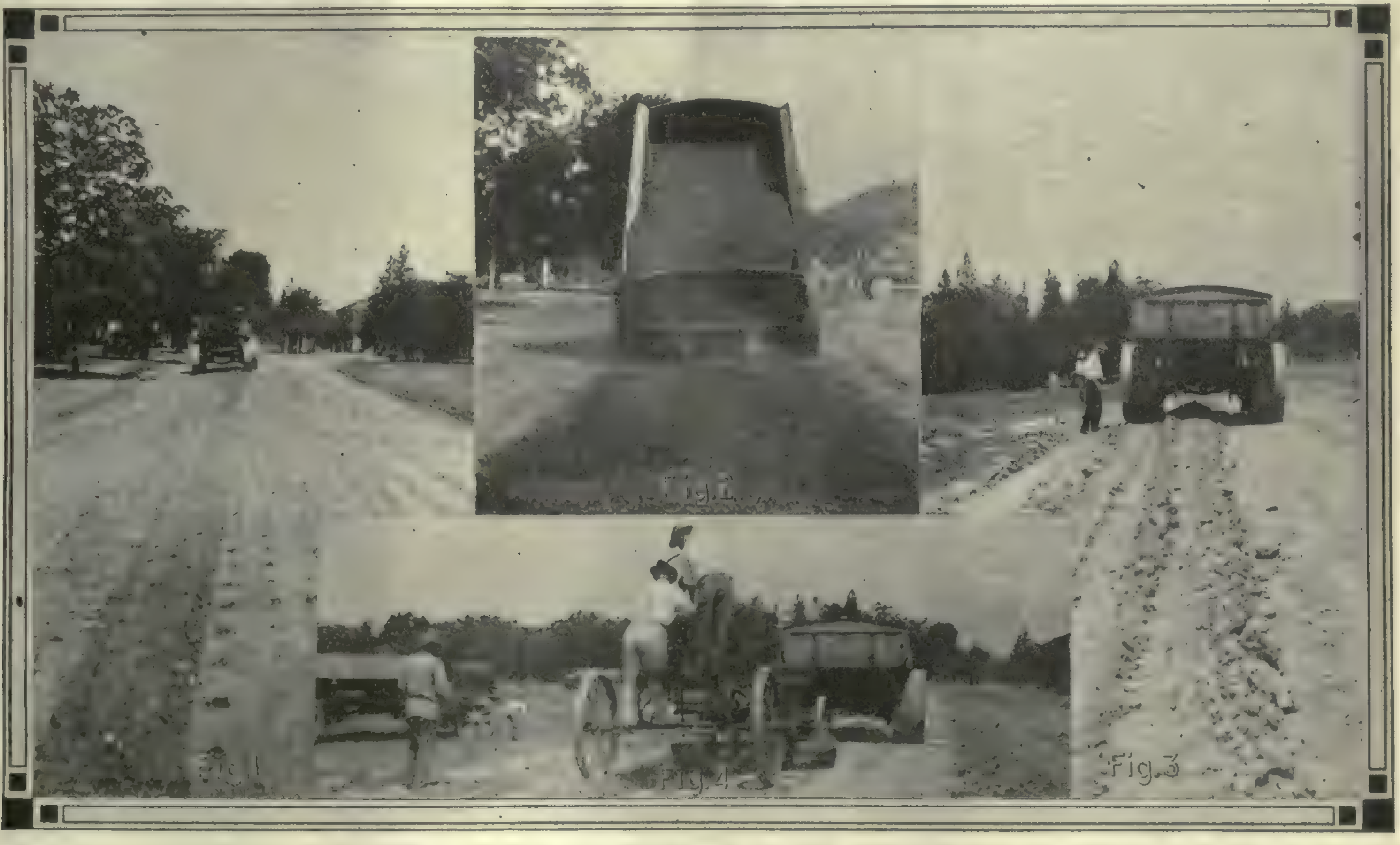
The cost of loading gravel was excessive, as the loading gang was idle while the truck was away, and under ordinary working conditions an unloader of some kind would, of course, be used. Also in event of ordinary road construction work more trucks would be used and, while the loading gang would be kept busy continually the cost per day would not be greater, therefore the yardage cost of loading would be considerably lessened.

The cost of spreading gravel was also excessive, as the laborer doing the spreading was idle much of the time.

It is hard to estimate very closely the cost of grading and rolling on a small job like this, assuming that teams and a steam roller are to be used, but the cost would probably be about the same as with the trucks. The cost of hauling, however, can be very closely estimated, and with teams costing $4 for an 8-hour day, it would be about 28 cts. per cubic yard. This shows a saving of about 18 cts. per cubic yard in favor of the truck for the one mile haul, and the amount saved would, of course, increase with the length of haul.

To get the net saving it would be necessary to figure the interest on the investment, depreciation, taxes and insurance, and these would vary with the number of working days in a year, the number of miles per day, and other local circumstances.

In this instance the motor truck performed all the operations usually done with teams and roller; that is, it acted as a tractor for pulling the graders, hauled the gravel from the cars to the road, spread the gravel in a practically uniform layer, and, with the broad surface tractor wheels, did the necessary rolling.



A Demonstration Gravel Road Construction Outfit.

Fig. 1—Motor Truck Hauling Gravel. Fig. 2—Motor Truck Spreading Gravel. Fig. 3—Motor Truck Rolling Gravel. Fig. 4—Motor Truck Hauling Grader.

Bitumen Deposit in Honduras.—There has been discovered in Honduras, on the west coast, in the vicinity of Juticalpa, a deposit of remarkably pure bitumen, or asphalt. Prospects uncovered for over 150 yards show the bed to be of great purity, and there are outcroppings for several miles. The discovery was made by an American citizen, resident in Honduras, who has the control of the property, says a report of a U. S. consul. It is considerably distant from the Pacific port of Amapala, which will have to be the port of shipment, but is on the line of a new model road the government of Honduras is preparing to construct, so that motor transportation will soon be available, and it is not greatly distant from the logical line of the contemplated railroad from Amapala to the interior of Honduras. There are over 15,000 acres in the tract that is controlled by the man who discovered the deposit.

Automobile-Tire Shortage in Sweden.—The situation of the automobile traffic in Stockholm is becoming worse daily because of the inability to get tires, according to a consular report. In Stockholm there are 336 taximeters, most of which belong to persons who own one or two automobiles. The largest company is the Taximeter Co., owning 25 automobiles.

BRIDGES

Design Features of the Alger Bridge, Columbus, Ohio,—A 1,166-ft. Reinforced Concrete Structure.

(Staff Article.)

The Alger Bridge, the design features of which are covered in this article, will span Alum Creek and the adjacent lowlands in Franklin Co., Ohio, the site being about 5½ miles northeast of Broad and High Sts., in the city of Columbus. It is a reinforced concrete structure with a total length of 1,166 ft. and an overall width of 27 ft. 2 ins. The bridge consists of a series of arch spans of varying lengths, with three small trestle approach spans at the west end and three similar spans and curved retaining wall approaches at the east end. Beginning at the west end of the bridge the lengths of the various spans are as follows: Three 10-ft. 2-in. spans supported on columns; ten arches having clear spans as follows: 67 ft. 8 ins., two at 90 ft. 8 ins., 113 ft. 8 ins., two at 136 ft. 8 ins., 113 ft. 8 ins., 102 ft. 2 ins., 90 ft. 8 ins., and 44 ft. 8 ins.; three 10-ft. 2-in. spans on columns; and curved retaining wall approaches. With the exception of the retaining walls and 10-ft. 2-in. spans at the east end, all piers and abutments are supported on wood pile foundations. The bridge has a 20-ft. clear roadway and a 4-ft. sidewalk, the latter being cantilevered from the north side. The use of curved retaining walls at the east end is due to the fact that the road on which the bridge is located terminates in another road within a few feet of the east end of the structure. Figure 1 shows a general elevation and half plans of the bridge.

GENERAL DESIGN FEATURES.

Floor System and Arches.—The bridge is so designed that all spandrel beams are of the same length throughout the structure. The floorbeams, which are spaced 11 ft. 6 ins on centers, are framed into spandrel columns, the distance between floorbeams being spanned by 12-in. slabs. There are no stringers, except a shallow one at the outside edge of the sidewalk, which was provided for the double purpose of supporting the sidewalk slab and of improving the appearance of the bridge. The floor system was designed for simple and economical construction in the field, and the sides of the floorbeams and the inside faces of the sidewalk stringers and fascia beams are beveled ¾ in. per foot, to allow the forms for the beams and slabs to be readily removed in units and again used.

Each arch consists of two ribs spaced 20 ft. on centers. At the crown the various arches have a less depth than width, as it was found advisable to use such a section to provide

cross sections of the arches at the crown vary from 25x34 ins. for the 67-ft. 8-in. span to 39x42 ins. for the 136-ft. 8-in. spans. In computing the temperature stresses it was assumed that any rise in temperature would be balanced by the rib shortening under dead load, and the effect of a rise in temperature was therefore neglected. A drop in temperature of 25° F. was assumed and combined with a rib shortening equivalent to a drop in temperature of 25° F., making a total drop of 50° F. The arch rings were designed according to the method given by Turneaure and Maurer.

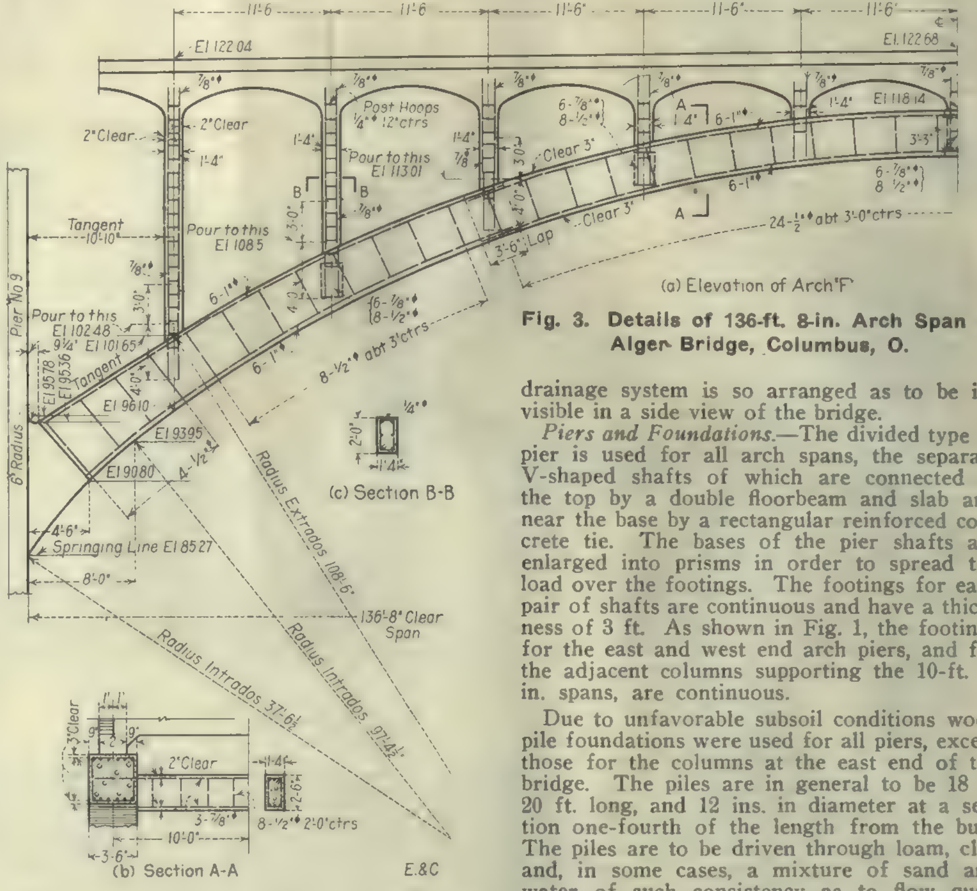


Fig. 3. Details of 136-ft. 8-in. Arch Span of Alger Bridge, Columbus, O.

The matter of expansion was given special attention in the design. The horizontal sliding surfaces have been reduced to a minimum, and surfaced steel or steel and bronze expansion plates have been used wherever horizontal sliding surfaces do occur. The vertical sides of all beam and stringer bearings are beveled, in order that the expansion joints

ever contraction and expansion take place. Expansion in the railings was also carefully considered, and in the design adopted there are only a few small vertical sliding surfaces and no horizontal sliding surfaces.

Scuppers are so placed that water will not flow over an expansion joint before reaching the inlets. The storm water is carried through 6-in. cast iron pipe to a point about 10 ft. above the ground and there discharged. The drainage system is so arranged as to be invisible in a side view of the bridge.

Piers and Foundations.—The divided type of pier is used for all arch spans, the separate V-shaped shafts of which are connected at the top by a double floorbeam and slab and near the base by a rectangular reinforced concrete tie. The bases of the pier shafts are enlarged into prisms in order to spread the load over the footings. The footings for each pair of shafts are continuous and have a thickness of 3 ft. As shown in Fig. 1, the footings for the east and west end arch piers, and for the adjacent columns supporting the 10-ft. 2-in. spans, are continuous.

Due to unfavorable subsoil conditions wood pile foundations were used for all piers, except those for the columns at the east end of the bridge. The piles are in general to be 18 to 20 ft. long, and 12 ins. in diameter at a section one-fourth of the length from the butt. The piles are to be driven through loam, clay and, in some cases, a mixture of sand and water of such consistency as to flow quite readily. The maximum load per pile is 20 tons, this load being based on the results of borings, test holes and test piles. The following data give the results of a test hole dug near pier No. 7 (see Fig. 1): First, about 5 ft. of loam; then water and about 5 ft. of gravel; then a bed of fine sand and water of such consistency as to flow quite readily, this bed having a depth of about 15 ft. and underlaid with gravel. In digging another test hole near pier No. 11 the following ma-

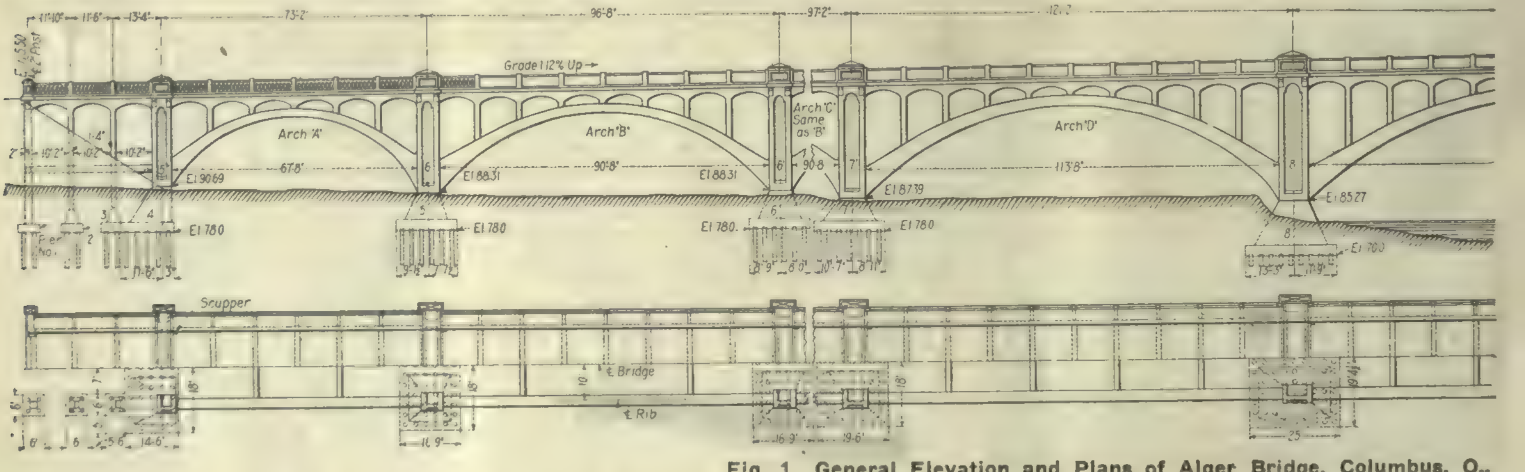
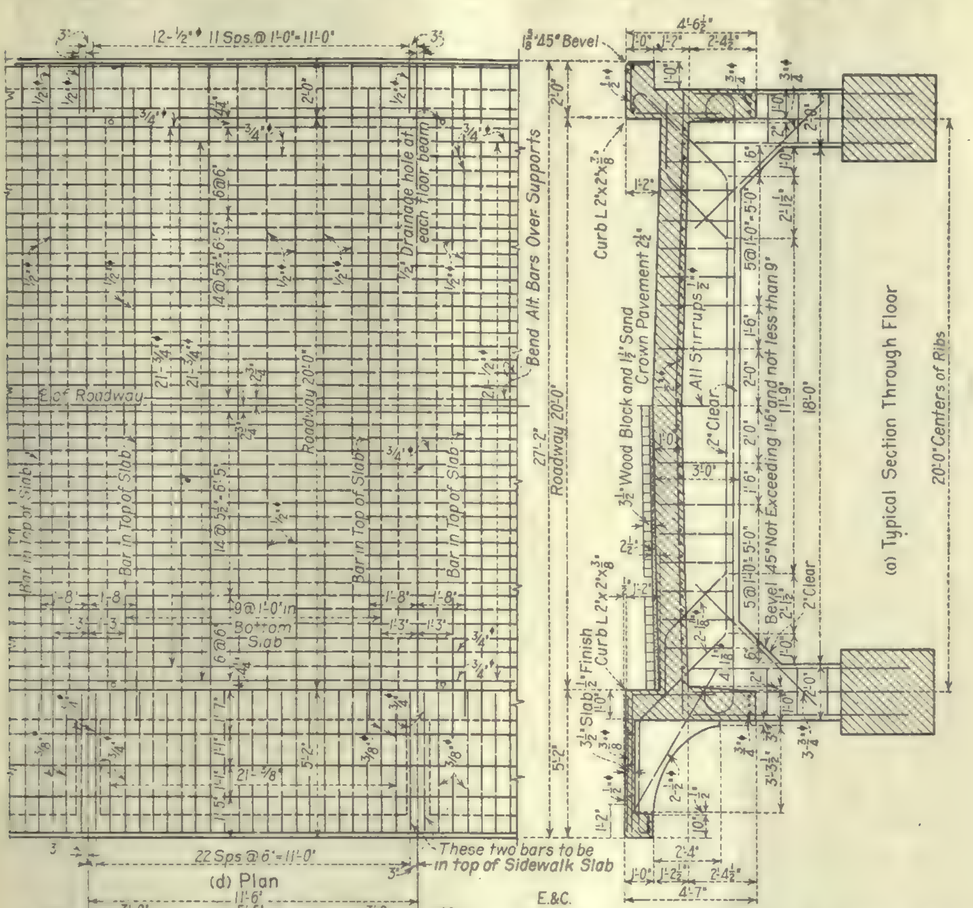


Fig. 1. General Elevation and Plans of Alger Bridge, Columbus, O.,

of loam; then water in a small quantity and 7 ft. of gravel; then a fine, blue clay, this clay stratum being about 6 ft. thick and underlaid with sand.



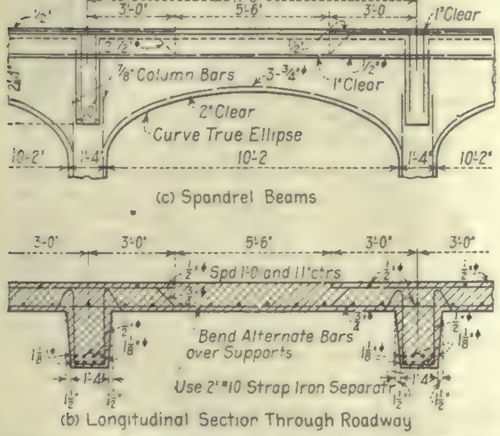


Fig. 2. Typical Panel of Floor System of Alger Bridge, Showing Details of Floor Slab Spandrel Beam, Sidewalk Bracket and Floorbeam.

Loads and Allowable Stresses.—For the floor and its supports a uniform load of 200 lbs. per square foot on the roadway and 100 lbs. per square foot on the sidewalks was used, each with 25 per cent impact; or a concentrated load on the roadway consisting of a 24-ton truck and a uniform load of 100 lbs. per square foot on the sidewalks, each with 25 per cent impact. For the arch rings and foundations a uniform load of 100 lbs. per square foot on both roadway and sidewalk was used, each with 25 per cent impact.

The allowable stresses used in the design were as follows: Concrete in compression, 650 lbs. per square inch, except in arch rings where 700 lbs. per square inch (including rib shortening and temperature) were allowed; shear in concrete, 50 lbs. per square inch; steel in tension, 16,000 lbs. per square inch; steel in compression, not more than 15 times that used for concrete.

Concrete Proportions.—For the footings the crete proportions are 1 part cement, 2 parts Canadian sand, and 4 parts of ¼-in. to 2-in. broken limestone. For arch rings, columns, beams, slabs, piers, braces and walls the concrete proportions are 1 part cement, two parts Canadian sand, and 4 parts of ¼-in. to 1-in. broken limestone. For the railings the cast concrete consists of 1 part cement, 2 parts Canadian sand, and 1 part silica gravel, ¼-in. to ⅜-in. in size.

Concrete Finish.—The exposed surfaces of all arches, piers, spandrel posts, beams and abutments are to be finished by rubbing in a thin mortar with carborundum brick. Panels in the outside faces of the piers are to be bush-hammered.

DETAILS OF DESIGN.

Floor System.—As has been noted, a uniform spacing of spandrel beams is maintained throughout the structure. Except at points directly over the piers the floorbeams are spaced 11 ft. 6 ins. on centers; at the piers double floorbeams, connected by a short span of slab, are used to conform to the U-shaped pier shafts. Figure 2 (a) is a typical cross section of the floor showing an elevation of a floorbeam. These floorbeams have a depth at the center of 36 ins. and a width varying as shown in Fig 2 (b), to facilitate the removal and re-use of the forms.

The spandrel beams are curved as shown in Fig 2 (c), which together with Fig. 2 (a) give details of their construction and reinforcement.

As shown in Fig. 2 (a) the sidewalk is cantilevered beyond the arch rib and is supported on brackets placed at each floorbeam. Figures 2 (a) and 2 (c) give details of these brackets.

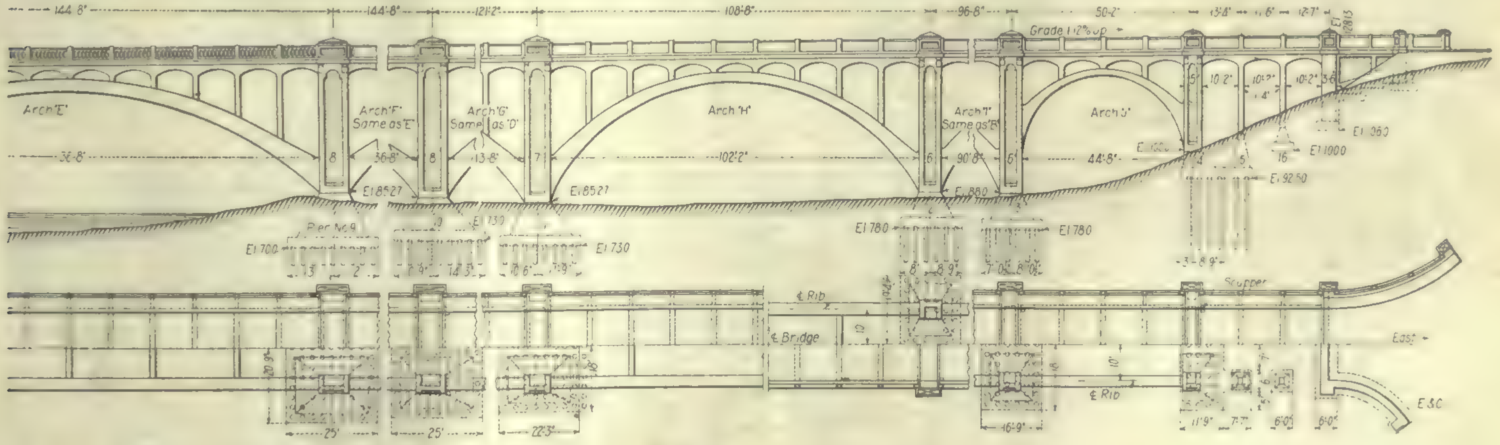
The reinforced concrete floor slab has a depth of 12 ins. and a clear span of 10 ft. 0½ in. Details of a typical panel of the floor slab are shown in Figs. 2 (a), 2 (b) and 2 (d):

Arch Rib Bracing and Spandrel Columns for 136-Ft. 8-In. Span.—Each arch rib of the 136-ft. 8-in. spans has a width at the crown of 42 ins. and a depth of 39 ins. This width is maintained throughout the arch, but the thickness of the arch increases gradually toward the haunches, as shown in Fig. 3 (P. 206). The arch is two-centered, the portion of the intrados extending from the spring line (for a horizontal distance of 8 ft., having a radius of 37 ft. 6½ ins.) while the remainder of the intrados has a radius of 97 ft. 4½ ins. The extrados is single-centered, with its end portions (for a horizontal distance at each end of 10 ft. 10 ins.) tangent to the extrados curve, which has a radius of 108 ft. 6 ins.

At the center of the arch, and at alternate spandrel columns, the arch ribs, which are spaced 20 ft. on centers, are connected by reinforced concrete ties having a cross section of 16x30 ins. Details of these ties are shown in Fig. 3 (b).

At the crown the spandrel beams spring directly from the arch rib; at other points along the arch these beams are supported on spandrel columns of varying lengths. These columns have a thickness of 16 ins. and a width of 24 ins. and are reinforced as shown in Fig. 3 (a).

Expansion joints in the floor occur at each pier. By means of double floorbeams, which with their gusset ends are made a part of the U-shaped pier shafts, the pairs of shafts are



Showing General Dimensions and Types of Structure.

braced together. These double floorbeams carry a short section of floor slab, the span of which varies according to the width of pier. The construction for pier No. 9 (which is an 8-ft. pier) is similar to that shown in Fig. 5, which gives detail for the top portion of the 5-ft. piers Nos. 4 and 14 (for location see Fig. 1). Figure 5 (a) is a plan of this divided pier; Fig. 5 (b) is an elevation of it; Fig. 5 (c) is a cross section of the double floorbeams and slab, showing the recess for the ends of the floor slabs of adjacent spans; and Fig. 5 (d) is a north elevation of the pier.

The following are the quantities of materials used in the construction of a 136-ft. 8-in. span:

Concrete in two arch ribs and rib struts, cu. yds.	169.2
Steel in arch ribs, rib struts, and spandril posts, lbs.	16.593
Concrete in arch deck between expansion joints and in spandrel columns, cu. yds.	186
Steel in arch deck between expansion joints, lbs.	25,614
Total area of rubbed finish to face of piers, sq. ft.	2,930

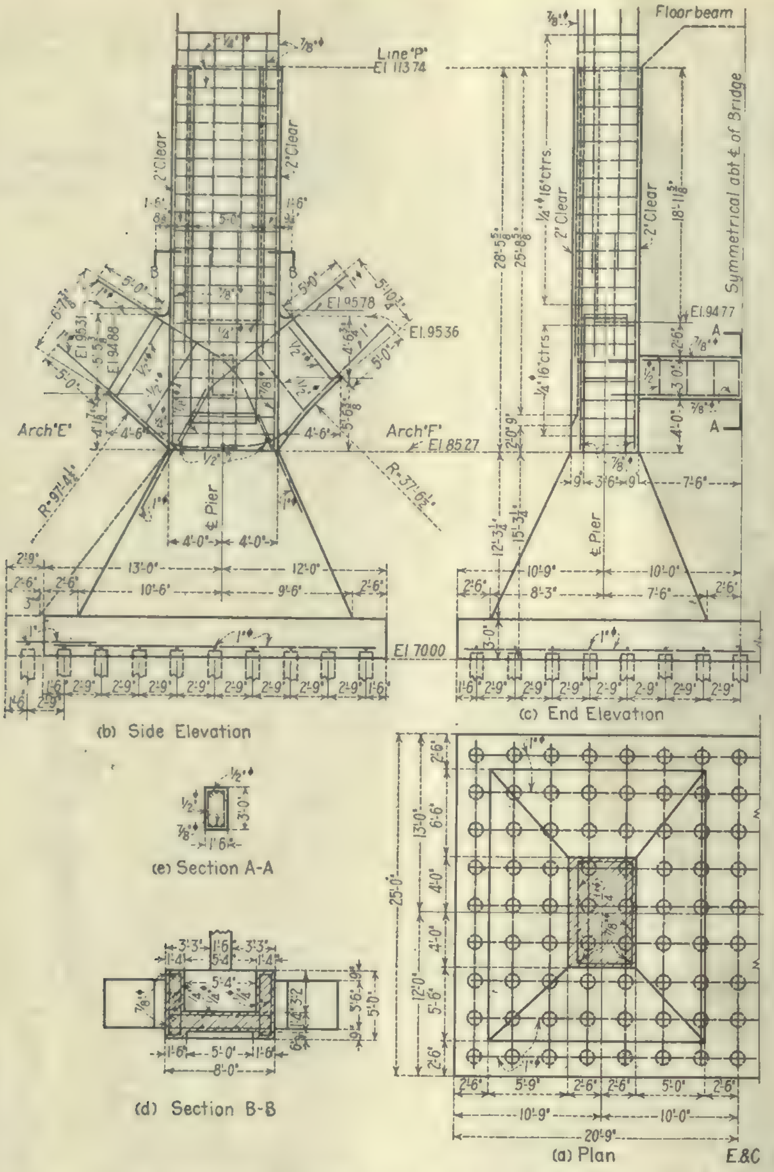
Pier Shafts and Footings for Pier No. 9.—The two U-shaped pier shafts for pier No. 9 (and for all other piers) rest on a continuous footing. For pier No. 9 this footing has a length of 25 ft., a width of 41 ft. 6 ins., and a thickness of 3 ft. Details of this footing are shown in Fig. 4 (a). The footing is supported on 135 wooden piles, arranged as shown in the drawings.

The pier shafts rest on pedestals, the details of which are shown in Figs 4 (a), 4 (b) and 4 (c).

The pier shafts are U-shaped, with extreme dimensions of 5 ft. x 8 ft. Figures 4 (b) and 4 (c) are end and side elevations, and Fig. 4 (d) is a cross section of these pier shafts. These drawings give the principal dimensions and show reinforcing details.

By referring to Fig. 4 (c) it will be noted that the pier shafts are connected by a reinforced concrete tie, the bottom of which is 4 ft. above the pedestal. This tie has a cross section of 18x36 ins., as shown in Fig. 4 (e).

Concrete Railing.—Between the railing posts, which are spaced 11 ft. 6 ins. on centers, there are paneled sections of the railing. The posts are 12x14 ins. in section and project 3 ft. 8 ins. above the curb, while the railing has a web thickness of 4 ins. and projects 3 ft. 6 ins. above the curb. Figure 6 shows de-



(b) Side Elevation

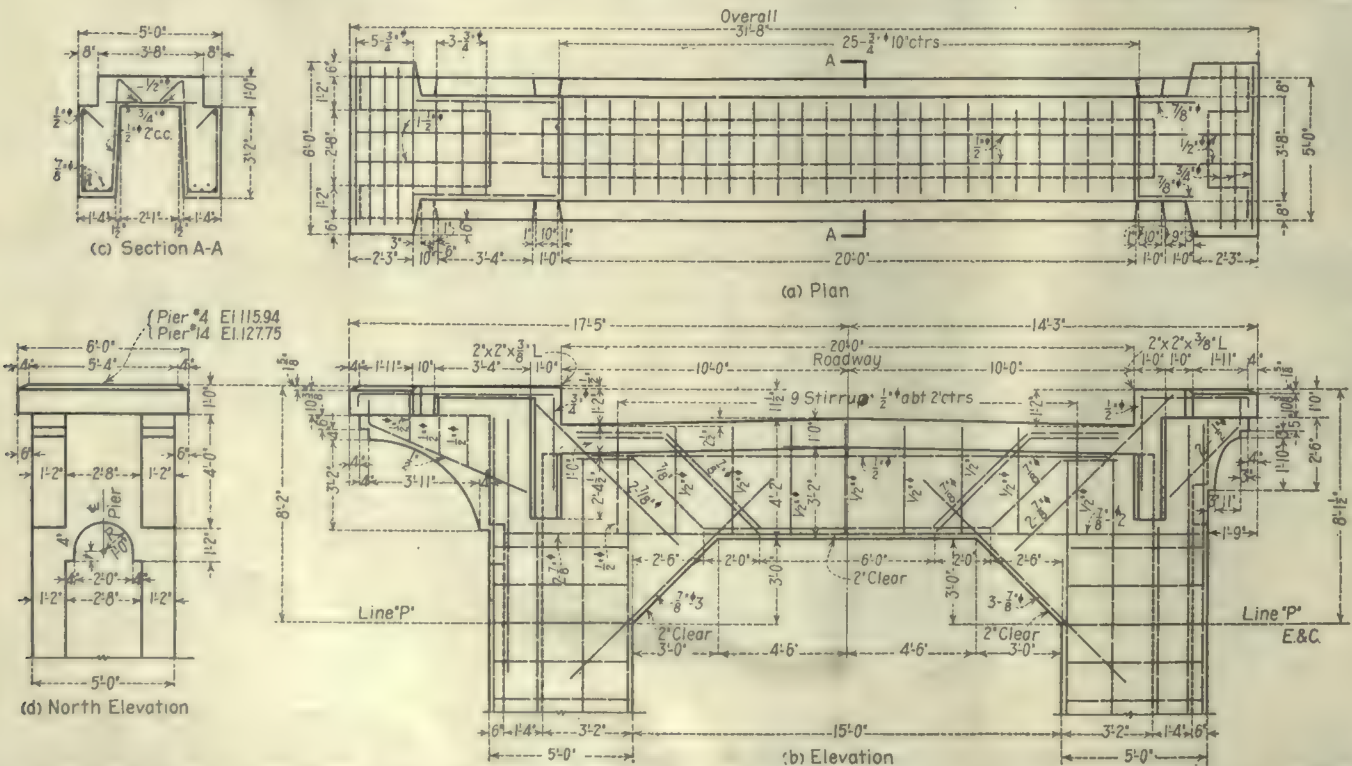
(c) End Elevation

(e) Section A-A

(d) Section B-B

(a) Plan

Fig. 4. Details of Pier Shafts and Footings of Pier No. 9 of Alger Bridge. This Pier Carries Ends of Two 136-ft. 8-in. Arch Spans.



(c) Section A-A

(a) Plan

(d) North Elevation

(b) Elevation

Fig. 5. Details of Upper Portion of Divided Piers, Nos. 4 and 16 of Alger Brigde, Columbus, O. Other Piers are Similar.

tails of a panel of the railing and of the construction over the piers.

ACTUAL QUANTITIES OF MATERIALS.

The following quantities of material were computed and estimated from the completed plans:

Dry excavation, cu. yds.	2,501
Wet excavation, cu. yds.	2,323
Wooden piling, lin. ft.	20,502
Concrete in footings (1:2:4 mix, ¼-in. to 2-in. stone), cu. yds.	991.8
Concrete in retaining walls above footings and in solid portions of arch piers (1:2:4 mix, ¼-in. to 1-in. stone), cu. yds.	1,169.7
Concrete in spandrel posts, trestle posts, hollow portions of arches, piers, sidewalks, deck and pier struts (1:2:4 mix, ¼-in. to 1-in. stone), cu. yds.	1,945.8
Concrete in arch ribs and rib struts (1:2:4 mix, ¼-in. to 1-in. stone), cu. yds.	1,004.3
Reinforcing steel, lbs.	409,800
Concrete railing, lin. ft.	2,322.8
Curb and finish angles, lbs.	12,132
Bush-hammering finish, sq. ft.	2,600
Rubbed finish, sq. ft.	30,000
Sidewalks finish, sq. ft.	5,240
Rolled steel expansion plates, lbs.	8,473

In addition to the above the following items are included: Cofferdams, sheeting and pumping; scuppers and 6-in. tile drains; conduits, fuse boxes; name plate; and ⅛-in. phosphor-bronze expansion plates.

PERSONNEL.

The bridge was designed by E. P. Knollman, Assistant County Surveyor, Franklin County, Ind., under the supervision of Walter Braun, County Bridge Engineer; John Peake is County Surveyor. The design was checked by Wilbur J. Watson & Co. We are indebted to Mr. Knollman for the data upon which this article is based.

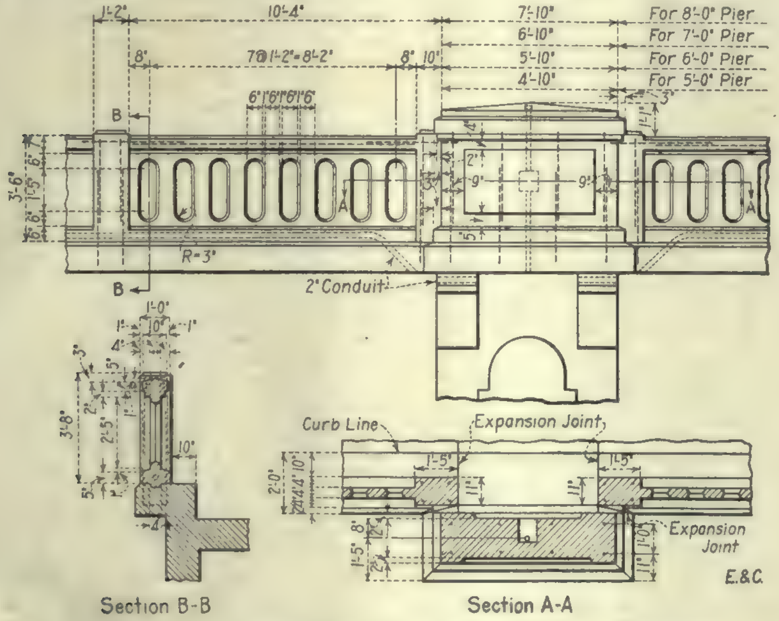


Fig. 6. Details of Concrete Railing of Alger Bridge, Columbus, O.

Raising a Concrete Girder Bridge with Screw Jacks.

Contributed by W. R. Mason, Arlington, N. J.

The following data refer to the methods and equipment used in raising a concrete girder bridge about 5 ft. The bridge consists of eight spans supported on concrete piers and is located over the Bical River in the province of Ilocos Sur, Philippine Islands. Each span consists of five longitudinal girders. The reconstruction work was started during the summer, at which time the river was dry. In raising the bridge screw jacks were employed, with timber braces bearing on the bed of the river.

PRELIMINARY WORK.

Preparatory to the actual work of raising the spans the river bed at the site was cleared of large, loose stones, and rows of 12x12-in. timbers, about 20 ft. long, were leveled on the ground to carry the necessary blocking. The jacks, which were 3 ft. long and were provided with 3-in. screws, carried working blocks directly on top of the jacks and just below the girders. These jacks were placed under each outside and middle girder, at points 40 ins. from each pier or pile cap. At the intermediate girders, Nos. 2 and 4, the jacks were placed at points 5 ft. from the piers. Before using, the jacks were well lubricated with ordinary axle grease and a little engine oil.

RAISING THE SPANS.

When everything was in readiness the jacks were tightened to bearing, each jack being manned by two strong laborers. The boss carpenter was in immediate charge of the gang. When one end of the span had been raised an inch, work was started at the other end and it was raised a like amount. The top of the bridge was then inspected to ascertain whether the girders were tending to slip past the abutting girders of the next span and whether the position of the outside curb line showed any appreciable tendency to tilt sideways. If the latter condition obtained the jacks on the side which jutted out were raised a sufficient amount to bring the span back in line, while if the ends of the girders were binding against the next span all of the jacks were turned up a little more. When the girders had been raised 2 ins. above the pier at one end, 2x4-in. blocking was placed under them. This process was repeated until the jacks had been turned up about 10 ins., in increments of 2 ins. The jacks were then released, screwed down, and more blocking inserted. After the girders had been raised another 10 ins. another set of blocking was added and the process repeated until the girders had been raised the required amount. The careful procedure followed greatly reduced the liability to buckling of the jacking equipment or to stripping of threads, due to eccentricity of loading. The most careful inspection was made at each 2-in. interval to make sure that the spans were being raised evenly.

SUPPORTING SPANS TEMPORARILY AND CONCRETING PIERS.

Before removing the jacks, posts were placed at each end of the span; thin wedges were then inserted at their tops, and the load transferred to the posts. These temporary supports consisted of 12x12-in. x 40-ft. sills, on which were placed 10x10-in. posts. Cross bracing was spiked to the posts on both sides, and longitudinal bracing was also provided.

The piers were concreted through holes cut in the slabs at their ends. The concrete was brought up to the underside of the girders, which had been set a trifle above the new grade to allow for the shrinkage of the concrete. When the concrete had set for three days the wedges were knocked out, and the spans brought to bearing on the new concrete.

The placing of the blocking and jacks required about a day for each span, and it required about half a day to start the span and raise it. The work was completed in about eight weeks.

Specifications for Waterproofing Solid Steel-Floor Railroad Bridges.

(Staff Abstract.)

In our issue of Jan. 27, 1915, we published a set of specifications for waterproofing solid steel-floor railroad bridges, proposed by Samuel Tobias Wagner. These specifications were open to discussion, and since their publication originally in the Proceedings of the American Society of Civil Engineers they have received much comment. After considering pertinent discussion from various sources Mr. Wagner has revised these specifications, and we herewith present the revised specifications in full, as published in the Proceedings of the American Society of Civil Engineers, Vol. XLI, p. 1503.

PART I.—DETAILS OF CONSTRUCTION.

1. *Depth.*—The depth of steel or concrete construction shall be such as to allow a sufficient distance from top of rail to top of steel or concrete floor for proper waterproofing and protection from the cutting action of the ballast. Under ordinary conditions, a depth of from 3.5 to 4.0 ft. from top of rail to clearance line below is sufficient.

2. *Drainage Grade.*—Provision shall be made for grades of at least 1 per cent on the floor of the bridge, to remove water promptly. Where this cannot be done in the steelwork, cement concrete, with a minimum thickness of 2½ ins., shall be placed so as to drain the water to the inlets.

3. *Inlets.*—Cast-iron inlets, with flanges embedded in the concrete shall be set at points not beneath the tracks where shown on the plans, and shall be provided with movable top grates. The down-spout from each inlet shall be provided with a trap and clean-out, which shall be accessible from below the bridge. The down-spout shall be of wrought iron, and connected to a sewer or arranged according to local conditions.

4. *Details of Steelwork.*—Where two longitudinal girders meet over a column, the end stiffeners shall be placed with the outstanding leg toward the center of the girder, and the girders shall be connected with ⅜-in. plates on each side of the web. A plate shall also be placed covering the joint on the top flange.

5. Stiffening angles on the outstanding edges of gusset plates in half-through or through girders shall be terminated below the level of the waterproofing, the gusset plates shall be heavier than usually designed when stiffening angles extend the full length of the plate, and shall be placed from 10 to 12 ft. apart.

6. Where the top of girder approximates the same height as top of rail, the waterproofing and protection shall cover the entire top of the girder.

7. The apron-plate from the steel floor over the back-wall shall be provided with a curb angle against which to finish the waterproofing, and to this angle shall be riveted a vertical plate to prevent dirt from collecting under the apron-plate. The apron-plate shall be anchored to the back-wall.

8. *Waterproofing—General Design.*—On top of the prepared surface of the concrete shall be placed either of the following:

1. One or more thicknesses of felt or fabric, of quality and applied as specified hereafter, together with proper protection.
2. Asphalt mastic at least 1½ in. in thickness, of quality and applied as specified hereafter.

9. *Felt or Fabric.*—When waterproofing of this kind is to be used, either of the following types shall be adopted:

1. From four to six layers of felt.
2. One middle layer of treated cotton fabric, with four layers of felt.
3. One layer of felt, two layers of treated cotton fabric, and two layers of felt.

4. One middle layer of treated cotton fabric, and two layers of asbestos felt.

5. Either one, two, or three layers of treated cotton fabric.

10. *Protection of Waterproofing.*—After the completion of the felt or fabric waterproofing, the entire surface shall be covered and protected by one of the following methods:

1. Straight, hard-burned brick laid flat, with joints filled either with waterproofing compound or cement grout; waterproofing compound should only be used as a filler on flat or nearly flat surfaces.

2. A layer of cement concrete from 2 to 2½ ins. thick, with wire reinforcement.

3. A layer of about 1½ ins. of asphalt mastic used only on top of asbestos felt. It is believed that no protection is necessary for the asphalt mastic.

11. *Special Drainage Over Protection.*—On top of the protection coat, and outside the line of the ties, a line of half-round cast-iron pipe, 6 ins. in diameter, and perforated frequently, shall be placed to collect the water and convey it to the inlets.

PART II.—PREPARATION FOR WATERPROOFING.

12. *Preparation of the Steel.*—All openings in the steelwork shall be closed, either by caulking with burlap dipped in hot asphalt, by the use of cement mortar, or by the use of sheet metal sufficient to retain the concrete base before applying the burlap and mastic.

13. *Preparation for Waterproofing Materials.*—Wherever called for by the plans, the decks of the bridges shall be protected with 1:3:5 concrete, with ¾-in. stone or gravel, mixed as specified hereafter, finished with a 1:2 mix of cement mortar, ½ in. thick, troweled to a smooth surface on top, as shown. This concrete shall be allowed to dry thoroughly so as to prevent the formation of steam when the hot waterproofing materials are applied.

14. All vertical or sloping surfaces of concrete or steel shall be thoroughly cleaned of dust, dirt, loose particles, paint, and grease. The use of hand-bellows is recommended for cleaning loose dust and dirt from the surfaces. For cleaning paint and grease from the steel, and freshening the surfaces of asphalt, where a junction of old and new is to be made, or where a pocket of pure asphalt is used against the girders and the felt or mastic, gasoline shall be used, either by swabbing the surface with it, or by pouring a small quantity over the surface to be cleaned and setting fire to it. The use of a blow-lamp is also recommended.

15. These surfaces shall then be painted with two coats of approved asphalt, diluted with gasoline. The materials of the first coat shall be proportioned so as to give a brownish tint. The second coat shall have a larger quantity of asphalt.

16. Both coats of paint shall be thoroughly applied and worked into the surfaces, so as to give a uniform coating of the asphalt.

17. Paint shall not be applied to damp concrete or steel. The painting shall be done immediately in advance of the application of the waterproofing materials and before dust has had time to collect.

18. If the concrete is damp before the waterproofing is applied, the surface shall be first covered with a 2-in. layer of hot sand and allowed to stand for from 1 to 2 hours, after which the sand shall be swept back, uncovering sufficient surface to begin work, and the operation repeated over a new surface.

19. *Concrete Proportions.*—The cement concrete shall be proportioned by measurement of volumes. The volume of a barrel of cement, 376 lbs., shall be assumed to be 3.6 cu. ft. The sand and stone shall not be packed more closely than by throwing, in the usual way, into a barrel or box at the time of measurement.

20. *Cement.*—Portland cement shall be used, of the quality specified by the American Society for Testing Materials, and all tests shall be conducted by the methods recommended by the Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers, of Jan. 17, 1912.

21. *Stone.*—The stone shall be clean, hard, crushed stone, or pebbles, to be approved by the Chief Engineer, and shall be composed of the whole run of the crusher, from ¼ in. to ¾ in. in size, screened of dust and particles less than ¼ in. in greatest dimension.

22. *Sand.*—The sand shall be clean and sharp, and shall be composed of grains graded from "fine to coarse," screened to reject all particles of a greater diameter than ¼ in. It shall be free from foreign matter, and subject to the approval of the Chief Engineer.

23. *Care of Sand and Stone.*—Sand and stone, when delivered on the work, shall be dumped on platforms and not on the ground.

24. *Hand Mixing.*—When mixed by hand, the cement and sand shall be first mixed dry and made into a mortar. The stone shall be spread on a suitable floor to a depth of about 6 ins., thoroughly wetted, and the mortar evenly spread over it, care being taken that the stone of each batch is mixed as to size. The whole mass shall then be turned over four times and raked, to secure complete and uniform mixture. If the contractor desires to use some other method, he shall submit it for approval. Should the mixture be permitted to set before placing or tamping, it shall be removed and not used. Hand-mixed batches shall not be larger than 1 cu. yd. in volume.

25. *Depositing.*—All concrete shall be deposited as the Chief Engineer shall direct. It shall be of such consistency that when dumped in place it shall not require much tamping, and shall be laid with a view to be an aid to the water-tightness of the structure, and not merely a support for the waterproofing materials. All showing surfaces shall be troweled to a smooth, hard surface.

26. In cases where concrete haunching against girders is called for by the plans, forms shall be used, and the concrete shall be of a wet consistency.

PART III.—MATERIALS AND APPLICATION.

Waterproofing Felt or Fabric and Asphalt.

27. *Materials.*—On the prepared surface, apply the specified number of layers of approved saturated and coated felt, with a finished surface, and weighing about 14 lbs. per 100 sq. ft.

28. The bids shall be based on the use of the type of felt specified in Paragraph 27, but additional alternate bids will be considered, based on felts or fabrics other than these, which shall be approved by the Chief Engineer. In the event of such alternate bids being made, the bidders shall present with them sufficient data as to the method of manufacture, quality of materials, and references to places where such felts or fabrics have been used, giving dates of application.

29. All materials shall be delivered on the work in their original packages, and properly branded.

30. The acceptance or rejection of an asphalt shall rest with the Chief Engineer, and shall be based on the requirements stated in Paragraphs 31 to 37.

31. The asphalt used shall consist of fluxed natural asphalt, or asphalt prepared by careful distillation of asphaltic petroleum.

32. It shall contain, in its refined state, not less than 98 per cent of bitumen soluble in cold carbon disulphide. The remaining ingredients shall be such as not to exert an injurious effect on the work.

33. When 20 grammes are heated for 5 hours at a temperature of 325° F., in a tin box 2½ ins. in diameter, it shall not lose more than 2 per cent by weight, nor shall the penetration at 77° F., after such heating, be less than one-half of the original penetration.

34. The melting point shall be between 150° and 190° F.

35. A briquette of the solid bitumen, having a cross section of 1 sq. cm., shall show a ductility of at least 3 cm. at 40° F., and at a temperature of 77° F. shall show a ductility of not less than 20 cm., the material being elongated at the rate of 5 cm. per min. (Dow moulds).

36. All tests shall be conducted according to the methods recommended by the Special Committee of the American Society of Civil Engineers on Materials for Road Construction, or such other methods as may be approved by the Chief Engineer.

37. The penetration indicated herein refers to the depth of penetration, in hundredths of a centimeter, of a No. 2 cambric needle, weighted to 100 grammes, at 77° F., acting for 5 seconds.

38. *Application.*—All flashing and reinforcing around inlets and other places specified shall be carefully executed.

39. Waterproofing shall not be done in wet weather, or at a temperature below 32° F., without special orders from the Chief Engineer. The felt shall be laid shingle fashion, the first two layers longitudinally and the last three transversely to the center line of the bridge, where five layers are called for, and as specified in detail in other cases, and shall be carried up the haunching and made secure against the girder in a satisfactory manner, or as shown on the plans. The flashing against vertical or inclined surfaces shall be in accordance with the directions of the Chief Engineer, if not indicated. The first layer of felt shall not be cemented to the floor of a steel bridge, except around the drain outlets. At no point shall there be less than the specified number of thicknesses.

40. As the hot asphalt is spread, the felt shall be immediately rolled into it, and rubbed and pressed over its surface, so as to eliminate air bubbles and insure thorough sticking. One mopful of the asphalt shall not be spread over more than 1 sq. yd. of surface at one mopping. Not less than 2.5 to 3 gals. of asphalt shall be used on 100 sq. ft. of a single layer of felt. The top layer shall also be mopped and the work done so that the layers shall be one compact mass. Asphalt shall not be heated at any time to a temperature higher than 450° F. The temperature of the asphalt in the pail just before being mopped into the felt or fabric shall not be below 380° F.

41. The finish of the waterproofing against the girders or concrete shall be made with a pocket of pure elastic asphalt of the quality specified in Paragraphs 31 to 37, except that the melting point shall be between 140° and 180° F., the ductility at 40° F., shall be at least 3 cm., and the adhesive qualities shall be satisfactory to the Chief Engineer. The surfaces with which this material comes in contact shall be dry, absolutely free from dust or grease, and, previous to its application, shall be covered with a thin paint made by dissolving the asphalt in gasoline, as specified in detail in Paragraph 15.

42. Particular care shall be taken to make tight joints around gussets, stiffeners, and the ends of girders.

43. Care shall be taken to prevent injury in any way to the waterproofing by the passing of men and wheelbarrows over it, or by throwing any foreign materials on it.

44. After the waterproofing course has been completed, the horizontal surfaces shall be protected, as shown on the plans, by a course of straight, hard-burned and dense brick, laid flat in a bed of 1 to 3 cement mortar, with full joints. There shall be not less than ½ in. of mortar between the felt and the bricks. The brick shall not increase in weight more than 10 per cent when immersed in water for 7 hours.

45. The haunching, and about 18 ins. in width of the horizontal surface adjacent to the haunching, shall be protected, as shown on the plans, by about 2½ ins. of 1:3:5 concrete, reinforced with No. 8 and No. 10 wire cloth, electrically welded, having a 3x8-in. mesh.

46. Every care shall be taken to insure satisfactory and thoroughly water-tight joints between the main layers of waterproofing and the girders; and special attention shall be given to stiffeners, gussets, etc.

47. Rolls of felt shall be stored on end and not laid on their sides.

48. Waterproofing shall be done only by experienced and expert felt waterproofers.

Natural Rock Asphalt Mastic.

49. *Rock Asphalt Mastic.*—Wherever called for by the plans, the decks of bridges shall be waterproofed with natural rock asphalt mastic, as specified in Paragraph 50.

50. The cement concrete, prepared as specified heretofore, shall be waterproofed with asphalt mastic equal in quality for the intended purpose, as to ingredients used and resistance to water, to the following specifications, and be approved as such:

Sicilian rock asphalt mastic	60 parts
Clean, sharp, graded grit and sand to pass a sieve of 8 meshes per inch	30 parts
Asphalt as specified in Paragraphs 30 to 37	10 parts

These proportions shall be varied when required by special conditions on the work. The asphalt rock mastic blocks shall be imported European asphaltic rock mastic, brought to the place of work in original blocks with the brand stamped thereon. The mastic blocks shall be shipped to the site of the work on a through bill of lading.

51. The mixture shall be made at the site of the work, shall be heated to a temperature of from 250° to 300° F., and shall be stirred until all the ingredients are thoroughly incorporated. It shall then be spread and thoroughly worked, to free it from voids, and shall be ironed to a smooth surface with smoothing irons, if so directed. All mastic shall be applied in two coats, making the total thickness shown on the plans. The two coats shall break joints, and the mastic shall be distributed evenly. Where the thickness of the concrete plus mastic is less than 2¼ ins., the full thickness shall be made up of asphalt mastic.

52. Waterproofing shall not be done in wet weather, or at a temperature below 32° F., without special orders from the Chief Engineer.

53. Pockets of asphalt shall be placed against all metal, and the mastic along girders, around stiffeners, gussets, etc., as specified in detail in Paragraphs 14 to 18, inclusive, and Paragraph 41.

54. In applying the mastic adjacent to expansion joints, and around inlets, drain pipes, etc., care shall be taken to insure adhesion of the mastic to the abutting surfaces, and, wherever directed, the joints shall be made with pockets of low-melting-point asphalt, as provided in Paragraph 53.

55. After the mastic is laid, it shall be mopped with pure melted asphalt, and the surface shall be spread with a layer of clean, coarse sand to harden the top.

56. The pockets of asphalt placed against the girders, stiffeners, and gussets shall be protected, as shown on the plans, by about 2½ ins. of 1:3:5 concrete, reinforced with No. 8 and No. 10 wire cloth, electrically welded, having a 3x8-in. mesh.

GENERAL CONDITIONS.

57. *General Conditions.*—The furnishing and erection of the steelwork for the bridge to be waterproofed will be executed under a separate contract, and the riveting will be completed, the erection finished, and the steel floor cleaned up ready for the waterproofing before the work on this contract is begun. In addition to the foregoing, the contractor shall make a final cleaning of the steelwork before the work of waterproofing is begun.

SEWERAGE AND SANITATION

Method and Cost of Collecting and Incinerating Garbage at Racine, Wis.

(Staff Abstract.)

The agitation for a garbage plant for Racine began in 1901 and, after a great deal of quarreling in the city council as to the style of plant to be adopted, its location and after advertising and readvertising for bids and rejecting them, and debating the question as to where the money was to come from for the construction of such a plant, the council finally decided to submit the question of a $30,000 bond issue to a vote of the people at the November election in 1910. The question was carried by a majority of over 700 votes.

Then the fight on the location of the plant and the kind of plant started again and, after a great deal of investigation, the council on March 12, 1912, authorized the Mayor and City Clerk to enter into a contract with Lewis & Kitchen of Chicago, for complete plans, specifications and details to govern the construction of an incinerator, together with the use of all patent rights in connection therewith for the sum of $1,000.

On April 9, 1912, the council decided to purchase the site where the plant is now located for the sum of $2,800. It is a strip of land 57 ft. wide and 240 ft. long. This site is almost the geographical center of the city at the present time. On October 28, 1912, the contract for the construction of the plant was awarded to James Corse, of Racine, for the sum of $21,000.

DESCRIPTION OF PLANT.

The plant consists of an absolutely fireproof building, two stories in height. The foundations and the lower story are of reinforced concrete and the upper story is of brick. The floors are reinforced concrete, the rolling doors and the window frames and sashes are of steel and the roof is of tile laid on steel purlins. The building is 40 ft. square. The entire upper floor is used for a dumping floor, except a small space in one corner which is used for an office. The incinerator is on the lower floor and consists of two units with a nominal capacity of 20 tons, each, in 10 hours. The stack is of radial brick and is 150 ft. in height. It is lined with fire brick for its entire height.

Each unit consists of two grates, two drying hearths, two storage bins, two emergency hoppers, a combustion chamber and a dust pit. Each furnace is also equipped with a hot water heater and a steel tank for storing the hot water, which is used for washing the wagons, steel baskets, floors, etc. Dampers are arranged so that the heat can be turned onto the hot water boilers or direct into the stack. The storage bins are connected with the sewer and all wet garbage is dumped into them. These storage bins are equipped with mechanical stokers, operated by electric motors and the garbage is fed onto the drying hearths as needed. All dead animals and dry combustible refuse is dumped into the emergency hoppers.

The plant was completed by Mr. Corse and accepted by the city on Dec. 20, 1913. For some time previous to this the city had been burning all garbage that was hauled to the plant but the city did not install its system of collection until Jan. 7, 1914.

GARBAGE COLLECTION SYSTEM.

The collection system at the start was an experiment. We did not know the amount of garbage we would have to collect nor the number of men, horses and wagons it would require. The council on July 15, 1913, passed an ordinance regulating the collection of garbage and placed the same under the jurisdiction of the Board of Public Works. This ordinance provides that the garbage shall be collected in the business districts, three times a week during the months of June, July, August and September and twice a week during the balance of the year; and in the residence districts twice a week during June, July, August and September and once a week the balance of the year.

On Jan. 9, 1914, we started collecting with three one-horse wagons, with the driver alone on the wagons. We found that we could not cover the city, as provided in the ordinance, with this force, so on January 20 we put a helper on each wagon. This force was sufficient until May 8, when an additional wagon with driver and helper was put on. Previous to May 18 but one furnace had been in use, but at this time we found it necessary to run both furnaces, so an additional fireman was put on.

On June 1, 1914, we started to carry out the provisions of the city ordinance for a tri-weekly collection in the business districts and twice a week in the residence districts, so two more wagons were started, making six wagons with 12 men collecting and two firemen and the superintendent at the plant, which is the same force that we have at the present time (August, 1915). These men worked nine hours per day. We found that during the months of July, August and September, the amount of garbage increased so much that it was necessary to work the men 12 hours instead of nine. After September, the amount of garbage collected began to decrease and the men were placed again on their regular time and during the winter months some of the wagons were taken off for a portion of the week and only one furnace was used. The men are now working 11 hours per day. Each wagon is making from 5 to 7 loads per day, according to the district the wagon serves.

The city is divided into collection districts and each wagon has certain districts to take care of. The wagons are steel bodied, steel covered dump wagons, with a capacity of 37 cu. ft. The wagons and horses are owned by the city, the barn for the horses being located in the rear of the plant. The cost of collection and disposal is borne by the city at large, provision therefor being made in the annual budget.

When we first began operating the plant, we were handicapped by the fact that we had no scales to weigh garbage, coal, etc., as it was brought to the plant. The city council authorized the Board of Public Works to install a modern 10-ton scale and on Aug. 13, 1914, we started weighing every pound of garbage that was brought to the plant, also all coal, hay, feed, etc.

QUANTITATIVE AND COST DATA.

From Aug. 13, 1914, to Aug. 13, 1915, there was brought to the plant and disposed of 3,392 tons of garbage, an average of practically 11 tons per day. There was used to incinerate this garbage 807,639 lbs. of soft coal screenings or practically 235 lbs. of coal per ton of garbage consumed.

From Jan. 1, 1914, to Jan. 1, 1915, there was practically 2,900 tons of garbage collected and disposed of, the total cost of which was $10,775.63, being $7,009.44 for collecting and $3,766.19 for incineration, or $2.42 per ton for collection and $1.29 per ton for incineration.

The amount of coal consumed per ton of garbage greatly exceeds the guarantee, which provided for 150 lbs. of coal per ton of garbage. But this guarantee was given on the condition that 500 lbs. of coal for each furnace be allowed before the test was started, to heat the furnace to the proper temperature. If we figured this 500 lbs. to each furnace or 1,000 lbs. for both furnaces, for the 309 days on which we collected garbage, it would mean 309,000 lbs. of coal which, if deducted from the total, would make the amount of coal consumed per ton of garbage about equal to the guaranteed amount.

In figuring the cost of collection I have included all expenses of every kind in connection with the collection and the same is true in connection with the cost of incineration with the exception of two items, viz., the interest on the investment and depreciation. The amount appropriated for garbage disposal for the year 1914 was $9,360 and the total cost was $10,775.63, leaving a deficit of $1,415.63, which was taken from the general fund of the city. The amount appropriated for 1915 is $11,000, and judging from the expenses thus far I think we will have a small credit balance in the fund at the end of the year. However, for the year 1916 I am afraid that the cost of garbage disposal will be nearly double what it will be this year, as then we will be operating under an 8-hour work day law with time and one-half for all overtime. The wages now paid are as follows:

Grade.	Weekly wage.
Superintendent	$21.00
Fireman	15.00
Assistant fireman	14.00
Head teamster	15.00
Teamsters and helpers	13.00

The city collects garbage only. The clause in the ordinance defining garbage is as follows:

> Garbage shall be held to include all refuse, animal, fruit and vegetable matter, and tin cans used for the storage of said animal, fruit or vegetable matter, also all rags, paper and other combustible refuse, and it shall be deemed unlawful to place in the garbage cans any ashes, earth, waste or other materials of a different nature whatsoever.

The property owner must take care of his own ashes and other refuse not classed as garbage.

IN GENERAL.

When the city first installed its system of collection it was rather hard to educate the people to comply with the rules and regulations of the ordinance. But we instructed our men to be patient and lenient and to avoid all friction. We had extracts from the ordinance printed on cards and labeled, "Rules Governing the Collection of Garbage by the City of Racine." These cards were distributed to every place in the city where garbage would accumulate and the people were given to understand that their garbage would not be collected unless these rules were complied with. At present everything is running along very smoothly, except that some people are demanding more frequent collections, some of them stating that the garbage should be collected at least once every day, which is unreasonable and unnecessary.

In conclusion I wish to say that I think that the installation of the garbage disposal plant and the collection system in connection therewith, was one of the best improvements ever made in the city of Racine. The system is working in an efficient way and creates no nuisance whatsoever.

ACKNOWLEDGMENT.

This information is taken from a paper before the Wisconsin League of Municipalities by Mr. P. H. Connolly, City Engineer of Racine.

Measuring the Drainability of Emscher Tank Sludge.

(Staff Abstract.)

Prior to the use of the Emscher tank it was expected that sludge from sedimentation or septic tanks would dry slowly, and it was therefore necessary in the design of works to provide ample space to receive and retain the liquid sludge until it had dried to a consistency fit to be removed to a dump.

The thorough digestion of organic matter in the sludge compartment of a mature Emscher tank results in a destruction of the sticky, colloidal matters, a breaking down of organized bodies into finely divided particles and a material reduction both in the volume of the sludge and in its percentage moisture. It also causes the presence of gas which is compressed when the sludge is in the bottom of the tank, but which expands when reduced to normal pressure as the sludge is withdrawn.

This expansion causes the solid portion of the sludge to float upon the water, which, due to the above described conditions, very rapidly separates at the bottom. For these reasons such sludge, applied to underdrained sand beds, will dry sufficiently to be removed in a few days instead of probably weeks or months with other kinds of sludge. The rapid drying permits the use of the same bed many times a year and it is common practice to provide only one square foot of drying bed for each three persons tributary to Emscher tanks. Hence the drainability of such sludge has become an important matter.

The methods of sludge analysis in most common use consists in determining the percentage moisture and specific gravity of the wet mass and the percentage of the dry residue that is fixed and that which is fat or soluble in ether. These tests are principally of value to show, in an indirect way, the good or bad qualities of the sludge, and it seems that an additional test is required to measure drainability.

The real and essential properties of sludge, when it must be disposed of on land adjacent to habitations, are odor, volume and drainability. The writer is not acquainted with any better apparatus than the nose for determining the first, a foot rule for the second and for the third the results of a few experiments are here offered in the hope that from them a simple test may be devised.

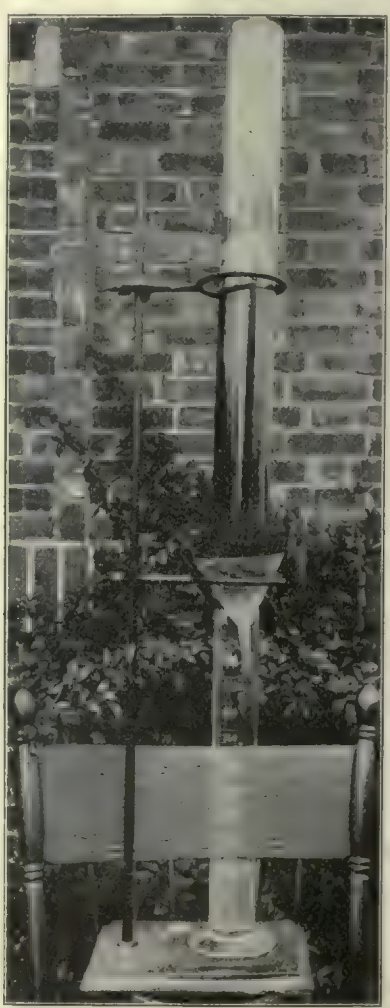


Fig. 1. Apparatus Used at Pennypack Creek Sewage Disposal Works, Philadelphia, in Testing Drainability of Emscher Tank Sludge.

For some time it has been the writer's practice, in order to determine the propriety of removing sludge from Emscher tanks, to withdraw a small portion, place some on a white enameled plate, as suggested by Dr. Imhoff, and another portion in a glass measuring cylinder to see if the water would separate out at the bottom.

Since April of this year a composite sample of each batch of sludge placed on the drying beds at the Pennypack Creek Sewage Disposal Works has been submitted to the two following procedures:

A portion amounting to 700 c.c. is placed in a 1,000 c.c. measuring cylinder and the amount of clear water separated at the bottom observed and recorded at hourly intervals. This is continued until the sludge begins to settle down into the water again.

Another 700 c.c. portion is placed in a vertical piece of glass tubing of the same internal diameter as the measuring cylinder. Over the lower end of the tube is secured a piece of wire screen which supports a ½ in. layer of small pebbles, a ½ in. layer of clean Jersey gravel and a 2 in. layer of fine sand. (The thickness of these layers could probably be reduced and thereby decrease the amount of entrained drain water.)

The tube is held in a retort stand over a funnel resting in a measuring cylinder to collect the water draining out of the sludge and the accumulated amount of water is read at hourly intervals until the sludge ceases to drain. The apparatus is shown in Fig. 1.

The results of the experiments are shown in Fig. 2, also the usual analyses; the number of days required for the sludge, exposed to the weather on the drying beds, to reach a consistency fit to remove; and the rainfall and air temperature during those times.

It may also be stated that sludge from Emscher tanks No. 1 and No. 2 was unsatisfactory during the early operation of the plant and was found to be highly acid. This condition was corrected by the addition of lime water by means of a pipe extending through the ventilator to about middepth of the sludge.

The settling basin is constructed in two parts. Instead of cleaning the side in service when it shows bubbling, the practice is to place the other side in service and allow the sludge to digest with a small flow of filter effluent passing over it. This has resulted in a practically inodorous sludge; but the water does not drain readily as from Emscher tank sludge.

In several instances the sludge placed in the measuring cylinder has begun to float on the water, after a few hours settled down, then separated and floated again.

Such action prevents obtaining a useful curve of drainability and it appears that the tube with filtering media is the better method.

An examination of the curves indicates that the factors which should be combined to obtain a number to represent the drainability of the sludge are:

(a) The rate of drainage represented by the slope of the first part of the curve.

(b) The ratio between the amount of water drained from a liter of sludge and the amount of moisture therein as determined by the usual evaporation method.

(c) The time required for the water to begin to drain out.

Good sludge will be indicated by (a) having a steep slope, (b) showing a large number for the ratio and (c) showing a short time; bad sludge the reverse.

No attempts have been made to combine these three factors to form a number similar to the relative stability figure for filter effluents because the data are too meager and only sludge from one works treating a sewage which is two-thirds institutional has been used in the experiments.

But the writer believes that more extended study in some of the sewage works or testing station laboratories might develop a simple field test capable of being made by the type of operator usually found in the smaller works and that its use would serve to indicate a very important characteristic of Emscher tank sludge.

ACKNOWLEDGMENT.

The foregoing discussion is practically the full paper entitled: Suggestions for a Test to Measure the Drainability of Emscher Tank Sludge, as read by W. L. Stevenson, Assistant Engineer of Sewage Disposal, Philadelphia, before the Sanitary Engineering Section of the American Public Health Association, at the meeting held in Rochester, N. Y., in September, 1915.

The Dominion Railway Department has placed orders for rolling stock aggregating $1,250,000 for government railways. The Canadian Locomotive Works, Kingston, is to supply 15 locomotives, while an order for 1,000 box cars is divided between three other companies. Delivery is to be ready by the crop-moving period.

Improving Sanitary Conditions on the Ashokan Reservoir Watershed.

(Staff Abstract.)

The area of the drainage area tributary to the Ashokan Reservoir, of New York City's new Catskill water supply is 257 square miles. A considerable portion of this is uninhabited, being wild forest land. The population is concentrated along the valleys and consequently adjacent to the streams feeding the reservoir. This mountain region is a favorite summer resort for city people and this fact leads to a wide variation between the summer and winter population. It has been estimated that the summer population is 10,000 and the winter population 3,000, being 39 per capita per square mile and 12 per capita per square mile, respectively. Two of the principal centers of population have public water supplies but not sewerage systems; there are also many large hotels without adequate methods of sewage disposal, and the tendency of the entire region is to be exceedingly lax in the disposition of all wastes.

The Board of Water Supply of the city of New York desired to better these sanitary conditions and had made a sanitary survey of the district. To improve the sanitary conditions in the centers of population a sewage collection and disposal system was planned and a bill was introduced in the legislature giving the city authority to construct this system. The bill failed to pass. For the outlying districts, not reached by the suggested sewerage system, it was decided to improve privies, cesspools, barnyards, etc.; this could be done if the city bore the entire cost.

The sanitary survey showed that some few places had no provision in the way of privies and that in a large majority of cases no pits were provided, fecal matter falling into a dry run or a small drainage course. The privies themselves were in many cases dilapidated buildings with no protection against flies or provision for proper ventilation. It was decided to furnish privies where none were in use, replace disreputable ones by new ones, repair and provide ventilation and screens for all privies that were in a reasonably good condition, and in all cases place the buildings over pits about 6 ft. deep with sides walled up with dry stone and located as far as possible from a water course.

A sanitary privy was designed as a portable building so that it could be built at a shop and delivered in sections at the place of erection. The privies were 4 ft. x 4 ft. 3 ins., provided with ample ventilation from beneath and behind the seat up through a small box chimney to the height of the roof, a good sized window which was screened with copper screening, and a door with a latch and spiral spring which insured it being kept closed. Additional ventilation of the building is secured by holes bored in the peak covered by screening on the inside. The construction of these buildings cost the city about $17 each for labor and materials. This does not include the cost of erection, which is small, when the cost of hauling is excluded.

A start was made in improving the outlying districts. This work was at first viewed with distrust by the natives and much objection and many prejudices had to be overcome before the work went smoothly forward, but these difficulties were gradually overcome. At places where there were strong objections on the part of the property owners the work was temporarily deferred and adjacent places improved, but ultimately the owner who had first objected asked that improvements be made on his property.

The work of improving the outlying districts was nearing completion when the 1914 legislature refused to pass the Esopus Valley Sewer Bill, previously mentioned, so it was decided to follow the above-outlined policy of individual treatment throughout the entire watershed.

Incidental to this work, an inspection has been made of all premises supplied with running water and the means of disposal of sewage investigated. The results of this inspection are recorded in sketch form with sufficient notes to record the actual conditions at the time of inspection. Where conditions need remedying, work is being undertaken to build or replace cesspools or install adequate methods of treatment. A total of about 600 premises have been improved, including the building of 112 new privies and 7 new cesspools. A garbage incinerator was built for one village which agreed to operate and maintain the plant.

These efforts have brought about a noticeable improvement in conditions and have awakened the people of the region to an appreciation of the necessity for better sanitary conditions.

ACKNOWLEDGMENT.

Abstract of paper by George G. Honness, Reservoir Department Engineer, New York Board of Water Supply, before New England Water Works Association.

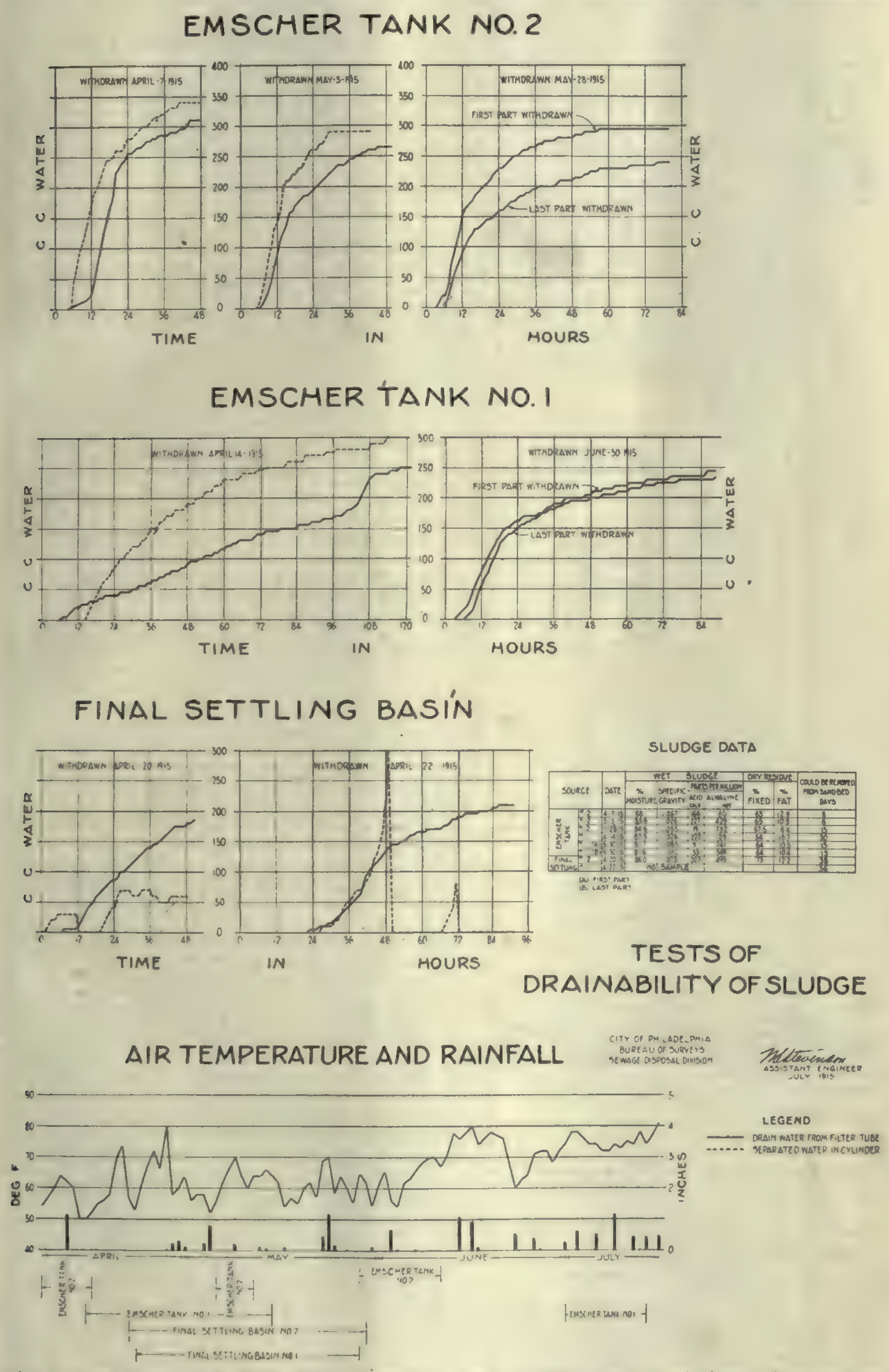


Fig. 2. Test Data on Drainability of Emscher Tank Sludge, Pennypack Creek Sewage Disposal Works, Philadelphia.

Oregon Run-Off Statistics.—A publication entitled "Water Resources of the State of Oregon" has just been issued by State Engineer Lewis. It is known as Bulletin No. 4. This bulletin of 353 pages contains a summary in tabular form of all available information relative to the amount of water flowing in the streams of Oregon. The information was compiled under the direction of John H. Lewis, state engineer, acting in co-operation with George Otis Smith, director of the U. S. geological survey.

The total run-off per month is given in acre feet for 293 regular stations, including the maximum, minimum and mean flow for the month in second feet. A large number of miscellaneous measurements are recorded. Copies of this bulletin can be had by addressing the State Engineer, Salem, Oregon.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

Corrugated Asbestos Cement Sheets for Roofing and Siding.

(Contributed.)

The first attempt to manufacture "Ambler" corrugated asbestos cement sheets was to take flat sheets of asbestos building lumber and bend them while still soft into the corrugated form, one corrugation at a time, the asbestos cement concrete being made under the "Hatschek" patented process, the essential features of which are as follows:

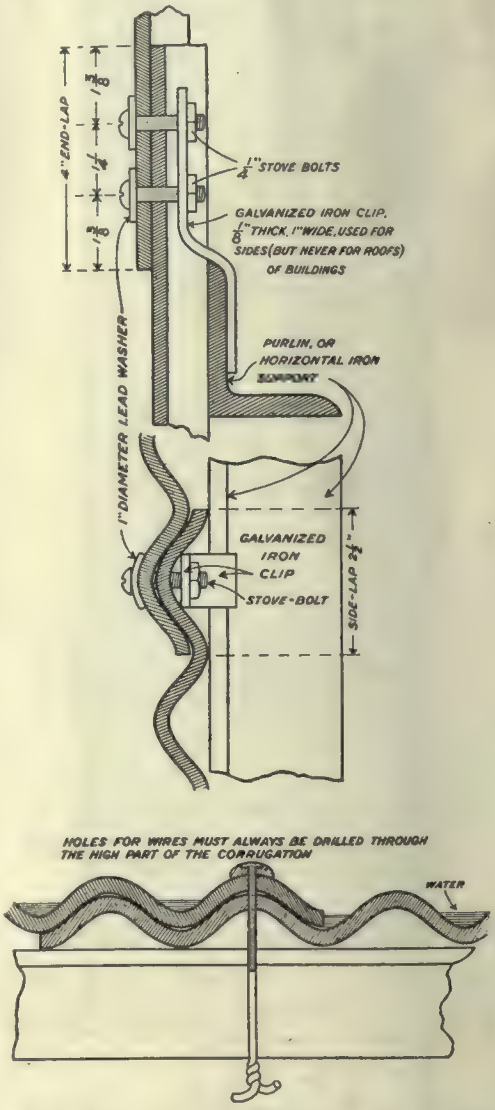
Hydraulic cement is first thoroughly mixed with water and asbestos fiber of the chrystolite variety in a beating engine similar to that employed in the manufacture of paper pulp. The prolonged, vigorous mixing and agitation to which the material is here subjected results in the formation of uniform pulp having the properties of a colloidal solution. The material then passes to the vat of a modified mill-board or paper machine, wherein it is kept in a state of agitation until picked up in thin coatings by a fine wire screen on a revolving cylinder, from which it is passed by an endless felt belt to a second rotating cylinder upon which it accumulates in layers until the desired thickness has been attained. The material is then cut across and removed in the form of sheets which are piled one upon another and placed between metallic plates. The latter are then subjected to heavy pressure to compact the material, drive out excess water and eliminate all voids and fissures. Due to the numerous layers, the asbestos fibers cross each other in all directions, giving a texture of great homogeniety and toughness.

To give the material greater tensile strength iron wire mesh or screen was imbedded between the layers of asbestos concrete. This was partially successful, but it was found that in some cases, particularly where the material was exposed to corrosive fumes or to salt air, sufficient moisture would enter through minute fissures in the convex side of the corrugations to cause the rusting and ultimate disintegration of the reinforcing material. The use of metallic reinforcement was therefore discarded, and the process of manufacture so modified that the material could be compressed while in the corrugated condition, a pressure of about 100 tons per square foot being employed. The result has been to produce a dense and thoroughly compacted structure. Corrugated asbestos sheets for roofing and siding purposes are made of uniform width of 27½ ins., comprising eleven complete corrugations, and in lengths of 4, 5, 6, 7, 8, 9 and 10 ft. The corrugations are 2½ ins. wide and 1 in. deep from top to bottom of corrugation. The material varies in thickness from 3/16 to 5/16 in. and weighs from 2.8 to 3 lbs. per sq. ft.

The method of applying and supporting the material for roofing and siding purposes is shown in the illustration. Roofing is lapped two corrugations sidewise and 6 ins. endwise, the inclined joints in succeeding courses being staggered from those of the preceding courses by the amount of the side overlap. Supporting purlins are so spaced that the greatest distance between purlins shall not be more than 36 ins. for roofing or 40 ins. for siding.

The best device for attaching roofing to steel work has been found to be aluminum tie wires. Two holes are drilled through the asbestos, one just above and one just below the purlin, care being taken to locate the holes in the tops of the corrugations and to make them no larger than necessary for drawing through the wire fasteners. The outer end of each tie wire is provided with a head similar to that of a wire nail and holds a soft lead washer and before the wires are drawn up against the roofing the inner surface of the washer and the head of the wire are daubed with plastic asbestos slaters' cement. The inner ends of the two wires are then twisted together around the purlin as shown in Fig. 1. In applying the material to wooden purlins iron wire nails with lead washers take the place of the aluminum tie wires just described.

The fastening for siding is somewhat different, consisting of a galvanized iron clip, bent so that the inner end rests over the purlin or other horizontal iron support. The clip is fastened to the corrugated material by two ¼-in. stove bolts, the heads of which are outside and rest against soft lead washers. Siding is secured to wooden frame work by means of nails.


4" END-LAP
1 3/8
1 1/4
1 3/8
1/4" STOVE BOLTS
GALVANIZED IRON CLIP, 1/8" THICK, 1" WIDE, USED FOR SIDES (BUT NEVER FOR ROOFS) OF BUILDINGS
PURLIN, OR HORIZONTAL IRON SUPPORT
1" DIAMETER LEAD WASHER
GALVANIZED IRON CLIP
STOVE-BOLT
SIDE-LAP 2 1/2"
HOLES FOR WIRES MUST ALWAYS BE DRILLED THROUGH THE HIGH PART OF THE CORRUGATION
WATER

Methods of Attaching Ambler Corrugated Asbestos Cement Sheets to Sides and Roofs of Buildings.

For the protection of corners and ridges, rolls of the same material as the roofing and siding are used. Those for corners are half cylinders made in lengths of 16, 42 and 56 ins. and are so applied that the ends overlap. The ridge rolls are provided with 6-in. wings, which overlap the corrugated roofing. To admit of applying the ridge roll to any peak or angle it is made in two parts, the half cylindrical parts turning one within the other to give the desired angle to two wings.

The corrugated asbestos cement sheets described above are manufactured by the Keasbey & Mattison Co., Ambler, Pa.

Steel Telescopic Sewer Forms.

(Contributed.)

The illustration (Fig. 1), p. 215, shows a new type of steel form. This form is a telescopic sewer form, and has some distinctive features. The picture illustrates a form 64 ins. in diameter.

The form is made in quadrants, the invert, or bottom sections being built with angles which form a track on which the small steel and wood carriage runs. After the forms have been erected, they are collapsed by removing bolts at the base through the angles, and the wedge-shaped wood filler piece in the lower right hand side of the picture. The wood filler piece is withdrawn and the four segments are placed one on top of another on the small carriage which runs on the invert of the forms. The carriage is then pushed through the forms which are in position, and which are being concreted. A turnbuckle is used to line up the forms when they are being concreted.

The forms are set up in the invert of the sewer either on small pedestals or on the concrete dish placed previously. These forms are used where it is desired to have a monolithic concrete sewer; concreting a sewer of any length can be accomplished without joints, either longitudinal or vertical.

On a contract in San Antonio, on which the Bailey-Reeder Co. are the contractors, 175 ft. of these forms were collapsed, moved forward and reset in seven hours, this while concreting was going on on the balance of the forms used on this contract. This type of form is being used on four contracts in San Antonio at the present time, as well as on several other contracts in other parts of the country, and is meeting with wonderful success. The manufacturers of this form are the Blaw Steel Construction Co., Pittsburgh, Pa.

A New Small Size Concrete Mixer.

(Contributed.)

The most satisfactory kind of a mixer is one that will meet the contractors' needs under the most trying conditions. The No. 10 Rex Mixer (Fig. 2) is a one bag machine with the low charging features. This machine can also be equipped with a power loader and automatic water tank if the contractor desires it. The mixer can also be supplied with steam engine and boiler, gasoline engine and electric motor. Due to this there are few conditions that a contractor using a mixer could not use a No. 10 Rex Mixer to advantage.

The No. 10 Rex has a capacity of 10 cu. ft. of unmixed material and will thoroughly mix and discharge a batch of concrete in 45 seconds. The charging platform is but 22 ins. above the ground, allowing the wheelbarrows to run up an easy incline to charge the mixer drum which has a 21-in. opening. The discharge chute is of the pivoted type and is high enough above the ground to discharge into wheelbarrows.

All materials entering into the construction of the mixer are steel or refined semi-steel, the only timber parts being the tongue and the charging platform. The drum is of cast semi-steel made in two sections bolted together in the middle. This drum is exceptionally hard and will outwear several drums that are made of plate steel, it is claimed, for the walls are several times thicker and have no rivets to work loose. The sprocket teeth are cast in sections which are bolted to the drum. If through some accident a tooth should be broken, it can be replaced in a few minutes' time at a very small cost. The mixing blades

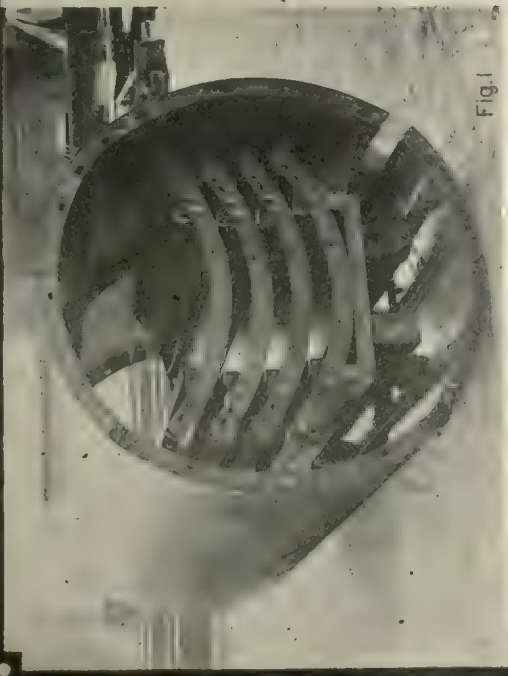


Fig.1

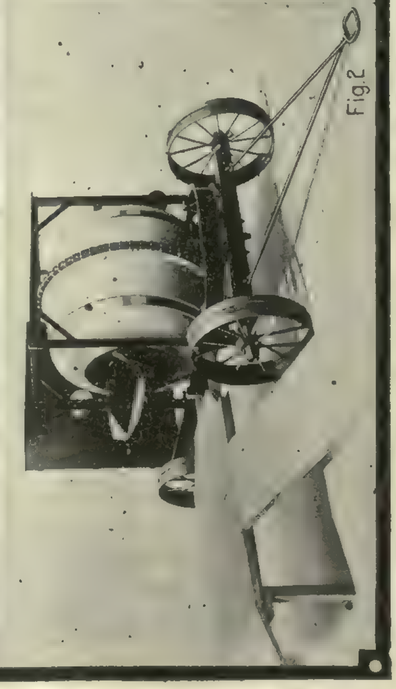


Fig.2

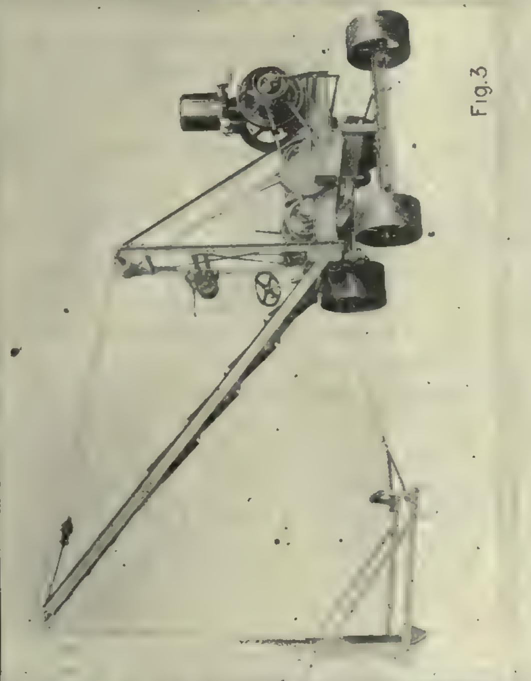


Fig.3

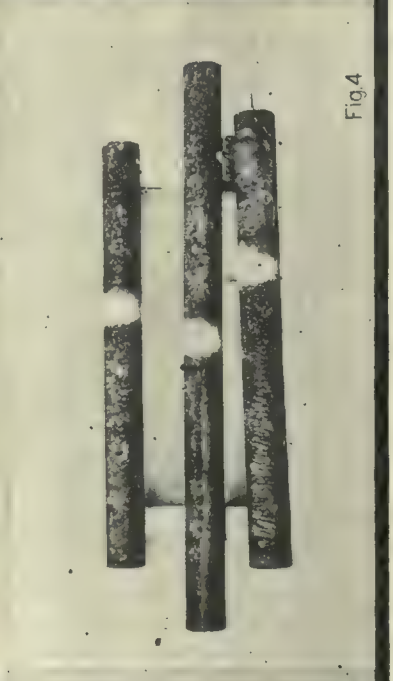


Fig.4

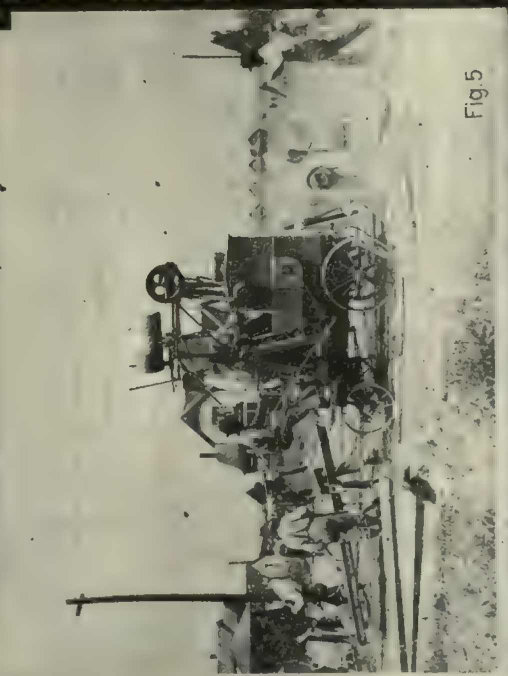
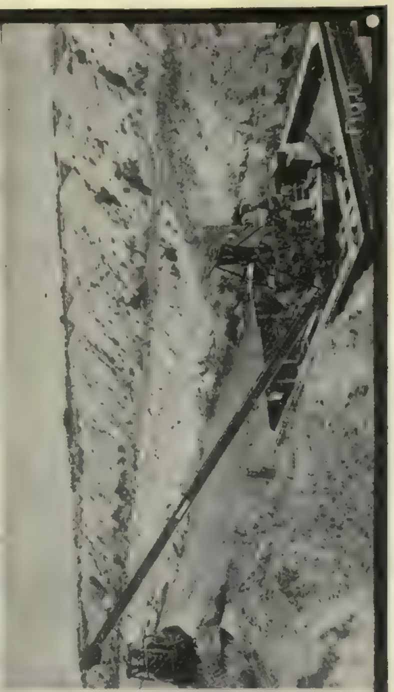


Fig.5



A Group of Labor-Saving Construction Devices of Interest to Contractors.

Fig. 1—Telescopic Steel Forms for Sewer Construction. Fig. 2—Handy Small Mixer for General Contractors. Fig. 3—Power Scraper for Backfilling Trenches. Fig. 4—Oxy-Acetylene Welded Paper Mill Cores. Fig. 5—Small Concrete Mixer for Road Work. Fig. 6—Locomotive Crane Ditch Cleaner.

carry the material in a very rapid manner from the large charging opening toward the center of the drum, where it is carried upward by discharging buckets and drawn back again into the mixing blades. The mixing operation is threefold and insures a very rapid mix and an absolutely uniform quality of concrete in a few turns of the drum. The drum is supported on large chilled tracker rollers which are lubricated by means of compression grease cups.

The mixer is driven by riveted chain belt. The frame is constructed of heavy steel channels and thoroughly braced. The road wheels are 28 ins. in diameter, with a 6-in. face, to facilitate hauling over rough roads. The mixer is guaranteed for a period of one year against inherent defects in workmanship and material and the Chain Belt Company, Milwaukee, Wis., its maker, will replace any parts that are defective. The price of this machine without power loader and automatic water tank is $450 F. O. B. Milwaukee.

A Power Scraper for Backfilling Trenches.

(Contributed.)

This backfiller (Fig. 3) is of the drag line excavator type and is designed to backfill all ditches ordinarily cut with trench excavators for water or gas or sewers. The machine is built of high-grade material throughout and the construction is first-class in every respect. All gears are made either of steel forgings or of the best semi-steel castings. All spur gears and pinions have teeth cut from the solid. All bearings are lined with the best babbitt metal and all clutches are friction clutches of the internal expanding ring type lined with asbestos clutch lining.

The front or steering wheels are 24 ins. diameter by 12 ins. face with plate steel tires and steel spokes cast into heavy iron hubs. The axle is composed of two 5-in. channels between which are bolted the 2 3/16 in. diameter wheel journals, which are readily removable if necessary on account of wear or for other reasons. The axle is pivoted both vertically and horizontally, providing a three-point support for the car body and preventing distortion of the structure when passing over uneven ground. The rear wheels are 30 ins. diameter by 18 ins. face and of the same general construction as front wheels. They are keyed on a 3 3/16 diameter steel axle, which is driven by means of a chain from the propelling machinery mounted on top of the car body and hereinafter described.

The car body is built up of two 7-in. I-beams running fore and aft and cross connected by means of 7-in. channels where necessary. The machinery base, consisting of two 9-in. I-beams, is mounted on top of these beams and efficiently connected to them. Cover plates are provided to prevent relative movement between the separate members. All shaft bearings are designed to be fitted squarely over the centers of the car members, eliminating eccentric loading with its tendency to cramp the shafts in the bearings. All connections in the car body are of ample strength and all rivets are power driven where practicable.

The main machinery consists of one intermediate shaft, chain connected to the engine, and two drum shafts, gear connected to the intermediate shaft. The pinion on the intermediate shaft is a steel forging with teeth cut from the solid. The gears on the drum shafts are of semi-steel, also with teeth cut from the solid. The drums run loose upon the shafts and are connected thereto by means of internal expanding ring type clutches 15 ins. diameter by 2½ ins. face, lined with asbestos clutch lining. The drum for the pulling rope is 10 ins. diameter. The drum for the back hauling rope is 15 ins. diameter. Both ropes are ⅝ in. diameter. The intermediate shaft is connected to the engine by means of a high-speed roller chain of 1¼ in. pitch. An internal expanding ring clutch is provided on the engine shaft, enabling all machinery to be placed out of action and the engine to be started without load.

A steel bevel pinion on the end of the intermediate shaft is provided meshing with two semi-steel bevel gears on the propelling shaft. These gears are provided with internal expanding ring asbestos lined friction clutches by means of which propelling motion is obtained in either direction. Connection between the propelling shaft and the rear axle is by means of a chain and sprockets. The propelling speed is approximately 1.8 miles per hour.

The steering machinery is mounted under the car body and is operated by a worm and worm wheel, which are self-locking. Connection between this shaft and the front axle is by means of chains. Cushion springs are provided to check the shocks occasioned by obstructions in the road. The steering shaft is hand operated, a large hand wheel with handle being provided for this purpose.

The operating levers are located at the rear of the machine and so grouped that they can all be reached from one position.

A sectional jib composed of two 5-in. channels placed back to back and efficiently cross braced is provided for hauling back the bucket. The total length of this jib is 25 ft., composed of one 10-ft. length and three 5-ft. lengths so that length may be varied to suit the requirements. Adjustment for this jib is obtained by means of a hand winch mounted on the uprights of the car body.

A self-acting scraper 4 ft. wide and built up of steel plate angles and oak planks is provided for handling the dirt. The design of this scraper is such that no men are necessary for guiding it when at work.

The machine is driven by a 10-hp. single cylinder vertical hopper cooled engine running at 400 revolutions per minute, provided with a friction clutch of the internal expanding ring type and connected to the machinery by means of a high speed roller chain, as hereinbefore specified. The fuel tank is located in the base of the engine, pump being provided to deliver the fuel to the mixer. The engine is provided with an efficient governor for regulating its speed.

A canopy covering the machine is provided, and all gears are efficiently guarded. Canvas side curtains can be furnished at slight additional expense, if desired. The general dimensions are:

Out to out of traction wheels	7 ft. 4 ins.
Wheel base	8 ft. 0 ins.
Height without jib	9 ft. 8 ins.
Weight in working order, approximately	8,000 lbs.

This backfiller is made by The Pawling & Harnischfeger Co., Milwaukee, Wis.

Oxy-Acetylene Welding of Defective Cores in a Paper Mill

(Contributed.)

At the St. Croix Paper Co. plant at Woodland, Me., by using the Prest-O-Lite process of oxy-acetylene welding, broken cores similar to those shown in the illustration, Fig. 4, are now repaired in nine minutes. No filling material is used, as a method has been found for handling the welding operation so that sufficient strength can be obtained with the material flowed into the weld from the pipe itself. Occasionally, however, a small quantity of filler rod has to be added to insure a joint that will be as strong as the rest of the core itself.

The two sections of pipe are prepared by simply cutting off in a machine with the regular cutting-off tool. The ends of the pipe are not beveled as the extra metal is needed where filling rod is not added.

The cores are steel tubes 3 ins. in diameter and average about 50 ins. in length. During the welding operation they are slipped over an iron arbor of the same diameter as the shaft on which the roll is designed to run, to insure perfect alignment with the longitudinal center.

As these cores accumulate very rapidly it is stated that enough material, heretofore scrapped, is now on hand to furnish several years' supply of new cores without making it necessary to draw on any new material at all.

Tests of welded paper cores indicate that the reclamation process does not affect the original strength in the least—the welded portions stand the punishment incident to rough handling during continual shipping, although frequently the original metal in the tube is broken.

The welding method described is controlled by the Prest-O-Lite Co., Inc., Cincinnati, O.

A Locomotive Crane for Cleaning Drainage Ditches.

(Contributed.)

On the Minidoka irrigation project in Idaho, the government has found it necessary to build ditches to take care of waste water running from the higher levels. The users on the upper sections have always allowed the waste water to take its natural course which was destructive to the land and crops on the lower levels. It was necessary to construct these ditches accurately as regards cross section and grade, to insure a flow of water to the desired point, on account of the country being nearly level and not being much difference in elevation between the highest and lowest sections.

After the ditches were built it was found that they must be kept comparatively clean of silt, weeds, etc., to allow a continual flow of water. Teams and hand labor were found to be expensive methods of keeping the ditches clean and the government decided to try mechanical means. A Brownhoist locomotive crane mounted on a steel barge, Fig. 6, was purchased and proved to be a success for this work. At present the crane is working night and day. It requires three men for the two shifts, one operator for the day and one for the night, and a helper during the day. The silt is dug from the bottom of the ditch and deposited on the bank.

The Brownhoist crane is operated by a 40-hp. White gasoline engine with self starter. It is equipped with a 33-ft. variable radius boom and ½-cu. yd. Brownhoist bucket. The barge is constructed of steel plates and angles and built so that it can be easily knocked down for removal to other points. A hand operated pump is carried for emergencies. An electric lighting system with two large lamps and reflectors was installed to provide light for night operation.

The barge and crane are designed to operate in 3 ft. or more of water without spuds. The center of gravity is very low and the rotating parts are balanced. The crane has been in operation several months and it has been proved that it will work in less than 3 ft. of water. It is propelled along the ditch by means of hand crabs, one in each end of the barge. The rope leading from the crab is fastened at some convenient place along the bank and the barge is pulled ahead a few feet to the next digging operation. Mr. F. N. Cronholn is superintendent of construction on this project, for the U. S. Reclamation Service. The crane was built by the Brown Hoisting Machinery Co., Cleveland, O.

A Small Job Mixer for Concrete Road Work.

The mixer illustrated by Fig. 5 is a concrete road mixer designed for jobs of moderate size. It also has the advantage that with the distributing chute removed there is had a standard mixer for general concrete work. The general construction is clearly indicated by the illustration. The power is furnished by an 8-hp. vertical gasoline engine completely housed. The traction speed is per hour 1½ miles ahead and 1 mile backward and a 20 per cent grade can be climbed. The drum capacity is 10 cu. ft. of unmixed material; the drum tilts to discharge and all operations are by power. There is the usual equipment of automatic measuring water tank, power loading skip, swinging telescopic distributing chutes, etc. The mixer complete weighs 7,500 lbs. It is made by the Waterloo Cement Machinery, Incorporation, Waterloo, Ia.

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Open Hearth Steel Plant in Los Angeles, Cal.—The first steel plant in southern California was placed in operation at Los Angeles, Cal., on April 10, 1915. This plant, which is of the open hearth type, uses crude oil as fuel and has a capacity of 1,500 tons per month. It is the property of the Southern California Iron & Steel Co. of Los Angeles. In addition to merchant sizes it produces heavier bar stock, reinforcing bars and bolts and nuts. The company has secured the Pacific coast rights for the Havemeyer reinforcing bars. It also plans to roll light channels and angles up to 3 ins. in size. The plant includes an extensive galvanizing department, which is equipped both for electrodeposition and hot galvanizing.

9/19-22

The Lighter Side of Engineering and Contracting

Write Your Own Caption.

LAST June a graduate from one of the middlewestern engineering colleges came to Chicago in search of a position. He was without practical experience but had enjoyed his academic study of railroad engineering so he decided to try for a railroad engineering job. He started out boldly enough but two or three turndowns depressed him somewhat. He was especially cast down on account of his failure to get past the chief engineer's chief clerk. Finally he called at an office where only the office boy was in. Quite willing to take sympathy if unable to get information he put this question to the boy: "Do you think that there is likely to be an opening here for a college graduate?" "Dere sure will be," was the reply, "lessen de boss raises me sal'ry to ten bones a week by termorrer night."

* * *

Twice Told Tales.

THESE two stories have been exhumed from the files and are reprinted by request:

1. Bill was a bridge builder and got the contract to do the bridge work for a railroad on a new line through a section of Mississippi. What he found down in that particular section was mostly bugs and mosquitoes, and they kept the men busy slapping. Naturally Bill didn't have anything complimentary to say of the locality and he said it freely to the natives themselves. One old planter in particular took offense at Bill's abuse. "Ah cayn't see why you-all cayn't stan' it. We-all live down hyar all right." "Sure you do," Bill retorted. "But all you can manage to do in a day is to slap bugs." "Sah, we-all don't slap bugs all day, sah." "Sure you do. I'll bet $10 you can't sit where you are and keep your hands folded for five minutes." The planter was game and indignant, so he took the bet. Bill complained that it was too hot to stay where he was and excused himself for taking up a position at the planter's back, ostensibly to sit in the shade. But the minute Bill got around to the back of the planter, he took out a sunglass and focused it on the back of the planter's neck. Within a minute the hair on that particular spot began to curl up and smoke. Another minute and a half and the skin was squirming and turning yellow. But the planter had grit. He ground his teeth and kept his arms folded. That lasted another minute and then he spoke: "Say, pard, Ah don't wanta hedge on the bet, but Ah'll compromise fo' five dollars right now if you-all will let me brush that damned bobtailed wasp offen the back of my neck."

2. The appended letter was received by a Kansas City engineering firm from the mayor of an Iowa town. Fearing that he had been misunderstood in a former letter, cautioning economy, he wrote the following letter:

"I did not mean to convey the idea that we wanted an inferior or poorly constructed reservoir. On the contrary, I want no stone left unturned to insure a perfect job. I want a reservoir that will stand an earthquake and never quiver, one that can be taken out bodily and carried off, one in which there will never be a crack, one that will never leak a drop, one that will stand there forever and ever, amen.

"What I want to avoid is the spending of money, I want the above described reservoir for little or nothing. I think I make myself clear."

Do It Now.

Here is a stanza, from the Philadelphia Telegraph, which carries a good suggestion to the higher-ups in the engineering and contracting world:

If with pleasure you are viewing any work a man is doing,
If you like him or you love him, tell him now;
Don't withhold your approbation 'till the parson makes oration
As he lies with snowy lilies o'er his brow;
For, no matter how you shout it, he won't really care about it;
He won't know how many teardrops you have shed.
If you think some praise is due him, now's the time to slip it to him,
For he can not read his tombstone when he's dead.

* * *

The Moral Doesn't Bear on This Department.

OWING to the fact that the financial depression has operated as a strong stimulus to sporadic literary outbreaks among engineers we offer the following as a counter-irritant. This is old stuff—very old, in fact. It was first pulled by Horace, not by Horace Who, but Horace Himself, in his "De Arte Poetica." It was done over into English about 1586 by William Webbe in his "A Discourse of English Poetrie." Have at you, then:

He that taketh in hande to write anything must first take heede that he be sufficient for the fame: for often vnwary fooles through their rashness are ouertooke with great want of ability.

Let no man esteeme himselfe so learned, but that he may submytte hys wrytinges to the judgments of others, and correct and thoroughly amend the same himselfe.

A wryter must learne of the learned, and he must not sticke to confesse when he erreth; that the worse he may learn to auoyde, and knowe howe to follow the better.

The confession of an errour betokens a noble and a gentle minde. Celfus and Quintillian doo report of Hippocrates, that least he should deceiue his posterity, he confessed certayne errours, as it well became an excellent minded man, and one of great credite. For (as sayth Celfus) light witts because they haue nothing, wyll haue nothing taken from them.

In making choice of such freends as should tell vs the trueth, and correct our wrytinges, heedefull judgment must bee vsed; least eyther we choose vnskylfull folke, or flatterers, or dissemblers. The vnskylfull know not how to judge, flatterers feare to offende, dissemblers in not praysing doo seeme to commende.

Let no man deceiue himselfe, or suffer himselfe to be deceiued, but take some graue learned man to be judge of his dooing, and let him according to hys counsayle change and put out what hee thinketh good.

* * *

The Igorotte as a Road Builder.

THE Igorotte has left off head hunting to take up road building. Just what agency was employed as a persuader is not clear—perhaps it was a Krag rifle. The roads, both during and after construction, have facilitated social intercourse and have promoted mutual understanding. Men who lived to decapitate ten years ago now work alongside their erstwhile enemies. Pictures of these road building gangs show the airy raiment worn by the laborers. Each man is clothed with his natural dignity and a shirt. It is surprising what one sometimes is able to deduce from pictures. In this case, for example, one sees that the manufacturers of wool soap should not longer delay opening a sales office in northern Luzon.

* * *

Within the Law.

A RESIDENT engineer, in charge of levee construction in Arkansas, in the days when the "station man" was in his prime, had scruples against requiring his inspectors to stay out on the line on Sundays. His chief advised him that he could forbid Sunday work on the ground that it was in violation of a State law. The prohibition order was promulgated, and met with disfavor among the "tarriers." The first Sunday morning following the order, an inspector walked out to breathe the fresh woodland air, and found several gangs of station men at work. When their attention was called to the breach of rules, one of the nearest gang promptly replied, "We're not wor-r-kin', Inspictor; we're jist puttin' on the shr-r-inkage." (Note.—20 per cent above net grade).—A. L. D., Memphis, Tenn.

* * *

Skinner Mulvey says: Co-operation is th' ketch word of t' hour. There's nothin' like it. Fer example, holdin' slip scrapers is a dern mean job till ya learn t' co-operate wid yer mules.

CURRENT NEWS

The Doings of the Week.

No unusual developments occurred during the past week. Business in general continued to gain. Bank clearings for the week showed a small increase over the previous week and a substantial gain over the corresponding period in 1914. An interesting report of the week was the announcement that the surplus reserves of the banks which can be used to help move the crops of the country exceed $730,000,000; this compares with only $41,000,000 available last year. There seems to be no let up in the placing of war contracts in the United States. Some of the concerns reported to have received orders from China, England, France, Italy and Russia, particularly the latter, are the Bethlehem Steel, Cambria Steel, American Locomotive and Electric Boat Co. The U. S. Steel Corporation's report showed its unfilled orders on Aug. 31 totaled 4,908,455 tons. Construction work for this season of the year has been holding up well. Several large jobs appeared and any number of small undertakings. In the railroad line about the most interesting is happening or is about to happen in the southeastern section. The Charleston Southern has let contracts for bridge work and grading for its new 85-mile line and the Southern Ry. is reported to have placed contracts for the double track work mentioned in our last issue. The city of Philadelphia is taking bids until Oct. 19 on about five miles of steel superstructure work for the Frankford elevated line. A small job was let by the Boise Ry. for 13 blocks of street tracks in Boise, Ida. A considerable amount of municipal construction work is being advertised this week. *The Iron Age* prices for finished iron and steel, nails and wire for the week ending Sept. 8 were as follows:

Finished Iron and Steel, Per lb. to large buyers:	Sept. 8. Cents.	Sept. 1. Cents.
Bess. rails, heavy, at mill.....	1.25	1.25
Iron bars, Philadelphia	1.459	1.459
Iron bars, Pittsburgh	1.35	1.35
Iron bars, Chicago	1.25	1.25
Steel bars, Pittsburgh	1.35	1.30
Steel bars, New York..........	1.519	1.519
Tank plates, Pittsburgh.......	1.35	1.30
Tank plates, New York........	1.519	1.519
Beams, etc., Pittsburgh.......	1.35	1.35
Beams, etc., New York........	1.519	1.519
Skelp, grooved steel, Pittsburgh	1.30	1.30
Skelp, sheared steel, Pittsburgh	1.35	1.35
Steel hoops, Pittsburgh........	1.35	1.35

Sheets, Nails and Wire, Per lb. to large buyers:	Sept. 8, 1915. Cents.	Sept. 1. 1915. Cents.
Sheets, black, No. 28, P'gh....	1.90	1.90
Galv. sheets, No. 28, Pittsburgh	3.60	3.60
Wire nails, Pittsburgh.........	1.65	1.65
Cut nails, Pittsburgh..........	1.60	1.60
Fence wire, base, Pittsburgh..	1.50	1.50
Barb wire, galv., Pittsburgh..	2.50	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.35c.

Railways.—Several good railroad jobs bobbed up during the week. The city of Philadelphia is asking bids until Oct. 19 on about five miles of steel superstructure work for the Frankford elevated line; the Charleston Southern let contracts for grading and bridge construction, and the Southern Ry. is reported to have let double tracking work for about 26 miles of line. Down in New York City contracts were given out by the Public Service Commission for the First District for the supply of trap rock for tracks of the subway and for a duct line in 44th street, Manhattan.

Roads and Streets.—A large amount of street paving work is being carried on at the present time. One of the best jobs is for the Park Commissioners at Kansas City, Mo. This calls for the improvement of the Paseo extension and of Meyer Blvd., estimated to cost $390,000. At Philadelphia contracts were let for $273,914, worth of standard paving. On Sept. 10 the State of Ohio awarded over $200,000 worth of roads, while at Hartford, Conn., bids are asked by the State Highway Commission on 7 native stone and other types of road contracts. Essex County, New Jersey, let two bitulithic jobs that will total $133,464. The state of Idaho is asking bids on 26 miles of highway for Bannock County; city of Chicago on 35 sidewalk contracts; Cass County, Minn., on State Rural Highways Nos. 80 and 82, and The Pitzman Co. of St. Louis, Mo., on grading for University Park Realty Co.

Bridges.—A fair amount of bridge construction work made its appearance since last week. While no particular large structures are being advertised for bids, still a number of small and medium sized ones are ready. Bids are asked on several in Illinois, to be constructed for the State Highway Commission. At Leavenworth, Kans., the county solicits bids on 26 bridges, while the State of Pennsylvania closes bids on Sept. 30 for four contracts. At Seattle, Wash., plans are to be ready within 60 days for a 216 ft. span over the Lake Washington Canal, which will cost about $365,000. An $80,000 structure is planned at Beaufort, S. C. In the contract let line perhaps the largest undertaking is the Chicago St. viaduct at Buffalo, N. Y., the successful bidder being the Stroebel Steel Construction Co.

Water Works.—Some dandy jobs have reached the call for bids stage this week in the water works field. At East Liverpool, O., bids are wanted for a 6,000,000 gal. filter plant, pumps, force main, etc.; at Urbana, Ill., for steel tower and tank; at Jamestown, N. Y., for ten 11-in. driven wells; at Belleville, O., for water works system, as well as at Gayville, S. Dak. At Manhattan, Kans., improvements to the system are planned at an estimated cost of $72,600, while at Columbia, S. C., and Hudson Falls, N. Y., elections are to be held this fall for systems to cost $300,000 and $270,000 respectively. Raymond, Wash., contemplates improvements to the recently-acquired plant that will total $100,000, and Aberdeen, Wash., will vote this month for a $400,000 system.

Sewerage.—Apparently nothing startling happened in sewerage work the past week. Boston, Mass., wants bids on quite an amount of pipe sewer construction and Richfield, Utah, for sanitary and storm systems. However, plenty of work is in prospect. At Fort Washington, L. I., a system is proposed; at Jersey Shore, Pa., a system for the Fourth Ward; at Rockville, Md., sanitary system and disposal plant, and at Scranton, Pa., purification plant and separate storm and sanitary sewers to cost about $5,000,000. This last job, at present, is only in the preliminary stages.

Rivers and Harbors and Drainage.—This class of construction for the week demands attention. From the U. S. Engineer's Office at New Orleans, La., has been issued a call for bids on about 1,093,400 cu. yds. of earthwork in the Lower Tensas and Atchafalaya levee districts, and from De Soto, Fla., a call for about $50,000 worth of repair work on the Quartermaster's wharf. At Marion, Ark., bids are asked by the Commissioners of Drainage District No. 6, Chittenden County, for over 53 miles of open ditches, comprising 1,645,600 cu. yds. of excavation, and at Atlantic, Ia., for 3½ miles of Indian Creek open ditch. At Worthington, Minn., bids are asked by the county on county ditch job No. 12 to cost $23,000. In the vicinity of Birmingham, Mo., a drainage district is proposed to levee land for industrial developments. A nice contract was secured at Bradentown, Fla., which calls for about 1,340,096 cu. yds. of excavation for main canal and nine laterals. This job was secured by Edgar Chapman of Plant City, at $113,000. The Northwestern Drainage Co., Thief River Falls, Minn., will excavate about 2,453,000 yds. of material in constructing Judicial Ditch No. 61 out of Roseau, Minn., and Rogers & Curtis Co., Minneapolis, about 274,000 yds. for County Ditch No. 15 out of Morris, Minn. The San Francisco Bridge Co. has a contract for 520,000 yds. of dredge work in Oakland Harbor, California.

Railway Contracts.

A much desired and long expected stranger made its appearance a couple of weeks ago. Several railway construction contracts were let. In fact, more work of this kind has been placed under contract during the past three weeks than was let in the entire first six months of this year. Of course this work is but a drop in the bucket as compared with the lettings of other days, but it was an encouraging development nevertheless.

Ventura County Highway System.

On Aug. 24, Ventura County, California, voted bonds for one million dollars for the purpose of constructing a system of paved highways. The election was carried by a majority of 10 to 1. The exact returns being 4,372 in favor of and 478 against the bond issue.

There will be improved under this bond issue about 104 miles of highway. The estimated cost of those items entering into the proposed improvement is:

Bridges and culverts......................	$ 170,000
Excavation and shaping roadbeds.....	204,000
Guard fences	9,000
Protection jetties	5,000
Pavement	563,000
Engineering and inspection..............	49,000
Total	$1,000,000

Two types of pavement were recommended, bituminous macadam and concrete base with the bituminous wearing surface. These two types are better known locally as Los Angeles County Specifications and State Highway Specifications.

All work of construction will be under the supervision of the County Highway Commission, composed of three members, A. C. Hardison, chairman; William McGuire and H. H. Eastwood. Their office will be at Ventura, Calif.

It is the plan of the commission to let contracts for the construction work, but all materials will be furnished to the contractors by the commission. To do this it will be necessary to install a rock crushing and gravel screening plant.

Some of the bridge work that is included in the road system will be started immediately. It is expected that contracts for several sections of the paving work will be let during the first months of 1916. The work will be prosecuted at such a rate that all construction will be finished inside of two years.

Bids Asked on Rapid Transit Work, Philadelphia.

Bids are invited until Oct. 19 by A. Merritt Taylor, Director of Transit of the city of Philadelphia, Pa., on steel superstructure work for the Frankford elevated line. This is the second contract to be let in connection with this particular section of the proposed Rapid Transit System, the first being awarded to James B. Dorney, of Philadelphia for column supports at about $150,000. The elevated work is to be divided into four contracts. The first calls for the superstructure in Front St., from Callowhill to south of Girard; the second in Front St. and Kensington, from south of Girard to north of York; the third in Kensington Ave., from north of York to north of Ontario, and the fourth in Kensington and Frankford Aves., from north of Ontario to south of Unity. These contracts are known as Nos. 511, 512, 513 and 514, and their respective approximate lengths are 4,074, 7,128, 7,769 and 7,653 lineal feet. Out of the $3,000,000 available for this feature of the work the Department of City Transit is expected to have sufficient funds to complete the structure as far north as Rhawn St., Holmesburg.

A New Drainage District in Missouri.

A drainage district has been organized in the State of Missouri to levee and protect about 5,400 acres of land for industrial development. It comprises territory immediately adjacent to the town of Birmingham. The first work to be put under contract will call for 10.8 miles of levee with a crown of 8 feet, slope on river side 3—1 and land side 2—1—station 0+00 to station 432; crown 6 feet, slope river side 2—1, land side 1½—1—station 432 to end. From station 2+60 to 209+70 the river side of the levee will be paved with rock, and the levee proper will call for 1,200,000 cubic yards of material and 50,000 square yards of paving. The maximum fill will be 18 feet, minimum fill 3 feet, and average fill 13 feet. The specifications provide for the construction of the levee 4 feet above the highest known flood. Bids will be called for on a basis of teams and drag line.

The necessary drainage work for the district will consist of interior ditches and drains to take care of hill and surface water, and together with pumping plant will be advertised and let after the levee work has been awarded to contractor. The nearest railroad stations to the work are Randolph and Birmingham, both being within the district and from one to five miles distant. The total cost of the district has been estimated at $335,400. Contracts will be let about November or December. John H. Powell, 312 Reliance Bldg., Kansas City, Mo., is secretary to the Board of Supervisors. Brooks and Jacoby, 512 Shukert Bldg., Kansas City, are the Engineers.

Bridge Work in the State of Maryland.

The State Roads Commission of Maryland has made up a rough estimate for the amount of bridge work necessary to connect up its new State road system. Borings for this work and a close preliminary cost are now being made under the supervision of Chief Engineer Henry G. Shirley. An idea of the amount of work required and its cost can be had from the following:

Allegany County—Arch in Narrows over Wills, Creek, $40,000; Flintstone, bridge over Town Creek, $15,000; bridge over Fifteen-Mile Creek, $14,000; total, $69,000.

Anne Arundel County—Bridge over South River, $220,000; bridge over Severn River, $250,000; total, $472,000.

Baltimore County—York Road, bridge over Western Run, $14,000; York Road, bridge over Gunpowder River, $16,000; Belair Road, bridge over Gunpowder River, $20,000; Belair Road, bridge over Herring Run, $25,000; total, $75,000.

Cecil County—Bridge over Principio Creek, widen to 24 feet, $12,000; bridge over North East Creek, 2 bridges in one, $15,000; Elkton, bridge over Elk River, $30,000; bridge over C. & D. Canal, Back Creek, known as Chesapeake Bridge, $100,000; bridge over Bohemia River, 167,000; bridge over Sassafras River,* $53,500; bridge over Susquehanna River, known as Conowingo Bridge, wood part (study), $15,000; total $392,500.

Charles County—Bryantown, bridge over Zekiah Swamp, $15,000; total, $15,000.

Dorchester County—Bridge over Nanticoke River, known as Vienna Bridge,* $67,500; and fill,* $40,000; total, $107,500.

Frederick County—Bridge over Catoctin Creek, near Middletown, $20,000; bridge over Catoctin on Jefferson Pike, $30,000; parapet and coping on bridge over Monocacy Creek, known as Jug Bridge, $3,000; total $53,000.

Harford County—Bridge over Susquehanna river, known as Conowingo Bridge, wood part (study),* $15,000; total $15,000.

Kent County—Bridge over Chester River,* $92,500; bridge over Sassafras River,* $53,500; total, $146,000.

Montgomery County—Darnestown, bridge over Big Seneca Creek, $14,000; total, $14,000.

Somerset County—Pocomoke City, bridge over Pocomoke River,* $30,000; total, $30,000.

Queen Anne's County—Bridge over Chester River,* $92,500; total, $92,500.

Wicomico County—Bridge over Nanticoke River, known as Vienna Bridge,* $67,500; and fill,* $40,000; total, $107,500.

Washington County—Bridge over Licking Creek (study), $35,000; total, $35,000.

Worcester County—Ocean City, bridge over Sinepuxent Bay, $200,000; Pocomoke City, bridge over Pocomoke River,* $30,000; total $230,000.

Total estimated cost of all bridge work, $1,854,000.

*County pays half.

NEWS LETTERS

St. Louis Items.

Harrington Bros. and M. C. Connors & Co. have been awarded contract for laying 50,000 ft. of water pipe at Christopher, Ill. This contract will amount to about $40,000.

A contract for the paving of Market St. with wooden blocks between Broadway and Twelfth St. was let by the Board of Public Service on Sept. 10. The board also contemplates the paving of the street with the same material from Fourteenth St. to Eighteenth St. in the near future. The contract for the Market St. paving was let to the Eyermann Construction Co. on a bid of $17,224. Another important street improvement for which a contract also was let on Sept. 10 is the paving with brick of Frosissant Ave. from Carrie Ave. to Bernays Ave. This was let to G. A. Heman, who bid $82,067. The awarding of this contract had been held up because several of the property holders desired bitulithic paving. The lowest bid on this paving was $99,000. Other street improvements for which contracts were let, the contractors and the estimated costs, are as follows: Marcus Ave., from Margaretta Ave. to King's Highway Northeast, brick, G. A. Heman, $29,707.40; Marcus Ave., from King's Highway Northeast to Florissant Ave., brick, G. A. Heman, $21,027; Ashland Ave., from Cora Ave. to Marcus Ave., asphalt, Granite Bituminous Paving Co., $5,844.45; Lilburn Ave., from Euclid Ave. to King's Highway, brick, Perkinson Bros. Construction Co., $7,650; Chariton St., from Broadway to Nebraska Ave., brick, Ruecking Construction Co., $7,614; Skinker road, from the south line of Forest Park to the south line of Forsyth Blvd., a private street, wood block, Webb-Kunce Construction Co., $84,712; Duncan Ave., from Vandeventer Ave. to Sarah St., running north of Duncan Ave., brick, Hanick Quarry & Construction Co., $13,480; Arlington Ave., from St. Louis Ave. to Natural Bridge Ave., brick, Hanick & Quarry & Construction Co., $15,493.

Geo. H. Sawyer, Beardstown, Ill., wants a 10 or 12 team outfit for day work, dressing levee near that place. Sawyer will supply slips. Work will last 4 or 5 weeks.

The J. W. McMurray Contracting Co. of Kansas City were awarded a contract last week by the Frisco R. R. Co. for building dikes on the Trinity river between Beaumont and Houston, Tex. Also secured a contract from the M. K. & T. R. R. on the Brazos river near Belasco, Tex.

E. Y. Sutherland has moved his office to 3905 North Broadway, St. Louis, Mo. Sutherland was awarded the contract for pile driving and decking bridge for the Illinois Terminal R. R. across Cahokia Creek near Edwardsville, Ill. This bridge was washed out several weeks ago by the flood we had in this part of the country. In addition to that Sutherland has a small job at the East St. Louis water works and another one at the Gabaret Slough Dike work across the river here. Sutherland has a few more pile drivers idle right now that he can place on work immediately.

List & Gifford Construction Co. of Kansas City were awarded a small steam-shovel job by the Illinois Terminal R. R. Co., near Alton, Ill.

R. J. Monahan of the Manegold Contracting Co. has been looking at several big jobs lately and we hope to be able to announce their being awarded one or more of them in next issue.

Quiet a number of new grading jobs are looming up in this part of the country. Contractors with idle team outfits send your names and addresses to Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 W. Fifth St., Kansas City, Mo. Mention size of your outfit and whether you are ready to ship on to work immediately or not. Koenig expects to have 23 miles of grading to let in this neighborhood within the next week or ten days.

The Alton, Granite & St. Louis Traction Co. are going to rebuild its tracks on Second St. in Alton in preparation for the proposed paving of that street. The improvement will cost in the neighborhood of $20,000.

The City of Alton, Ill., last week began preliminary plans for the biggest sewer building job ever undertaken in Alton. Mayor Beall states the sewer will inclose Shield's branch and will be large enough to carry a large volume of water, exceeding by 75 per cent the water that fell during the recent heavy rains. There will be a sewer district established, to be bounded on the east by Washington St. and on the west by Central Ave. It will extend north to Staunton St., where the Mayor has a project for paving that will extend from Central Ave. to College Ave., passing Rock Spring Park and completing a fine boulevard in Alton.

The Pitzman's Co. of surveyors and engineers, 615 Chestnut St., St. Louis, will receive bids until noon, Sept. 23, 1915, for grading approximately 600,000 cubic yards of earth work for the University Park Realty Co. in the western part of the city. Average haul is estimated at about 900 ft. and work will have to be completed by June 1, 1916. The work can be divided into six parcels.

The new addition to Koenig's Labor Agency is completed and the shower bath working fine. Koenig has 80 ft. of plate glass top counter in his office and considers it the most up to date and sanitary labor office in the country. Contractors when in this neighborhood call and look it over.

PERSONALS

Mr. R. S. Bryant, for many years consulting engineer for the Standard Welding Co. of Cleveland, Ohio, has been appointed factory manager in charge of all manufacturing.

Mr. H. W. Cregier, county highway superindent of Schenectady county, New York, is among the delegates to the Pan-American Road Congress, appointed by the Board of Trade of Schenectady, N. Y.

Mr. W. P. Danford, formerly city engineer of Durant, Okla., has been appointed to the position of assistant state engineer for the State Highway Department of Oklahoma. He is acting temporarily, until Oct. 1, as state engineer.

Mr. Charles B. Buerger, principal assistant engineer of the firm of George W. Fuller, consulting engineer, 170 Boardway, New York, has resigned. He has been appointed consulting engineer for the Atlantic Refining Co. of Philadelphia.

Professor J. G. D. Mack, for many years connected with the engineering department of the University of Wisconsin has been nominated by the State Railroad Commission as state engineer, under a law passed at the last session of the legislature creating an engineering department.

Mr. R. L. Sanders has been appointed resident engineer on the staff of the Illinois State Highway Commission. He was formerly associated with the American Society of Civil Engineers, assisting Prof. A. N. Talbot of Champaign, Ill., in the determination of railroad track stresses.

The Morgan Engineering Company, of Memphis, Tenn., have received notice of their appointment as engineers on the Upper Scioto Drainage and Conservancy District in Hardin County, Ohio. The work will consist of the preparation of plans for the protection of about 25,000 acres of valuable truck land, and for a portion of the city of Kenton, Ohio. This territory was recently visited by floods which did an immeasurable amount of damage. It is planned to begin the field surveys at once in order that contracts for construction may be let during the coming winter.

Mr. Charles L. Wood, civil engineer, formerly with the U. S. Coast Survey, has been appointed by the Board of Supervisors of Lowdnes County, Mississippi, as highway and bridge engineer for that county. He will have charge of construction and maintenance of all culverts and bridges.

Mr. Edward Anderberg has been appointed resident engineer in charge of terminal work in New York City and vicinity on the State Barge Canal. He succeeds Mr. Earl Talbot who has resigned. Mr. Anderberg was formerly assistant engineer in charge of bridge and lock work on the canal.

Mr. Julius Edgar Willoughby, assistant chief engineer of the Atlantic Coast Line Railroad, with headquarters in Wilmington, N. C., has been appointed chief engineer, succeeding the late Mr. E. B. Pleasants. Mr. Willoughby was born on Oct. 12, 1871, at Arkadelphia, Ala., and was educated at the University of Alabama. In 1887 he began railway work as a rodman on surveys on the Louisville & Nashville, a subsidiary of the Atlantic Coast Line. From 1892 to 1899 he filled subordinate positions in the land and engineering departments of the same road. In 1900 he was promoted to assistant chief engineer of construction for the lines in Alabama, and the following year became engineer of construction of the Alabama & Florida, now a part of the Louisville & Nashville system. For a while Mr. Willoughby left this country to do railroad work in Haiti. Upon returning to the United States in 1913 he entered the service of the Atlantic Coast Line as assistant chief engineer, which post he held at the time of his recent appointment as chief engineer.

OBITUARIES

Samuel Todd Davis, Jr., founder and president of the Locomobile Company of America, died Sept. 2, after an illness of three days, with cerebral hemorrhage, at his home in Sasco Hill, Southport, Conn. Mr. Davis was founder and first president of the National Association of Automobile Manufacturers.

Sir William Van Horne, noted railroad builder and financier of Canada, died in Montreal Setember 11, aged 72. Sir William was a native of the United States, and gained his first training in this country. He started in as telegraph operator for the Illinois Central, and after various experiences soon rose to the position of general superintendent of the St. Louis, Kansas City & Northern, in 1872. Before going to Canada he had been general manager of the Southern Minnesota and of general superintendent for the Chicago & Alton, and also for the Chicago, Milwaukee & St. Paul. In Canada he superintended the extension of the Canadian Pacific to the Western coast. He was knighted by Queen Victoria in 1904 in recognition of his work in the railway and industrial development of Canada. He was interested as officer or director in a large number of corporations in Canada, the United States and Cuba. He was called the "Hill and Harriman" of Canada.

INDUSTRIAL NOTES

Mr. C. H. Quereaux is manager of the Troy Wagon Works Co., 50 Church St., New York City, succeeding Mr. F. H. Graeney.

The Packard Motor Car Company, which employs 9,000 men, has fallen into line with the movement of the national and state governments to promote and encourage military training among the civilian population. President Henry B. Joy announces that the Packard board of directors, at a meeting held Tuesday, Sept. 7, passed a resolution to the effect that any Packard employe shall be granted leave of absence at any time he is eligible to take part in any military tour of instruction, naval reserve cruise or national guard encampment. It is expressly provided that such leave of absence shall carry with it full pay for the entire period of military instruction, and that the time shall not be deducted from the employe's regular vacation.

The National Tube Co., Pittsburgh, Pa., has received the Grand Prize, the highest possible award, at the Panama-Pacific International Exposition, "for the general excellence of its tubular products and fittings;" the greatest merit being recognized in the following special products:

"NATIONAL"—
- Oil Well Casing.
- Tubing.
- Drill Pipe.
- Drive Pipe.
- Drill Pipe and Tubing with upset ends.
- Line Pipe.
- Lead Joint Pipe.
  - All above manufactured in 40 ft. lengths.
- Spellerized Pipe and Boiler Tubes.
- Steel Poles.

"NATIONAL"—
- Protective Coating.

"KEWANEE"—
- Unions, Valves and Fittings.

"SHELBY"—
- Seamless Steel Tubing.
- Special Alloy Steel Tubing.
- Boiler Tubes.
- Cylinder and Flasks.
- Steam Pipe.
- Drill Pipe.
- Mechanical Tubing.
- Trolley Poles.

NEW CATALOGUES

GRAB BUCKETS.—Paper, 8¼x5¾ ins., 20 pp., The Owen Bucket Co., 525-527 Rockefeller Building, Cleveland, Ohio.

"The Business End of the Rig" is the title of a pamphlet which consists of photographs showing Owen buckets on various types of rigs and on various classes of work.

BLAWFORMS.—Paper, folder, Blaw Steel Construction Co., Pittsburgh, Pa.

Describes and illustrates some of the many types of Blaw steel forms, including those for sewers, shafts, manholes, curb, sidewalk and gutters, walls, floors, foundations, columns, etc.

TRACTOR.—Paper, 7x10 ins., 16 pp., The Good Roads Machinery Co., Kennett Square, Pa.

Bulletin K-C-R., describing the Yuba Champion Ball Tread Tractor, contains a number of views illustrating the work done by this tractor, and explains its construction in detail. Its distinguishing feature, the ball tread, is especially described, and the design shown in the cuts.

PAVING MIXER.—Paper, 8x10½ ins.; 88 pp. Waterloo Cement Machinery Corporation, Waterloo, Ia.

Describes and illustrates the Wonder Paver, giving specifications and details of special features. The paver is of the same type as the Wonder Mixer, embodying the rapid single-bearing tilting drum principle, combined with traction and paving distributing chute.

DRILL SHARPENERS.—Paper, 6x9 ins.; 24 pp. Sullivan Machine Co., 122 S. Michigan Ave., Chicago.

Bulletin 572, describing the Sullivan Drill Sharpener, a compressed air machine for forging and sharpening rock drill and hammer drill bits and forming shanks by hammering. Book is well illustrated and gives tables of dimensions, weights, etc., and lists of dollies and dies for standard bits and the usual forms of shanks.

The Colorado School of Mines at Golden, Colo., has established the Joseph A. Holmes Professorship of Safety and Efficiency Engineering, as a memorial to the late Dr. Joseph A. Holmes, director of the Bureau of Mines.

The next meeting of the Institute of Paving Brick Manufacturers will be held at the Purington Paving Brick Company's plant at Galesburg, Ill., Sept. 22.

RAILWAYS

BIDS ASKED.

District of Columbia:

Washington, D. C.—Until Sept. 21 by Bureau of Supplies and Accounts, Navy Dept., for 2,000 white oak railroad ties, and 500 burr oak and chestnut cross railroad ties.

PROSPECTIVE WORK.

Arkansas:

Guion, Ark.—A. C. Veach of Gravette is interested in the proposed construction of a railroad from this city to Melbourne, a distance of 12 miles up Rocky Bayou.

Georgia:

Macon, Ga.—Architect Fellheimer and Engineer Lawrence, of the Macon Terminal Co., have submitted plans and specifications to the railroad commission, for the proposed new $1,100,000 station. It is planned to place construction contract about Oct. 1 or Oct. 10.

Adrian, Ga.—F. J. Garbutt, of Sandersville, has purchased the Wrightsville, Adrian & Lyons Ry. Co., and plans to complete the line and put same in operation.

Kansas:

Larned, Kans.—An election is to be held in this city this fall to vote on a bond issue to make possible the extension of the Anthony & Northern R. R. into Larned. G. L. McLane, Chief Engineer, Hutchinson.

Hutchinson, Kan.—The Anthony & Northern Ry. will extend its line into Larned and Kinsley, before Jan. 1, in all about 50 miles. G. L. McLane, Ch. Engr., Hutchinson.

Kansas City, Kans.—City Commissioners have passed a 200-year franchise for the Kansas City Terminal Ry. It will now be sent to the Terminal Co. for approval and if approved will be submitted to the people. The franchise calls for the erection of one union depot to cost not less than $900,000 or two depots.

Kentucky:

Lexington, Ky.—The Lexington & Eastern Ry., according to reports, is locating a new branch line up Colly Creek about 6 miles, to tap coal and timber territory. H. C. Williams, Chief Engineers, Louisville.

Montana:

Billings, Mont.—Advices from this city are to the effect that surveys are being made for the proposed electric line up the Stillwater Valley to Cooke City.

Great Falls, Mont.—The Great Falls & Southwestern Ry. has been incorporated with a capital stock of $750,000. A line from Ulm, 11 miles east of here, about 60 miles to the mouth of Hound Creek, is proposed.

New York:

Middleburg, N. Y.—It is reported a Brooklyn Syndicate has had engineers in the field surveying for an electric railway line, from Catskill via Middleburg to Richfield Springs.

Albany, N. Y.—Until Sept. 20, extension of date, by Board of Contract and Supply, for the purchase of a franchise for a street railroad in Madison Ave. and Grand St.

Oklahoma:

Oklahoma City, Okla.—The Fort Smith & Western R. R. is reported to have made definite plans to build into this city from near Warwick, about 35 miles distant. Terminal property has been acquired. A. L. Mills, General Manager, Fort Smith, Ark.

Oregon:

Portland, Ore.—The Oregon-Washington R. R. & Navigation Co. will build its proposed line between the Point Defiance line and Olympia, Wash., at once. The work is to be completed this fall; grading has already been done. Estimated cost $500,000. J. P. O'Brien, Gen'l Mgr., Portland.

West Virginia:

Grafton, W. Va.—The West Virginia Midland R. R. plans to standard gage its road from Holly Junction to Webster Springs and tunnel the mountain, which will make the

Engineering and Contracting

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and to Methods and Cost of Construction**

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How the Engineer Can Widen His Influence and Better His Condition.

In an address delivered before the American Association of Engineers, and abstracted in this issue, Professor F. H. Newell calls attention to the fact that the engineer is rapidly awakening to a realization of his duty to society in general, to his profession, and to himself in particular. It is becoming increasingly evident that engineers are giving more serious attention to their welfare and influence, and are seeking to correct errors which have prevented them from securing fuller recognition from the public. At first, discussion centered largely on the direct compensation of the engineer, but it is encouraging to note that the term "compensation" does not enter so largely into the present discussion. It is being realized by those who have given the subject careful consideration that a more general recognition of the engineering profession, bringing with it improved conditions, must be secured on the grounds of public service. The public must be educated to a better understanding of the service which the engineering profession can, and is, rendering, and the engineer must present his claims for recognition in such a way that they will be readily accessible to, and understood by, those not technically educated in engineering.

In his discussion of the subject Professor Newell, who was formerly chief engineer and director of the United States Reclamation Service, stated that the quality which distinguishes the engineer as a professional man from his brother, the mechanic, is education. To be an engineer in the true sense one must possess an education which will enable him to understand the true perspective of things, to know the big from the little, to obtain facts, and to judge correctly from these facts. To build the foundation for such an education we believe our engineering schools must give increased attention to those subjects which teach the fundamental principles of engineering, supplemented by subjects which tend to educate a man broadly and thus enable him to occupy common ground in dealing with well-educated men in other lines of work. In the past the average engineer has not appeared to advantage in dealing with the public.

In speaking of service Professor Newell said:

> What is this service which all should be eager to render and which is the fruition of years of training? What do we mean when we claim that the highest function of the engineer and his greatest reward is found in engineering service? The word conveys the idea of help rendered to another, not as a favor involving an obligation, nor, on the other hand, as a matter of self-sacrifice. It is something which may be expected, although it cannot be demanded, and may be performed among equals. Service consists of those acts which tend to lessen trouble or increase the health, prosperity and convenience of others.
>
> Engineers in performing service are by this very fact entitled to full recognition. Service implies a suitable reward, and, while the effort may be altruistic, it does not involve unnecessary self-denial. A proper remuneration, one assuring a good living, is due the engineer.

By his training the engineer is particularly fitted for public service, but he has not been able to accomplish the most good because the public has not been educated to a realization of the service which he is capable of performing. As pointed out by Professor Newell, the public is not wholly to blame for its lack of appreciation—the engineer is to a certain extent culpable. He has not fully felt the need for diffusion of information, except among his professional brothers. He has not taken the public into his confidence and explained, in ways which would attract the public, the results already achieved, nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work affects him, or how his condition may be improved. In this respect the engineer unquestionably has shown a decided weakness. He has demonstrated that he can solve great engineering problems of vital interest to all, but he has not shown the same degree of intelligence in improving the human machinery or in his dealings with other men. In other words, he has proved himself to be a good mechanic but a poor salesman.

As has been pointed out previously by this journal, engineers can greatly benefit themselves, and at the same time better serve the public, by increased attention to those factors which do not involve the technical side of their profession. By co-operation, by educating the public to an appreciation of the service which they are capable of rendering, and by cultivating those qualities which tend to make them better citizens and better neighbors, they can vastly improve their present standing. Professor Newell deserves credit for the attention and skill which he is bringing to bear on this important subject. We believe the success of the American Association of Engineers, or that of any like organization, will depend upon its facilities for treating problems similar to those discussed by Professor Newell.

Analysis and Publication of Highway Commission Construction and Maintenance Cost Records.

Anyone who has examined even briefly the records and reports filed in the offices of state highway commissions has been impressed with the volume of the information that they contain. Also anyone who lets himself think further is impressed with the deplorable fact that because of failure to collate and analyze this information a large part of its value is lost. This statement is not made in criticism. Because of the overburden of actual construction problems which leave little or no time for statistical analyses and also because limited funds and restricted application of funds granted do not permit expenditures for statistical bureaus, state highway officials have had small liberty in the directions indicated. These are faults that should be corrected.

Road building under state direction has long ceased, in most states having highway commissions, to be an avocation of the body politic and has become an established vocation. The time then to take account of the work done and the procedure followed has arrived. No business management outside of public works business management would for a moment think of not making such an inventory and accounting. There are evidences that the force of this truth is being felt. In several states bureaus of the highway department have been inaugurated and set at work studying the work done and the methods being followed for the purpose of determining their economic efficiency. In our issue of Sept. 8 and again in this issue we publish accounts of the system of recording and analyzing road construction and maintenance data by the New York state highway department. Whether or not the system of records described in these two articles is in all respects the best that can be devised may perhaps be argued, but there can be no question that the New York highway department equipped with these records is in a more advantageous position to conduct economic road construction and maintenance than is New York state or any other state without such records.

In the article which we publish in this issue, Deputy Highway Commissioner Breed urges not only that construction and maintenance records should be compiled, but that all states should unite in formulating and keeping a uniform system of records. The usefulness of such concerted action is obvious. To believe in its early accomplishment is a strain on credulity. For years a uniform system of municipal accounting, and in particular a uniform method of presenting water works accounts, have been urged with energy. There has been progress. Indeed the progress may be justly claimed to have been great, but withal adoption of uniformity has been only partial. We can hardly hope for more rapid progress in adopting uniform recording of road data by state highway commissions. But the idea is a worthy and meritorious one and the road organizations to which Mr. Breed appeals for support can extend it in few causes more worthy.

Whether the states having executive highway commissions adopt uniform methods of recording construction and maintenance data or whether each state adheres to an individual method there is one thing that all states can do and which we have urged before they should do. This thing is to make public their records or at least the analyses of these records. A few years of such publication would furnish data to place highway construction and maintenance on a higher plane than is now conceived of. There is an obligation on highway commissions as public servants to make such publication of their determinations. And the excuse of lack of funds is no excuse. There is not a state highway annual report published that does not contain pages enough of useless schedules of names and lists of routine expenditures entailing enough clerical and publication expense to accommodate and pay for all the analyses of construction and maintenance economics that are in any year worth publication.

Percolation and the Upward Pressure of Water on Dam Foundations.

Subjects for discussion in dam design have a strong leader in "Upward Water Pressure." At the extremes of the discussion are disputatious advocates—one set proclaiming it criminal design not to provide for upward pressure, another set protesting it to be a negligible factor—and between these extremes are the majority of engineers confessing uncertainty and playing safe in design by resort to mass and weight. The state of mind that prevails is due very largely to want of facts. There is considerable information about upward pressure on foundations on sand and gravel, but there is almost no information about upward pressure on foundations on rock. It is known that such pressure exists, but how great or small it is cannot be calculated. As a recent writer puts it: "Until accurate experiments are made to determine the exact force of this upward water pressure with different rocks, assertions may be confidently made that it is 3 per cent with shale or 96 per cent with granite, for there will be no proof to the contrary."

As a contribution to facts relating to upward pressure we have had translated results of the German experiments conducted at the Oester and Nye dams. This translation is published in another section and we urge its careful study by those interested in this question of upward water pressure. As supplementary reading reference is made to "Percolation and Upward Pressure of Water," written by Capt. W. A. Mitchell, U. S. Engineer Corps, and published in "Professional Memoirs," January-February, 1915. Captain Mitchell's paper is too voluminous and detailed to be given space in its entirety, but an editorial review of its conclusions will be worth study in connection with the German experiments just previously mentioned. These conclusions, it may be well to emphasize, are all drawn from recorded experiments.

Data on transmission of water pressure through rock and masonry are most scarce and, for this reason, being capable of dismissal soonest, may be considered first. Water pressure is transmitted slowly through concrete, more rapidly through joints in concrete and still more rapidly through joints between concrete and rock. In all these cases, if the water is allowed free exit, the pressure is practically negligible. In joints the water travel is through small veins. Closure of exit raises the pressure to that given by the head of the upper pool. The area of pressure varies with the amount of space occupied by the small veins, and this may range from nearly zero to half of the total joint area or to even more. These are, it will be repeated, the conclusions from available records of experiments. It is observed that they give no precise information; pressures exist, but their amounts cannot be calculated.

Percolation and pressures of water through soil foundations have been most carefully determined by the tests conducted in 1913-14 under the direction of the U. S. Engineer Office at Wheeling, W. Va. The materials listed were washed sand passing a ¼-in. screen; washed gravel from ¼ in. to 2 ins.; gravel aggregate which was river bottom mixture of sand, gravel and mud, and alluvial soil which was ordinary river bank sedimentary deposit. As might be expected, the percolation was greatest in washed gravel, less in gravel aggregate, still less in washed sand and practically negligible in alluvial soil; pressure where exit of water was closed varied, naturally, as did percolation. Summarizing in more detail the following facts were concluded:

With drainage provided, water pressure through alluvial soil is negligible. Such material, however, has little resistance to erosion and a running leak soon disintegrates it. Drains to relieve pressure must therefore be so devised that only percolation and no erosion takes place. With washed sand, as with alluvial soil, only very moderate drainage is required to relieve upward pressure. In the tests made, with outlet closed at the toe of the slab, one open hole reduced pressure to one-twentieth of the head. With a row of sheet piles at the heel and free exit at the toe, the upward water pressures varied from ⅓-head at the heel to ¼-head at the toe.

Gravel aggregate, which was the natural river bed deposit, permits more active percolation than sand, and of course pressure heads are transmitted through it more quickly and with greater intensity. For example, with exit closed at toe of slab one relief hole, such as is mentioned above for sand, reduced upward pressure to ⅛-head. Obviously, more relief holes are required for gravel aggregate than for sand. With heel cut off by sheet piling and free exit at toe, the recorded upward pressure on the slab were 1/16-head at heel and 1/40-head at the toe.

Washed gravel gives smallest resistance to percolation and with exit at toe closed numerous relief holes are necessary to relieve the foundation from pressure. With heel cut off by sheet piling and free exit at toe the upward pressures recorded were full head at heel and ⅓-head at toe. A fact to be noted at this place and disclosed by the tests of sand and gravel is that the upward pressure decreases in intensity from heel towards toe. For the less permeable sand and gravel aggregate there is shown also a loss of head on entrance at the heel.

Percolation is a danger to dam foundations because of undermining as well as because of upward pressure. When the ratio of head to length of travel from heel to toe exceeds a certain amount, varying with different soils, a channel of flow is established and "boils" occur below the toe. As soon as the current in the channel of flow becomes fast enough to carry the surrounding soil grains undermining begins; continued, this undermining may remove enough material to cause the dam to fall in. If the soil is alluvial the action may be so rapid that no warning of collapse is given.

These conclusions, very briefly stated, indicate that consideration of upward pressure of water is essential in designing dams. Available test records of upward pressure are, however, not quantitative. This is most particularly true of rock foundations. Until more precise pressure data are determined dam design specifically to resist upward water pressure must be more or less tentative. In a succeeding issue there will be given accounts of some tentative designs as worked out by the engineers of the Ohio River Board.

GENERAL

German Studies of Uplift Pressure on Masonry Dams.

Abstracted by Alfred W. Hoffmann from an article by R. Schaefer in Zeitschrift fuer Bauwesen.

A large number of big and important dams have been built in the Rhine province and in Westphalia, Prussia, during the last twenty years, most of them having been designed by the late Dr. Intze, Professor at the Technical University at Aix la Chapelle, one of the greatest authorities on this subject. These structures were designed to be stable against direct water pressure; no uplift pressure was taken into consideration. None of these structures failed, yet it was found that the actual stability or safety against overturning was not so great as anticipated. This observation, combined with the fact that slight leakage of water occurred in most of them, seemed to prove the existence of an additional overturning force which could not be caused by anything but the uplift pressure of the water filtering into the ground under the dam or into the masonry itself. Professor Intze devised, shortly before his death, a method for measuring this uplift pressure which was used for the first time at the Oester dam by Mr. R. Schaefer.

A number of vertical pipes of about 2¼ ins. diameter were placed dry on the rock foundation of the dam, near the two main drains. These pipes were turned horizontally, at the elevation of the drains, into the same and closed. A smaller pipe which was fitted at its end with an indicator from which the pressure above the indicator existing in the horizontal pipe could be directly read was inserted into the main pipe. By adding the vertical height from the rock surface to the horizontal pipe, the total uplift pressure was easily found.

The test pipes at the Oester dam were located in four transverse sections through the dam, one to each side of the two main drains and approximately parallel to the same, as indicated in Fig. 1, p. 219. The test pipes *a, b, c, d, f, g, h* and *i* were set upon an absolutely dry rock surface. The test pipes *e, k, l* and *m* were placed on the surface of water carrying rock, near the maximum flow but not exactly into the same. A spring of water existing near the test pipe *k* had been led into the nearby drain. This spring discharged 72 liters per hour before the basin was filled with water. When the water level had reached the top of the dam it discharged 3,300 liters per hour.

The rock foundation for this dam was grey wacke and slate of widely varying description. Massive grey wacke was encountered near test pipe *g*, Fig. 1. On the left slope and near pipes *a, b, c* and *d* a crumbling slate was found. Deeper layers of slate full of cracks were encountered on the other slope, the cracks being filled with clay. These layers slope in the general direction of the valley.

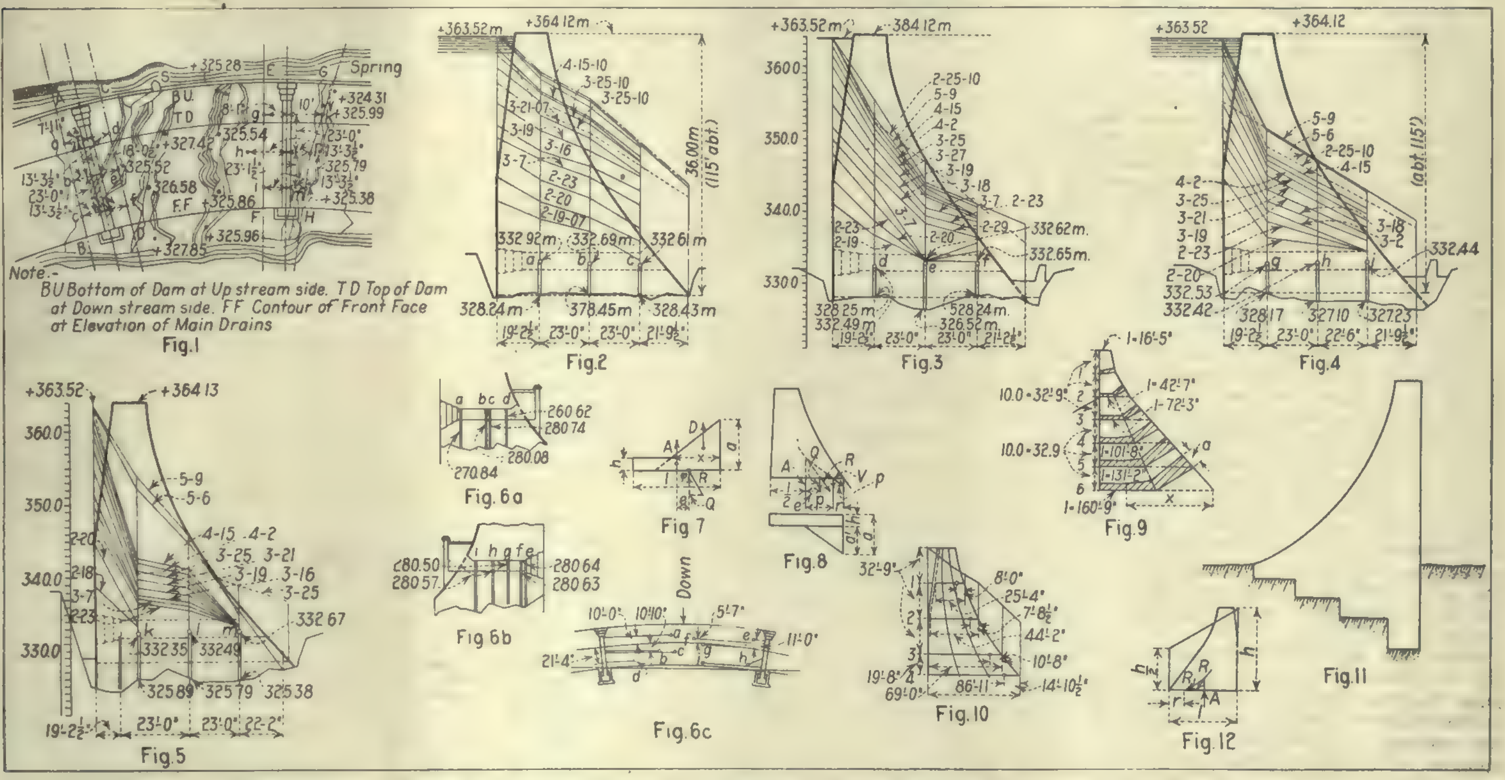
A large basin formed on the left slope by the grey wacke was filled with blue clay and shale. This clay and shale was excavated about 8 to 13 ft. below the intended base of the dam foundation, and concrete poured up to the surface. In connection with this preliminary work the above mentioned spring was brought under control and the test pipes *k, l* and *m* were set in place and concreted in.

The basin formed by the dam was filled with water between Feb. 16 and May 6, 1907. On May 6 the top was reached for the first time. The uplift pressure in the test pipes was measured during the process of filling and the actually measured pressures were plotted, and are shown by the heavy full lines in Figs. 2, 3, 4 and 5. The full light lines between the heavy lines and the back of the dam indicate the connection of the observed pressures with the water pressure behind the dam. The full light lines between the heavy lines and the front of the dam show the probable decrease of the uplift pressure near the front face of the dam. If we compare the four sections of the dam in which the observations were made, it is apparent that the pressures underwent considerable variations. In the sections *A-B*, *C-D* and *G-H*, it is reasonable to assume that the uplift pressure at the back of the dam was equal to the actual head of the storage water. This condition did not seem to prevail in section *E-F*, as is shown by the dotted line, which is the line of actual uplift pressure produced until it intersects the back of the dam.

In section *A-B* the pressure at the front is $0.43h$, or about one-half of the pressure at the back. In section *G-H* the pressure at the front becomes zero.

The uplift pressure is a maximum for section *A-B* where the depth of the foundation below the rock surface is a minimum. The uplift pressure is a minimum for section *G-H*, where the foundation had been carried to a greater depth below the rock surface than at any other section. Even if some allowance is made for the elimination of the above mentioned spring near this section, it must be concluded that the uplift pressure was reduced primarily by the increase of the depth of the foundation. This conclusion is also carried out by the fact that at the sections *C-D* and *E-F*, where the foundation was made somewhat deeper than at section *A-B* the uplift pressure was found to be correspondingly less than at section *A-B*. Other facts which will be reported later will tend to support this important conclusion.

The uplift pressure was reduced when the water level fell, and it increased with a rising water level. In most test pipes the pressure has, however, never again touched the maximum attained at the first filling. The only exceptions to this rule were pipes *e* and *m*, in



Note.- BU Bottom of Dam at Up stream side. TD Top of Dam at Down stream side. FF Contour of Front Face at Elevation of Main Drains

Figs. 1 to 12. Diagrams Showing Results of Upward Water Pressure Tests on a Masonry Dam.

which the pressure was greater in 1910 than in 1907. The diagrams of the maximum uplift in 1910 are represented by the dotted lines in Figs. 2, 3, 4 and 5.

A study of the pressure variations in section *G-H* reveals some highly interesting facts.

From May 4 to May 6, 1907, the pressure in pipe *k* rose 10 m (about 32 ft. 9 ins.), whereas it rose only 4.2 m (about 13 ft. 9 ins.) in pipe *l*, and only 3 m (about 10 ft.) in pipe *m* during the same period. The water level in the basin rose only 1.11 m (about 3 ft. 7½ ins.) in the three days during which these observations were made. This would seem to prove that the joint between the rock surface and the masonry did actually crack open, thus permitting the water to penetrate far below the dam. The uplift pressure attained its maximum in sections *G-H* and *E-F* not sooner than May 9, 1907, while the maximum was reached in sections *A-B* and *C-D* as early as May 6.

In 1908 the maximum pressure attained in test pipes *k* and *l* corresponded very closely to the pressure observed on May 6, 1907. The maximum pressure measured in 1908 in pipe *m* exceeded the maximum of the year 1907 by 4.5 m (about 14 ft. 9 ins.). On the other hand, the maximum uplift pressures measured in 1910 were considerably lower in pipes *k*, *l* and *m* than the maximum pressures observed prior to that year. The 1910 maximum pressure in pipe *k* was 15.2 m (about 50 ft.), in pipe *l* 5.1 m (about 17 ft.) and in pipe *m* 1.2 m (about 4 ft.) below the previous maximum. In the years 1909 and 1911 the storage water did not reach the top of the dam. It was, therefore, impossible to make comparisons with other years.

The considerable reduction of the uplift pressure in section *G-H*, in the years 1908 and 1910, may be explained by the fact that the spring near pipe *k* discharged 300 liters (about 75 gals.) more per hour into the drain than in 1907.

At the first filling in 1907 leaks were found in the head-races to the turbines, below the dam at each side of the ravine. These leaks reached a maximum of 9,900 liters (about 2,500 gals.) per hour on the right hand side, and 4,400 liters (about 1,100 gals.) per hour on the left hand side. The flow of water through these leaks decreased very rapidly, although the water level remained practically the same. The flow through the leak on the right hand side was, in 1908, reduced to 6,600 liters (about 1,650 gals.) and in 1910 to 4,950 liters (about 1,250 gals.) per hour, or about one-half the flow in 1907. It must be concluded that the leaks in the dam were gradually stopped by sedimentation and by filling of the pores with the minerals contained in the water. This observation is in harmony with the reduction of the uplift pressure measured in the test pipes in 1910.

If the faucets at the test pipes are opened, the water runs out under high pressure in a strong jet. At pipes *a*, *c*, *e*, *f*, *h*, *k* and *m* the pressure becomes zero in one to five minutes, and the water stops running. If, however, the pipes *b*, *d*, *g*, *i* and *l* are left running even for three hours, the pressure is not reduced by more than 11.5 per cent to 52 per cent, and the flow of water is still very considerable. In about 9 to 21 minutes after the faucet is closed again the full pressure is restored in the latter pipes. In the former pipes the full pressure was either not attained at all or only after several hours. These experiments were made while the water level was 19.9 m (about 65 ft. 3 ins.) to 21.4 m (about 70 ft. 2 ins.) above the bottom.

The conclusion to be drawn from the experiments made is that the rock under the dam contained many cracks and voids which gradually became filled with water. This water resulted in an uplift pressure acting on the structure. The resistance which the water had to overcome on its way down to the front of the dam reduced its pressure, and is a plausible explanation of the difference of the uplift pressure at the back and at the front.

The same arrangement of test pipes had been suggested by Mr. Schaefer, in connection with the revision of Prof. Intze's design for the Neye dam. Unfortunately, the pipes were not grouped conveniently in sections, and for that reason the results could not be so clearly shown in a few diagrams. The arrangement is shown in Fig. 6 (*a*), (*b*) and (*c*). The foundation for this dam was similar to that at the Oester dam, consisting mainly of grey wacke and slate. The various layers did not, however, slope in a direction parallel with the ravine, but almost at right angles with the same.

At the bottom of the ravine and near the left drain narrow and deep cracks were encountered between different layers of rock. These cracks were filled with soft earth. As much of the filling as possible was removed and cement grout injected into the hollows.

TABLE I.—UPLIFT PRESSURE COMPUTATIONS FOR SECTION OF DAM, FIG. 9.

		Joint I.	Joint II.	Joint III.	Joint IV.	Joint V.	Joint VI.
Head of water, h..	In meters........	10.0	20.0	30.0	40.0	50.0	60.0
	In feet...........	32'-9½"	65'-7"	98'-4½"	131'-1¾"	163'-11¼"	196'-8½"
Width of base, l...	In meters........	7.0	13.0	22.0	31.0	40.0	49.0
	In feet...........	22'-11½"	42'-7½"	72'-1½"	101'-7½"	131'-1¾"	166'-8"
Vertical component of R, Q..........	In long tons.....	138	368	771	1,381	2,198	3,222
Eccentricity of Q, e	In meters........	.75	1.44	1.62	2.20	2.86	3.40
	In feet...........	2'-5½"	4'-8⅝"	5'-3¾"	7'-2½"	9'-4½"	11'-1¾"
Uplift pressure, $A = h \times l$	In long tons.....	70	260	660	1,240	2,000	2,940
Resultant $V=Q-A$	In long tons.....	68	108	111	141	198	282
Eccentricity of V, p.	In meters........	1.52	4.91	11.23	21.60	31.75	38.30
	In feet...........	5'-0"	16'-1¼"	36'-10"	70'-10"	104'-1¼"	127'-2½"
$r = \frac{l}{2} - p$	In meters........	1.98	1.59	—.23	—6.10	—11.75	—14.30
	In feet...........	6'-6"	5'-2½"	—0'-9"	—20'-0"	—38'-6¼"	—46'-10½"
Fibre stress $a' = \frac{2V}{3r}$	In tons per sq. m.	23	45.3	*	*	*	*
	In tons per sq. ft.	214	421	*	*	*	*
Maximum fibre stress $a = a' + h$ ..	In tons per sq. m.	33	65.3	*	*	*	*
	In tons per sq. ft.	306	607	*	*	*	*
$m = 1 - \frac{hl}{R \cos \alpha} = 1 - \frac{hl}{Q}$		.493	.293	.144	.102	.090	.088
$n = \frac{2e}{l}$		.214	.222	.147	.142	.148	.189
$\frac{n}{m}$		.434	.758	1.02	1.39	1.59	1.58

*Infinity.

The test pipes *a*, *b*, *g* and *e* were placed upon such cracks filled with mortar; all other pipes were placed on perfectly sound rock.

When the basin of the Neye was filled for the first time, in February, 1910, the water level being 31.2 m (about 102 ft. 4 ins.) above the base of the foundation, the following uplift pressures were observed, all pressures being referred to the same base:

In pipe.	Uplift pressure. In meters.	Ft.	Ins.
a	17.61	57	9
b	16.50	54	1½
c	15.04	49	4
d	9.62	31	7
e	14.04	46	0½
f	17.33	56	10
g	16.47	54	1
h	13.61	44	7½
i	10.00	32	10

From these observations it follows that the uplift pressure is a maximum at the back and grows less as it approaches the front of the dam. The same conclusion had been reached at the Oester dam. The main difference between the two structures is the existence of considerably less uplift pressure near the back of the Neye dam, as compared with the pressure near the back at the Oester dam. At a distance of 4.27 m (about 14 ft.) from the back, the uplift pressure at the Neye dam was 57 per cent of the maximum head of water, while at a distance of 5.86 m (about 19 ft. 3 ins.) from the back of the Oester dam the pressure was 85.5 per cent of the maximum head of water in 1907, and was reduced to 71.2 per cent in 1910. This seems to be further proof for the conclusion that the uplift pressure becomes less as the depth of the foundation is increased, since the foundation of the Neye dam had been carried down to 8 m (about 26 ft. 3 ins.) below the rock surface.

Another reason for the difference in favor of the Neye dam is the more favorable slope of the rock strata.

With a view to reduce the uplift pressure if possible, a test was made with five drain tiles 7.5 cm (about 3 ins.) diameter, embedded in the masonry, in one-half of the dam only. These drain tiles discharged into one of the two main drains. The maximum flow of water through these drains was, in 1909, 25 liters (about 6¼ gals.) per hour for drain No. 1, 6 liters (about 1½ gals.) per hour for drain No. 3. Drain No. 2 dripped only and drains Nos. 4 and 5 remained dry.

After the drain tiles had been kept closed for 84 days the pressure in the nearby test pipes had not increased. It seems, therefore, evident that such an arrangement of drains in the masonry of the dam cannot be counted upon to reduce the uplift pressure on the base of the dam.

This writer believes that a drainage of the base of the dam itself might prove more effective. Such an arrangement would, however, require either pumping the water out of a sump in front of the dam or carrying it off in a ditch or tunnel through the rock.

Uplift pressure had not been considered at all in the design of the Oester dam. After the existence of a very considerable uplift pressure had been proved by the observations just described, an investigation of the stability of the structure was made on the following basis:

The greatest uplift pressure actually measured was used, and the assumption made that the distribution of the pressure was the same throughout all sections through the dam. The water level was assumed to be at the crown of the dam and the uplift pressure was correspondingly raised, as indicated by the dot and dash lines, Fig. 2. Allowance was made for the reduced pressures at the sides of the ravine where the heights of the dam are less. The formulas are derived as follows (See Fig. 7):

Let

R = the resultant of all forces acting upon the dam,

Q = the vertical component of R, or the sum of all vertical forces,

$\propto$ = the angle between R and the vertical,

e = eccentricity or distance between the center of the base and the intersection of R with the base,

A = uplift pressure, uniformly distributed over the base,

D = uplift pressure, variable, acting near back dam,

l = width of base,

x = base of triangle representing diagram of uplift pressure D, or zone of action of pressure D,

h = unit fibre stress at back of dam = head of water,

then, the fundamental equations are:

$$(1)\quad Q = R\cos\propto = A + D, \text{ and}$$

a = maximum fibre stress at front of dam;

$$(2)\quad Q.e = R\cos\propto.e = D\left(\frac{l}{2} - \frac{x}{3}\right).$$

Substituting D as found from equation (1) in equation (2).

$$3l - 2x = \frac{6eR\cos\propto}{R\cos\propto - A} = \frac{6e}{1 - \dfrac{A}{R\cos\propto}}$$

If we get

$$1 - \frac{A}{R\cos\propto} = 1 - \frac{A}{Q} = m, \text{ and}$$

$$e = \frac{nl}{2}, \text{ or } n = \frac{2e}{l}, \text{ we get}$$

$$3l - 2x = \frac{3nl}{m}, \text{ and}$$

$$(3)\quad x = \frac{3(m-n)}{2m}.l$$

Putting

$$D = (a-h)\frac{x}{2}, \text{ we get}$$

$$Q = A + (a-h)\frac{x}{2}, \text{ and}$$

$$a = \frac{2(R\cos\propto - A)}{x} + h, \text{ or}$$

$$(4)\quad a = \frac{2mR\cos\propto}{x} + h, \text{ and finally}$$

$$(5)\quad a = \frac{4m^2}{3(m-n)} . \frac{R\cos\propto}{l} + h.$$

TABLE II.—UPLIFT PRESSURE COMPUTATIONS FOR OESTER DAM, FIG. 10.

		Joint I.	Joint II.	Joint III.	Joint IV.
Head of water, h	In meters	10.0	20.0	30.0	36.0
	In feet	32′-9½″	65′-7″	98′-4½″	118′-0½″
Width of base, l	In meters	7.72	13.45	21.00	26.50
	In feet	25′-3¾″	44′-1¼″	68′-10¼″	86′-10½″
Resultant R	In long tons	146	447	939	1,336
Vertical component of R, Q	In long tons	138	400	812	1,140
Angle between R and Vertical	cos $\propto$	.939	.894	.865	.853
Eccentricity of Q, e	In meters	.78	1.94	2.42	2.43
	In feet	2′-6¾″	6′-4½″	7′-11¼″	7′-11¾″
Moment $M_r = Qxe$	In m. t.	117	775	1,964	2,769
	In ft. t.	1,089	7,210	18,270	25,750
Uplift pressure, A	In long tons	—41	—194	—467	—691
Eccentricity of A, b	In meters	—.76	—.66	—1.15	—1.66
	In feet	—2′-6″	—2′-6″	—3′-9¼″	—5′-5½″
Moment of uplift pressure, $M_a = A \times b$	In m. tons	31	128	537	1,147
	In ft. tons	288	1,190	5,090	10,680
Total moment $M = M_r + M_a$	In m. tons	148	903	2,501	3,916
	In ft. tons	1,377	8,400	23,360	36,430
$V = Q + (-A)$	In tons	97	206	345	449
$p = \frac{M}{V}$	In meters	1.53	4.38	7.25	8.72
	In feet	5′-0¼″	14′-4¼″	23′-9½″	28′-7¼″
$r = \frac{l}{2} - p$	In meters	2.33	2.35	3.25	4.53
	In feet	7′-7¾″	7′-8½″	10′-8″	14′-10¼″
$a' = \frac{2V}{3r}$	In tons per sq. m.	27.8	58.5	70.8	66.1
	In tons per sq. ft.	258	545	658	615
Water pressure at front, h′	In tons per sq. m.	2.8	10.2	14.2	15.4
	In tons per sq. ft.	26	95	132	143
$a = a' + h'$	In tons per sq. m.	30.6	68.7	85.0	81.5
	In tons per sq. ft.	284	640	790	758
$m = 1 - \frac{A}{Q}$		.703	.515	.424	.394
$n = \frac{2e}{l}$		.202	.288	.230	.183
$\frac{n}{m}$		.288	.560	.566	.465
$\frac{r}{l}$		$\frac{1}{3.32}$	$\frac{1}{5.72}$	$\frac{1}{6.45}$	$\frac{1}{5.85}$

The same results can be derived by the following method, which is even simpler (Fig. 8):

The resultant of the uplift pressure A which is applied at the center of the horizontal section or base can be combined with the resultant R to another resultant P which acts nearer the front of the dam. The size and location of the vertical component V of P can be determined from the following equations:

$$(6)\quad V = Q - A, \text{ and}$$

$$Vp = Qe, \text{ or}$$

$$(7)\quad p = \frac{Qe}{V}.$$

If p is less than $\frac{1}{6}l$, then the fiber stress is

$$(8)\quad a' = \frac{V}{l}\left(1 - \frac{6p}{l}\right).$$

If p equals $\frac{1}{6}l$ or more, then we get

$$a' = \frac{2V}{3\left(\dfrac{l}{2} - p\right)}, \text{ or, if we put}$$

$$\frac{l}{2} - p = r.$$

$$(9)\quad a' = \frac{2V}{3r}.$$

To this fibre stress the water pressure corresponding to the head of water above the horizontal section under consideration must be added. The total fibre stress is then

$$(10)\quad a = a' + h.$$

The dam section, Fig. 9, has been figured according to these formulas for an uplift pressure equal to the full head of water. The results of the computations are given in Table I. It will be seen that this dam section which would be amply safe if uplift pressure is disregarded, would collapse under the action of full uplift pressure, since the fibre stress becomes infinitely large in horizontal section III. We shall show later that this assumption is too severe. This example is, however, a very good illustration of the fact that if any of the larger dams were subjected to full uplift pressure as is claimed to exist, by some engineers, they would necessarily fail.

The same method has been used to check the stability of the Oester dam for the actual uplift only, and under the assumptions which were mentioned before, and the results have been tabulated, as shown in Table II. The line of resultant stress passes, as might be expected, outside of the middle third, as will be seen in Fig. 10, which is a section through this dam. At horizontal section II the resultant intersects only 2.35 m (7 ft. 8½ ins.) from the front. The ratio $\frac{r}{l}$ which is a good criterion for the stability becomes $\frac{3.25}{21.0} = \frac{1}{6.45}$. This ratio is very small, yet the structure is still stable, and the maximum fibre stress is only 8.5 kg per square centimeter (about 120 lbs. per square inch). The ratio $\frac{n}{m}$ (for the mathematical definition of m and n see equations 1 to 5) is smaller than $\frac{2}{3}$.

An investigation of the same dam for full uplift pressure gives the following results:

$Q = 812$ long tons.
$A = 21 \times 30 = 630$ long tons.
$V = Q - A = 182$ long tons.
$M_R = 1{,}964$ m. t. (about 6,440 ft. t.).
$M_A = O$.
$e = 2.42$ m. (about 7 ft. 11 ins.).
$l = 21.0$ m. (about 68 ft. 10 ins.).
$p = \frac{1964}{182} = 10.79$ m. (about 35 ft. 4½ ins.
$r = \frac{l}{2} - p = 10.50 - 10.79 = -.29$ m (about 11½ ins.).
$\frac{n}{m} = 1.02$.

Since r is negative the line of stress passes outside of the dam, and the latter must collapse.

Conclusions and Recommendations.—Foundation of a dam on good sound rock is the main requirement for low uplift pressures. It should, however, be plainly understood that every dam is subjected to some uplift pressure, even if the greatest care has been exercised in the selection and preparation of the foundation. It sometimes happens that water from distant layers of bad soil seeps through the strata offering the least resistance to the flow, and then is forced by the head of water through the rock underlying the structure. Sometimes such conditions are created by the increased water pressure, due to the filling of the basin behind the dam. At any rate, it must be considered impossible to eliminate entirely all uplift pressure on dams.

It is, however, possible to keep the uplift pressure low by proper care and precaution in locating the structure and preparing the foundation. Most of the large dams are built of ashlar masonry, which is considerably more impervious than concrete, such as in most cases is used for the bottom layer on the rock surface for the purpose of providing an even base on which to start the masonry. This common practice is to be condemned. The water forces a passage through the pores of the concrete, and then exerts an uplift pressure on the masonry. It is recommended to lay the masonry in cement mortar directly on the rock; care must be taken to fill all voids, and to fit the masonry to the irregularities of the rock surface.

The best protection against excessive uplift pressures, and incidentally the only reliable protection against sliding, is a deep foundation into the rock. The most important lesson to be learned from the tests as described before is the fact that the uplift pressure decreases with increasing depth of foundation. The present writer would suggest, instead of carrying the full width of the base far down into the rock, to provide a very deep foundation for the back of the dam, and to reduce gradually the depth as the front is approached. This scheme, as shown in Fig. 11, would be, this writer believes, the most efficient protection from excessive uplift pressures.

Since the uplift pressure cannot be eliminated entirely, the important question how much uplift pressure is to be considered in the design of a dam, remains to be settled. From the figures given before it is apparent that the assumption of an uplift equal to the full head of water extending over the entire width of the base is far in excess of the actual pressure existing in practically all dams. Almost all large dams in Germany which are very conservatively designed would fail if subjected to the full uplift pressure. If the latter were made the basis of the design, uneconomical structures would result, and the assumptions made not based on facts. Just what percentage of the full pressure should be considered will, to a certain extent, depend on local conditions. In most cases, where good and perfectly sound rock is the immediate foundation, it is recommended to assume the uplift pressure at the back to be equal to the full head of water, same to be decreased proportionately to one-half of the full head of water at the front, Fig. 12.

The dam is, then, to be considered safe and stable if the maximum fiber stress does not exceed the allowable limit (about 200 lbs. per square inch) and if r does not become less than ⅙ l. For dams not exceeding 36 m. (about 118 ft.) in height, a width of base of .74 h will satisfy these requirements.

In order to supplement the knowledge gained from the tests made at the Oester and Neye dams, it would be desirable to make provision for similar tests in the design and specifications for future dams. Test pipes should be so arranged as to allow the results to be plotted in transverse sections through the structure, at least five pipes being required in each section. The cost of such tests is negligible.

The Engineer Awakes.

(Abstract of an address before the American Association of Engineers, Sept. 14, 1915, by F. H. Newell.)

Now is the day of awakening of the engineer as a man and as a citizen to a larger realization of his duty to society in general, to his profession, and to himself in particular. He is not alone in this. The world-wide war has shocked into life many dormant conceptions and has opened the eyes of mankind to the larger claims of brotherhood. The horrors of the destruction of life and property and the ruthlessness with which the accumulations of centuries and the hopes of the future have been sacrificed is bringing about a reaction and is preparing the way for the growth of a larger human consciousness. The engineers in this peaceful country are not unaffected. Their occupation in a large part has been reduced and as a result they have been afforded time and need for thinking on these vital matters. They are getting fully awake to their part in the world's progress.

The present century is that of organization. The zeal for the study of efficiency, the demand for larger and more effective organizations, the value of preparedness, all of these are being forced on the attention of the thinking man; he is seeing as never before the need of organization and of sacrificing of some of his individuality in the interest of work for and with his neighbor.

What distinguishes an engineer? Before going further into details of this awakening, it may be wise to inquire what we mean when we speak of the engineer. It is a word in common use, but few of us can agree upon a definition.

The quality which distinguishes the engineer as a professional man from his brother, the mechanic, is education. The engineer is undoubtedly benefited if at the same time he is a good mechanic, although he may be a success even if he has little or no mechanical ability. To be an engineer in the true sense, he must have, however, that education which enables him to understand the true perspective of things, to know the big from the little, to obtain facts, and judge correctly from these.

Why should he serve? The education of the engineer, whether obtained through books or through things, has been largely at the expense of some other person—either society, the state, or his more immediate employers. It is safe to say that the great majority of engineers are indebted to some one for the opportunities which they enjoy; as a body they owe a duty to the state and to society as well as to their profession.

ETHICS.

It is this recognition of duty which gives rise to the ethics of the engineering profession and which distinguishes the engineer as a professional man from the ordinary mechanic, who from lack of this education does not feel bound to the same degree by written or unwritten codes. These ethics are well recognized, although, like many other matters of common knowledge, they are often difficult of exact definition. We know when they have been violated and yet may debate long as to the exact line between ethical and unethical conduct. The conception of engineering ethics is fundamental to the profession, and finds its highest expression in *service*.

Service to the public and to the engineering profession by means of service to the members should be the motto of any organization of engineers.

SERVICE.

What is this service which all should be eager to render and which is the fruition of years of training? What do we mean when we claim that the highest function of the engineer and his greatest reward is found in effective service? The word conveys the idea of help rendered to another, not as a favor involving an obligation, nor, on the other hand, as a matter of self-sacrifice. It is something which may be expected though it cannot be demanded, and may be performed among equals. Service consists of those acts which tend to lessen trouble or increase the health, prosperity and convenience of others.

Engineers in performing service are by this very fact entitled to full recognition. Service implies a suitable reward and, while the effort may be altruistic, it does not involve unnecessary self-denial. A proper remuneration, one assuring a good living, is due to the engineer. He who performs service rightfully does it with full expectation of reward, directly or indirectly, in the satisfaction of duty well done.

Among all the various occupations there is none which is more capable of leading in service to mankind and in realizing higher ideals than engineering. The engineer should be a man of vision—a missionary of light and progress. His life is devoted to careful, impartial measurement and weighing of facts. He cannot afford to be deceived or to mislead others on these facts; having ascertained them in their true proportion, it is then his business to idealize, to plan and to use his ingenuity in devising methods for adding to the comfort and convenience of mankind, such, for example, as through better conditions of transportation, of communication, of heating, lighting, water supply, and of the things which tend to produce better health and longer life in the community.

EDUCATING THE PUBLIC.

In this work the engineer is far ahead of the public. The latter in many ways has not yet caught up with the growth of knowledge and does not appreciate the possibilities which are awaiting realization under the touch of the skilled engineer. The people as a whole do not as yet have the vision of better things which lie within their grasp and which can be called into being when ignorance is dispelled. Many a community is existing or even declining because it does not utilize the available water supply or have constructed the needed sewerage system. The more progressive people and the young men are leaving to go to localities where these better things are accomplished.

The public is not wholly to blame. The engineer in part is to a certain extent culpable. He has not fully felt the need of diffusion of information, except among his professional brothers. He has not taken the public into his confidence and explained in simple terms, in ways that would attract the public, the results already achieved, nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work affects him or how his condition may be improved.

NUMBER OF ENGINEERS.

Without attempting to discriminate very nicely between the different classes of men who may be considered as engineers, it is safe to assume that there are in North America over 100,000 men whom we would class as "engineers," outside of the purely mechanical occupations. Of these over 40,000 are members of approximately 100 organizations. The greater part of this number is included in four great national societies, the membership of which in round numbers is as follows:

American Society of Civil Engineers.....	7,700
American Society of Mechanical Engineers	6,100
American Institute of Mining Engineers..	5,000
American Institute of Electrical Engineers	7,750
Total	26,550

The above total of 26,550 includes many duplications, particularly of names of the more prominent engineers, as they are usually members of two or more of these larger national societies. It is safe to assume that there are at least 20,000 engineers, embracing most of the men who have become leaders in the profession, included in the membership above noted.

These organizations have their headquarters in New York City, three of them in the Engineering Societies Building (29 West 39th St.), the headquarters also of a number of smaller organizations. Many efforts have been made toward co-operation among these, and at one time it was hoped that all four societies would come together under one roof. It is still possible that such results may be accomplished. There are certain advantages to be derived from physical contact, even though there may be no organic connection. Progress has been made to some extent at least by the formation of a Society of Technical Association Secretaries, by which means a certain unity of action may be produced on matters of common interest.

The organizations next in point of size are the Engineers' Society of Western Pennsylvania, with headquarters at Pittsburgh, 1,150 members; and the Western Society of Engineers, with office in Chicago, 1,200 members; next, the Associated Engineering Society of St. Louis, with 800 members.

The hundred or more local engineering societies organized at the principal centers of population have a membership each of from 100 or less up to 500 or more, averaging about 200. The importance of these societies has not been fully appreciated, even by their members, and the most enthusiastic will hardly claim that they are as yet fulfilling their largest or best function. They have in one sense boundless opportunities for useful work if only they can grasp them.

The total membership of these local societies aggregates in round numbers 20,000, so that for the purpose of discussion we may say that of the 100,000 men who claim the right to be called engineers 20,000 are members of the four national societies with headquarters at New York; about an equal number, including many of the above, are members of local societies; leaving over 60,000 of the men not enrolled in any engineering organization.

In the latter group are many men of ability and standing in the profession, who have never seen the necessity of joining with their fellows in organized efforts. By far the greater part, however, are the younger or less prosperous men who are performing routine work in engineering offices or engaged in the details of the country surveyor and engineer. As a whole, they include the more poorly paid professional men whose compensation averages less probably than that of the high-grade mechanics. We do not have any definite data on this point, but those who have employed engineers and graduates of engineering schools are aware of the fact that, under present conditions at least, we can obtain the service of highly educated skilled engineers as computers, draftsmen, office or field assistants at a nominal wage.

It is not the "submerged tenth" but the six-tenths for whom special appeal should be made to ascertain whether their condition may not be improved by applying to it the same painstaking study to ascertain the true facts and to provide a remedy as should be done by the engineer to meet and overcome physical obstacles. If we can solve some of the great problems of control of electrical current, of storage of floods, of winning coal and iron from the earth, of devising ingenious mechanism, we should be able by using the same degree of intelligence to materially improve the human machinery. We have, however, in the past often overlooked the things which lie nearest to us while going to the unsettled west, or to the ends of the earth, to attempt tasks more remote.

ENGINEERING RECRUITS.

To this large body of engineers there is being added each year about 5,000 recruits, mainly from the engineering colleges, more or less well trained in the fundamentals of engineering. There was a time within recent years when there was a demand for every one of these young men in active engineering work. At present, however, it is necessary that many of them go into other lines. It is not to be supposed that their education is by any means wasted, as the training of a good engineering college is probably the most valuable to be had in preparing young men for their life work in lines of trade and commerce. While during the first few years they may not receive salaries as high as that of other men of their age who have gone into business directly from the common schools, yet in the long run the training they have acquired gives them opportunities for more rapid and substantial progress.

One of the problems that is now confronting us is the fact that each year this large group of graduates, as well as the thousands of young men employed in engineering offices, are coming into a profession apparently overcrowded. This overcrowding, however, is more apparent than real. A relief is to be obtained not by limiting the influx of men, but rather by widening the field of service.

OPPORTUNITY.

The field is practically unlimited, the bounds extending with every improvement in the conditions favorable to human health, comfort and industry. Artificial limits, the cramping efforts of which we now appreciate, are set solely by ignorance. They exist only in the mind, and arise because of lack of knowledge by the public in general and of individuals in particular. To put it in another way, if every taxpayer and voter in the country, every town, city, county and state officer was fully aware of the conditions which surround him, and the extent to which the engineer could remedy or improve these conditions, there would be an immediate demand for all engineers who could be found. Take, for example, the matter of road building. The public has been slowly educated toward the need of good roads, but not so fully to the fact that to build these good roads a certain amount of skill and experience is needed. We have the spectacle, surprising in a country which prides itself on its good sense, of millions of dollars being spent on new roads and in improving old roads, often without any preliminary survey or study of correct location or preparation of plans and estimates, nor of adequate supervision of the work, even if well planned.

The amount of money which is being wasted today in the amateur efforts of elected officers, who will be replaced next year by men no better qualified, would furnish employment to a great part of the engineers in the country. The point to be observed, however, is not that we are arguing for the employment of these men, but that the claim is based upon the far more substantial grounds of benefit to the public and to the man who pays the bill.

Take the matter also of public health. Imagine for a moment that every local official was aware of the conditions which are affecting the health of his community and of his family, and that he knew that these conditions could be remedied by intelligent and skillful engineers, and, moreover, that the cost of this work would be far less than the extravagant waste of time and money now taking place because of preventable sickness and death; would he not at once set about employing the man who could save not merely the money values, but what is far more precious, the happiness and lives of his own kind?

The opportunities are boundless—they stand on every hand ready for us when we awake.

SALESMANSHIP.

To properly seize the opportunity the engineer who rises to the occasion must cultivate some of the qualities summed up in the term "salesmanship." We recognize that the success of many a merchant is due to a peculiar art which he has acquired and one which enables him to sell goods at a profit. We have more slowly come to recognize the fact that his success is due not to the fact that he personally makes a profit, but that the other party, the world to whom he sells, is benefited. It is true that for a time the merchant may sell inferior goods and may temporarily make money by so doing, but in the long run he has learned that the established business can only rest secure on honest advertising and on the realization by the public that he is performing a real service to mankind.

In the same way, the engineer to succeed must acquire the art of salesmanship. He may not recognize or label the quality, and may even deny its existence. He points to the code of ethics rigidly observed against advertising or self-exploitation, and yet, while conscientiously observing all proper rules of ethics, he may possess to a high degree the real art of presenting his ware in such a way as to convince the world that the general welfare is promoted by purchasing from him.

He has for sale not boots and shoes or legal opinions, but what is more difficult of delivery—he has ingenious but true ideals, he has imagination, trained by years of study and practice. He has acquired the power of making these "dreams come true," in proportion that the public or his employer recognizes these qualities, to that degree is he able to sell his wares. There is perhaps nothing more instructive to the young engineer than to try to ascertain the methods of salesmanship which have led to the recognition of certain well-known and respected engineers. Some have succeeded through or in spite of extreme modesty and a reticence which has been hard to break through; but in each case there has been not only true value of the goods to be delivered, but some quality of mind or action which has impressed upon others the fact that the goods are of superior value.

PARALLEL LINE OF ACTIVITY.

In the preceding paragraphs there have been very sketchily outlined the opportunities for service and an indication given of the great body of men who are available for such service to the community—one for which they are entitled to proper reward. In what has been said it is apparent that there are difficulties to be met. In the present awakening innumerable schemes have been suggested for action, but most of these fall under one or another of two principal lines:

First. Co-ordination and co-operation of existing engineering societies and organizations.

Second. Formation of one or more new associations devoted almost exclusively to the material welfare of the engineers.

These movements are the natural outgrowth of the discussion and unrest which has prevailed. They are not antagonistic and may be mutually helpful. Not all men think alike and the path which will be attractive to one group is not to another.

In establishing a new movement or society the burden of proof of the need of such organization is upon the promoters. If it is proposed to assume new costs and create new obligations, it must be clearly shown that there exists not only real need for this additional machinery, but that the public will be the gainer thereby. It is hardly to be expected under present conditions that any plans will be cordially received by the officials and by supporters of long-established and tested societies. As a rule engineers are conservative. They prefer to trust to veterans in the cause rather than to new volunteers, and above all things look for the efficiency and economy which comes from unity of action.

We can therefore hardly present too strongly the arguments for branching out on any new line. In what has been said it may appear as though undue emphasis has been placed upon the public welfare and too little upon the benefit to the individual. It goes without saying that the individual must be convinced that he has much to gain in entering upon a new movement, but at the same time we must not lose sight of the fact that no such movement as is now discussed can be successful unless it is firmly founded on the public welfare. This may sound a strange doctrine to those who have not given thought to the matter; it is the popular conception that every business man is looking out for himself and that his success is based upon purely selfish considerations and that every organization must do likewise.

SUMMARY.

Summing up the needs and opportunities, it appears that a great part of the main body of engineers is not fully employed to the best advantages to society and to themselves, with corresponding loss to all. Nearly two-thirds of those who may properly call themselves engineers, or perhaps 60,000 men, are not members of any well-recognized organization, and are not utilizing their potential strength to help themselves or each other. There is need of enlightenment, of raising ideals and of united effort toward better things. The existing engineering organizations, which include perhaps 40,000 men, are devoted almost exclusively to technical questions as distinct from those things which concern the engineer as an individual and a citizen. Few of the older societies attempt to bring in the rank and file of the profession.

Assuming that the great mass of engineers are now awakening to a full appreciation of their opportunities, there is every reason to suppose that with the use of their united intelligence an early and sure progress can be made. We cannot at once overcome all of the inertia of the past, but with a wider diffusion of information we may confidently look forward to a rapidly widening field of work and a larger appreciation of results to be attained. If we could only comprehend the power for good that exists in the united effort of this great body of intelligent, experienced men we could see that nothing can withstand their efforts. Properly directed, they may bring about in the near future even greater progress than in the past in the promotion of general welfare by the development of new industries, the creation of new means of communication, as well as the improvement of those now existing to a point where the dreams of the most optimistic have become solid facts.

WATER WORKS

Recent Experiences With Machine Banded Wooden Water Pipe in New Hampshire.

(Staff Abstract.)

EARLY USE OF BORED LOGS IN NEW ENGLAND WATER WORKS.

In the older American cities such as New York, Philadelphia, Boston, Portsmouth, N. H., and others, wood pipe was used in the first water systems installed, and at the present day these old pipes are removed in a perfect state of preservation. The writer has in his office a section of bored log pipe dug up in Bowdoin Square, in the city of Boston, during the excavation for the subway in the street, that is as sound as when cut in the forest. It is a white oak log 10 ins. in diameter, cut in octagonal form, with an inside bore of 4 ins. This was a part of Boston's first water system, laid more than 200 years ago. The water was taken from a pond on Beacon Hill, and this supply and pipeline was abandoned in 1814, when an extension to the State House occupied a part of the ground covered by the pond.

Several years ago the writer saw a portion of the ancient pipe lines at Portsmouth, N. H., dug up. This line was constructed with pine logs, of a 3-in. bore, with tenons and chambers similar to the modern stave pipe. Every pipe uncovered was as sound, and in as good condition for carrying water as when laid. This pipe must have been in the ground for more than 200 years, and its condition was in striking contrast to that of a riveted steel pipe replaced in that city the same year, which, after seven years' service, was riddled with holes. At Exeter, N. H., a similar wood pipe aqueduct was in use up to the installation of the present water system in 1886, and had given good service for nearly 100 years. The pipes of this aqueduct when encountered in street excavations are invariably found to be entirely free from decay.

These ancient wooden water pipes were bored logs, and in their manufacture the best part of the timber, namely, the heart, had been removed. It may be asked, Why, if wood pipe was so durable, was cast iron, or any other material, substituted? The answer to that question is just this: The old method of making a wood pipe, limited its inside diameter to the size of the log and, therefore, large pipes of this kind were necessarily expensive, and usually impracticable.

MODERN USE OF MACHINE BANDED PIPE IN NEW ENGLAND.

Machine banded wood pipe was first laid in New Hampshire in 1895 at Penacook, N. H., and in the following year at Antrim, N. H. Penacook is a suburb of Concord, the State capital, and this system was afterwards incorporated into the Concord water system. The Antrim water system, constructed in 1896, is a gravity system. Its source of supply is Campbell's Pond, some three miles north of the village, and the head is slightly over 200 ft. for the greater part of the distribution system. The entire system is laid with wood pipe. The writer on several occasions, during the past ten years, has seen sections of this pipe line uncovered, and has invariably found it as perfect as when laid with no apparent change whatever. The leakage here, as in all wood pipe lines that he has had to do with, is infinitesimal. Among other New Hampshire water systems using wooden pipe, most of them designed and constructed by the writer, are: Campton Village, a gravity supply, with a maximum head of 186 ft. The supply pipe here is 12 and 10-in. pipe, and the distribution mains are 8 and 6-in. pipe. This system was installed in 1905. Freedom, N. H., constructed in 1912, has a head of over 300 ft. on the greater part of the village. Neither of these systems have shown any apparent leaks or given any trouble, since their installation. Bristol, N. H., has a 20-in. wood pipe supply line, connecting the village distribution system with New Found lake, its source of supply. Laconia, N. H., has a wood pipe intake, extending 500 ft. into Lake Winnepesaukee, and connecting with their pumping station. Hudson, N. H., has an 8-in. supply line from Tarnic pond.

View Showing the Laying of a 14-in. Machine Banded Wooden Stave Pipe Around a Curve for the Pembroke, N. H., Water Works.

This year (1915) New Hampshire water systems are using a good deal more wood pipe than ever before. Salem, N. H., is using it for an extension, and Lisbon, N. H., for a supply line from a new source. The writer is constructing two water systems, with wood pipe supply lines, and one of them with a three-mile distribution line, on a suburban street. The smaller system is at Troy, N. H. The source, a small stream that drains the western slope of Mount Monadnock, and the wood supply line, of 12 and 10-in. pipe, some three miles long, lies in a narrow valley between high hills. The maximum head here on the lower parts of the village is 310 ft. The distribution system here is cast iron pipe. This is now in progress of construction, and is about three-quarters completed. The wood pipe used is of the Michigan type.

The Pembroke water system is a reconstruction and extention of the former Suncook water works, with a new source of supply. The old system, formerly owned by the Suncook Water Co., that supplied water to Suncook Village, in the towns of Pembroke and Allenstown, was never satisfactory, either in the fire service rendered, or the quantity or quality of the water furnished, and in 1914 was acquired by the town of Pembroke. In order to secure a satisfactory source it was found necessary to go to Pleasant Lake, in the town of Deerfield, N. H., some 14 miles away. Lake Pleasant is 316 ft. above the lower levels of Suncook Village. The first proposition was to convey the water from the lake to a reservoir nearer the village, at an elevation sufficient for a good fire service. But as the pipe line, necessarily following the valley of the Suncock River, would pass through a populous section, including two villages in the town of Epsom, it was decided to draw direct from the lake and to supplement the system with the old reservoir of the Suncook water system, that has a capacity of 3 000,000 gals. for emergencies. This reservoir is not sufficiently high to cover the new extension to Pembroke street, a residental section north of the village. The supply pipe line, 14 miles in length, that is nearly completed, is laid with 16, 14 and 12-in. wood pipe. The suburban distribution line on Pembroke street, four miles in extent, is laid with 8 and 6-in. wood pipe.

One-half of this pipe was purchased from the Wykoff Co. of Elmira, N. Y., and the remainder from the Michigan Pipe Co. of Bay City, Mich. The saving in first cost to construct these pipe lines under what it would have cost to construct them with standard cast iron pipe is slightly over $52,000. One river crossing 110 ft. in length was made with cast pipe. A section where the wood pipe saved considerable expense and difficulty, was in the first two miles from the source. Here the pipe was laid through a swampy tract of land. A portion of it was an impassable morass, except when the surface was frozen. These two miles were laid in December and January last. The surface of this ground at the time was frozen to a sufficient depth to hold up teams, and provide a footing for the pipe layers. At places the flow of ground water was so copious that it required the continual use of a 6-in. Cameron steam pump, operating day and night, to care for it. The trench required close sheet piling, carefully braced. This was laid with 16-in. pipe, and it would have been almost an impossibility to lay and calk cast iron pipe in this place, without incurring great expense. As the lake is elsewhere surrounded by high hills and ridges, this was the only practical place to get a pipe line out of it. This pipe was laid through the swamp at a true grade, the trench that averaged nearly 10 ft. in depth (the maximum being 14 ft.) was, when the grade did not carry it through the mud and quicksand, filled with brush and small wood removed from the right of way, and the pipe was laid on this, and weighted with sand bags, as it could not well be filled with water until connected with the intake. Considerable difficulty was experienced by the clogging with vegetable matter and roots, of the pumps first used, but after securing the Cameron pump we had no further troubles of this sort. This supply line has been well equipped with both air and vacuum valves.

For the Pembroke Street installation, wood pipe was chosen, mainly for the reason that the Manchester & Concord Electric Railway runs over almost its entire length; and as no provision for a return current is made there, an iron pipe line would undoubtedly have served to take this return current, with danger from electrolysis imminent. Upon Pembroke Street is located the Pembroke Academy, the town hall and other public buildings, several churches, and many fine residences. It is in fact the residential section of the town. Nearly all have large lots and some extensive grounds, so that service pipes are not very near together. The saving on 6-in. wood pipe over cast iron is small, and for city and village streets, where services are taken off at short intervals it should not be recommended.

Ablett & Bowes, of Cohoes, N. Y., are the contractors for this work. The difficult part of it, consisting of laying the 16-in. wood pipe through the bog was done on the percentage plan, as no satisfactory proposal was submitted for this part of the work. A considerable saving was made in this way. Mr. Frank S. Ablett, of the contracting firm, has been in immediate charge of the construction work, with Mr. Harry W. Sawyer, the business partner of the writer, as engineer.

The intake at the lake, where the pipe line extends about 200 ft. into the water, and the gate house at its extremity, were finished in January last. The ice furnished a firm footing, and a support for the sheet piling of the coffer dam used. The ice also made access and delivery of material comparatively easy. Hot water was used in mixing the concrete and a stove set inside the gate house helped in drying out, and in preventing freezing. This gate house and intake stands in about 15 ft. of water but as the lake at the time of its construction was drawn down to low water limits, only about one-half that depth of water had to be worked in.

ADVANTAGES OF WOODEN PIPE.

Wood pipe has, besides the saving in cost on both pipe and installation, these advantages:

(1) It is preserved by water, and not rusted or corroded by it.

(2) It is not corroded by any substance, or destroyed by acids or salts.

(3) Its carrying capacity is 20 per cent greater than cast iron pipe, and remains constant, while that of metal pipe decreases with age.

(4) It does not taint or affect fluids going through it.

(5) It does not burst if frozen. The elasticity of the wood prevents breaking.

(6) It requires less labor and experience to lay in place than metal pipe, and a considerable saving can be made here.

(7) It can, when service pipes are not taken off, be laid in shallower trenches than metal pipe, for it is not easily affected by frost.

In the writer's experience, while more or less joints show slight leakage when the pipe is first filled, they soon swell up, and give less trouble in the end than cast iron pipes do.

At Pembroke the cost of the various sizes of wood pipe in the ground were as follows (cost of laying the 16-in. pipe owing to the difficult location, etc., being abnormal):

Size of pipe, ins.	Cost of pipe, per ft.	Laying, per ft.	Total in ground, per ft.
16.........	$0.81	$1.60	$2.41
14.........	0.75	0.35	1.10
12.........	0.73	0.24	0.97
8.........	0.50	0.20	0.70
6.........	0.38	0.20	0.58

A close approximate estimate of cost for cast iron pipe in place of wood follows:

Size of pipe, ins.	Cost of pipe, per ft.	Laying, per ft.	Total in ground, per ft.
16.........	$1.30	$2.50	$3.80
14.........	1.15	0.60	1.75
12.........	1.05	0.45	1.50
8.........	0.62	0.35	0.97
6.........	0.40	0.30	0.70

This estimate for cast iron pipe is based on the weights necessary for the varying heads on this pipe line, at a price of $24 per ton and includes lead and jute for calking.

While it is not the purpose of the writer to recommend the indiscriminate use of wood, or for that matter of any kind of pipe, he would suggest that after a thorough investigation of all conditions applying to each particular case, wood pipe merits the fullest consideration for localities suited to its use.

ACKNOWLEDGMENT.

From a paper before the annual meeting of the New England Water Works Association by Arthur W. Dudley, Consulting Engineer, Manchester, New Hampshire.

Reasons for Retaining the Solid Wedge Type of Valve in Boston.

(Staff Abstract.)

A valve as generally considered by water works men consists in the main of three parts: the casing or body, the stem and the gate or plug. There appears to be a general uniformity or standard in the design of the casing and stem but in the matter of plug or gate for some reason or another a number of the manufacturers have abandoned the old solid wedge type of plug and have taken up with many and varied kinds of loose double discs with more or less complex expansion devices. Some of the manufacturers produce more than one design of actuating mechanism. This fact might possibly indicate that there was doubt as to which design is the most efficient.

The Boston Water Department manufactures its own gates, hydrants, bronze fittings, etc. All its fixtures are made from its own special designs and while in a general way they are similar to those used by various water works throughout the country yet in detail they differ.

Recently new sets of designs and patterns have been prepared for the manufacture of valves up to and including 12 ins. in diameter. The question of changing from the solid wedge to the loose double-disc was considered with the result that we adhered to the solid wedge with some slight modifications in its structure for the ultimate purpose of reducing its cost.

We were influenced towards this decision by several reasons, principal among which are the following: Sixty-seven years of experience with the solid wedge has developed no convincing reason why we should discontinue its use. No inherent weakness or objectionable characteristics have been observed during that time. It has done its work satisfactorily. Whenever it becomes necessary to remove from service a gate with a plug of this type, it is usually because of some defect in a part other than the plug.

This good record of durability and satisfactory service of the solid wedge is nothing more than a demonstration of the proposition that in things mechanical, simplicity should be the pre-eminent characteristic and that it is only through that property that true excellence is attained. The solid wedge can certainly lay claim to being mechanically simple and it is in this quality that we find its greatest virtue.

It is claimed by those favoring the double-disc type of valve in preference to the solid wedge that with the former a double seating is assured when the gate is closed with consequently increased tightness, and with very little frictional resistance on the way down.

In considering the merits of the respective types we were impressed by the fact that there is practically but one seat to a valve in operation and that is the seat opposite to the side on which the pressure is, hence the superfluousness of the second disc in the double seating plug of the expansion type.

In a hydrant designed and built for the High Pressure Fire Service of Boston the nozzles are controlled by bronze valves consisting of a single solid disc, loosely seated but closing tightly when the pressure is admitted to the barrel. Although these valve discs control an orifice only 3 ins. in diameter they prove the efficiency of the solid wedge by seating tightly through the force of an unbalanced pressure.

The author is informed that in San Francisco they have advanced so far on the premise that there is but one seat to a valve in action, that they are building a valve with parallel seats and a solid plug without a taper thus depending entirely upon the pressure to seat the valve.

What moved us furthermore in this matter was the uncertainty of the double disc type of valve overcoming rust and other solid matter that is generally encountered between the seats of valves infrequently operated, as against our ability to dislodge with the solid wedge an amount of such matter sufficient to allow of the tight closing of the valve by manipulating the wedge: i. e., raising and lowering it and crushing and washing out the obstructing material. The horizontal movement of the expanding discs is more apt to drive the matter against the seats with such a force as to adhere and prevent tight closing.

What also impressed us was the liability of the double disc plug by reason of its looseness when not seated to vibrate during a quick rate of flow, water hammer, air pockets or any other condition that would cause a disturbance in the main. The sound of this vibration might enter houses nearby and prove objectionable, but its serious possibility is the wear on the more or less complicated mechanism of the discs. I know of cases where the rings on the discs have been shaken off by vibration.

One of its weakest spots in my opinion is the opportunity for rust or other matter to accumulate between the discs and adhere to the various knuckles, hinges, wedges, trunnions, loose joints, etc., of the operating mechanism, clogging the same and interfering with their action. In waters of heavy lime content or those with a corrosive constituent, the effect would tend practically to put the valve out of commission. While in theory it is very attractive to contemplate the loose double disc plug descending without frictional resistance and upon reaching the bottom to expand to a watertight bearing on both sides, it strikes me that such smooth action a great many times is in theory only.

In a large city where a gate is frequently operated and is subject to rough usage by unskilled and indifferent men who are inclined to apply a surplus of energy to their work, a plain rugged type of gate is almost a necessity.

After an earnest consideration of the various points for and against both types we felt that we could not very well improve on the simple, sturdy and honest solid wedge that descends into its seat filling the same tightly and performing the chief function of a valve, viz., the absolute stoppage of the flow. Without complex mechanism its very simplicity insured its durability and reliability of action, and its record of many years' service without defect or weakness confirmed its claim for all those good qualities.

The wisdom of changing from a fixture of proved satisfaction to one which possessed possibilities of uncertain performance seemed doubtful to us, hence our decision to continue with the solid wedge.

ACKNOWLEDGMENT.

From paper by George H. Finneran, Superintendent of Water Service, Boston, Mass., before annual convention of the New England Water Works Association.

Works for the Collection of a Ground Water Supply at Brooklyn.

(Staff Abstract.)

The following matter is descriptive of the works, including two infiltration galleries, for the collection of the ground water supply of the Borough of Brooklyn of the City of New York.

The watershed from which Brooklyn derives its water supply is located along approximately the southerly half of Long Island, extending from Gravesend to the Suffolk County line, or a distance of about 35 miles and from about ½ mile north of southerly shore line to the summit of the ground water table which is located a short distance to the south of the ground surface divide or backbone of the Island. The watershed area within these limits comprises about 200 square miles. The underlying strata are mainly of coarse sands and gravel several hundred feet in depth with one or more intermediate clay beds.

The rainfall percolates slowly downward through the sands to the saturated sand bed and thence generally southerly toward the bays or ocean along the south shore. There is also a comparatively small flow of the ground water into the streams which during rainfall periods receive direct accessions from the rain. This slow-moving body of water has a downward slope of about 12 ft. per mile in a southerly direction from the ground water summit and its upper surface is commonly referred to as the "ground water table."

The collection system is located in the southerly portion of the watershed area about ½ mile north of its southerly limit and practically the entire ground water flow and stream flow is thereby intercepted.

Ten surface streams are utilized, of which number eight flow by gravity into the conduit system and two are pumped. In addition there is one storage reservoir with a content of about 880,000,000 gals., which furnishes a gravity supply into the conduit system and which is held in reserve. Twenty-seven pumping stations obtain their supply from the ground water flow of which number 25 are driven well stations and two are infiltration galleries. Four of these stations deliver their supply directly into the distribution system and 23 deliver into the conduit system. All water delivered into the conduit system is pumped into high level reservoirs from which it flows into the distribution system.

There are about 975 wells, varying in depth from about 30 ft. to about 325 ft., and varying in size from 4½ ins. to 24 ins. In general, the wells are of the iron pipe type with solid brass strainers. Some are of the slotted vitrified pipe type varying in diameter from 6 ins. to 18 ins., with a maximum depth of about 50 ft. The wells deeper than 90 ft. penetrate one or more blue clay beds and they are driven by means of a well driving machine. After the pipe has been driven to the depth desired, about 20 ft. of brass strainer with a short length of plain brass pipe and lead packer at the top is lowered into the hole; the casing is then pulled back, thereby leaving the strainer exposed to the water bearing sand and gravel. The lead packer is then expanded, thereby sealing the annular spaces between the strainer and the outer casing. Many of the shallow wells are also of the iron pipe type with solid brass strainers; these wells are placed by sinking larger casing to the desired depth by the weight and bucket methods; after all material is removed from within, the strainer with pipe attached is lowered; then as the larger casing is withdrawn, the annular space is graveled.

The two infiltration galleries have a total length of about six miles and are composed of vitrified pipe with socket, in 3-ft. lengths, varying in size from 20 ins. to 36 ins. The pipes are laid with open joints about 10 ft. below the ground water table, to a grade of .04 in 100 ft. toward a central pump well, located about midway in each gallery, from which the water is pumped into the conduit system.

Owing to the water waste campaign during the past three years, it has been possible to discontinue the use of six driven well stations and one stream of those previously mentioned, representing a saving of about 18,000,000 gals. daily and to furnish about 7,000,000 gals. daily to the Borough of Queens from the remaining sources of supply.

ACKNOWLEDGMENT.

Paper by Wm. F. Laase, Assistant Engineer in charge of Watershed Division, Department of Water Supply, Gas and Electricity of New York City, before annual meeting of New England Water Works Association.

Experiences With Electrically Operated Valve Installations, Under Remote Control, in New York City.

(Staff Abstract.)

In the event of a break in any part of the high pressure fire distribution system in the Borough of Manhattan, it is possible immediately to divide the network of mains into three districts, from one of the pumping stations, by means of electrically operated gate valves in the streets.

Two of these districts are separated by a line which extends across the city about midway between the two stations and the third is wholly included within the limits of one of these larger districts and constitutes what is known as the duplex system. This protects an area on the southeasterly side of the city, the mains in that section being so connected that in the alternate streets they receive pressure from one feeder and in the other streets from another feeder, both of which are separable at the pumping station, the only physical connection between the two sets of mains in the streets being through the motor operated valves controlled at the stations. The various hand operated valves on the boundary lines of the districts are always closed. In order to maintain good distribution the motor operated valves are ordinarily kept open.

Two of these valves were installed in 1911, one about ½ mile from the Oliver St. Station and one about 1⅞ miles from the Oliver St. Station. These are 16-in. Chapman valves operating with 2½-hp. 230-volt motors. The power is taken from the nearest service box in the street and the operating or control cables are carried to Oliver St. Pumping Station in ducts. The operating or auxiliary current is 115 volts. In 1913 three more valves were installed, one in connection with the duplex system described above, and two for the purpose of separating the stations. It was decided at the time to keep the stations regularly separated and for that reason, on the theory that the valves would be opened with full pressure on one side, 5 HP. motors were used in these two instances. It has proven impractical, however, to keep the stations always separated, principally because of the difficulty of giving reliable service on the border line as alarms are frequently sent from boxes some distance from a fire and the pressure might be applied to the wrong side of the system.

The distances from the point of control for these recent installations are: 1½ miles, 1 mile, and 1¾ miles, respectively, from the points of control.

In each station there is a panel board with labelled operating switches for each valve and index lamps showing red when the valve is open and green when the valve is closed. When the switch is thrown the motor in the vault is started by means of an automatic starter operated by an auxiliary circuit. The motor is geared directly to the operating nut on the valve stem. Attached to and revolving with the operating nut is an extension sleeve provided on the outside with a fine thread on which the reversing switch collar travels as the sleeve revolves. The position of this collar is adjustable so that the limits of its travel may be accurately set. The operation of the reversing switch results in shutting off the motor and reversing the field connections for the next start. The signal lamps at the station and in the valve vault are also changed in this operation.

The only mechanical difficulty encountered so far has been the separation of the extension sleeve from the operating nut on one valve. This permitted the motor to drive the wedge down on the seats rather hard before the overload relay broke the circuit. The operating nut and sleeves are now made in one piece and no more difficulty is anticipated from this cause. The electrical repairs in the past two years to the five valves have cost $120, which was expended principally in replacing solenoids and coils in the panel boards in the vaults, which while sealed with gaskets and heated by a 16-candlepower carbon lamp are still to some degree affected by dampness. A repair charge averaging $1 per month per valve, however, is not alarming.

The valves are operated every day from the station and are inspected, cleaned and lubricated every month. The cable insulation is tested every month. It may be interesting to note that the February test on one cable indicated an insulation resistance of 1,655 megohms per mile, while the same cable in July possessed an insulation resistance of only 365 megohms per mile. It is expected that next February the resistance will be back to 1,655. The two valves originally installed cost $9,895 including vaults, panel boards and control apparatus. The cables cost $3,200. The three later valves were installed with the rest of the distribution system and their cost is not definitely known. The cables, panel boards and all control apparatus for these three valves cost $10,397.

In order to determine upon proper charges to be paid for power for operating these valves, tests were made in opening and closing with 200 lbs. pressure on one side. The maximum power at the moment of starting to close was 5 HP. The maximum time for closing was 25 seconds; the maximum power at the moment of opening was 4.3 HP.; the maximum time of opening being 28½ seconds.

It was expected that some difficulty would be encountered in keeping these vaults dry and where permissible, drains have been installed through traps to the sewer. Several of the vaults, however, are too low to be so drained and the installation of syphons was considered, but they have not been found to be necessary. Leakages from valve stuffing boxes are almost wholly avoided by the monthly inspection. The operators at the pumping stations are instructed to close all motor-operated valves when a sudden or unusual discharge occurs while the station is operating at a fire or while the system is not under pressure. When pumps are in operation the station operator is at the switchboard and will detect a sudden discharge immediately on the Venturi meters directly in front of him. When the station is not pumping, however, the operators are not attentive to the meters and therefore signal bells and automatic cut-outs have been installed on the low pressure by-pass meters connecting the supply to the high pressure system. The ringing of the bell will, of course, call the operator's attention to the unusual flow through the meter and the automatic cut-out will prevent the loss of mercury which would otherwise result from such flow.

ACKNOWLEDGMENT.

Condensed from a paper before the annual meeting of the New England Water Works Association by Mr. Alfred Williamson, Mechanical Engineer, Department of Water Supply, Gas and Electricity of New York City.

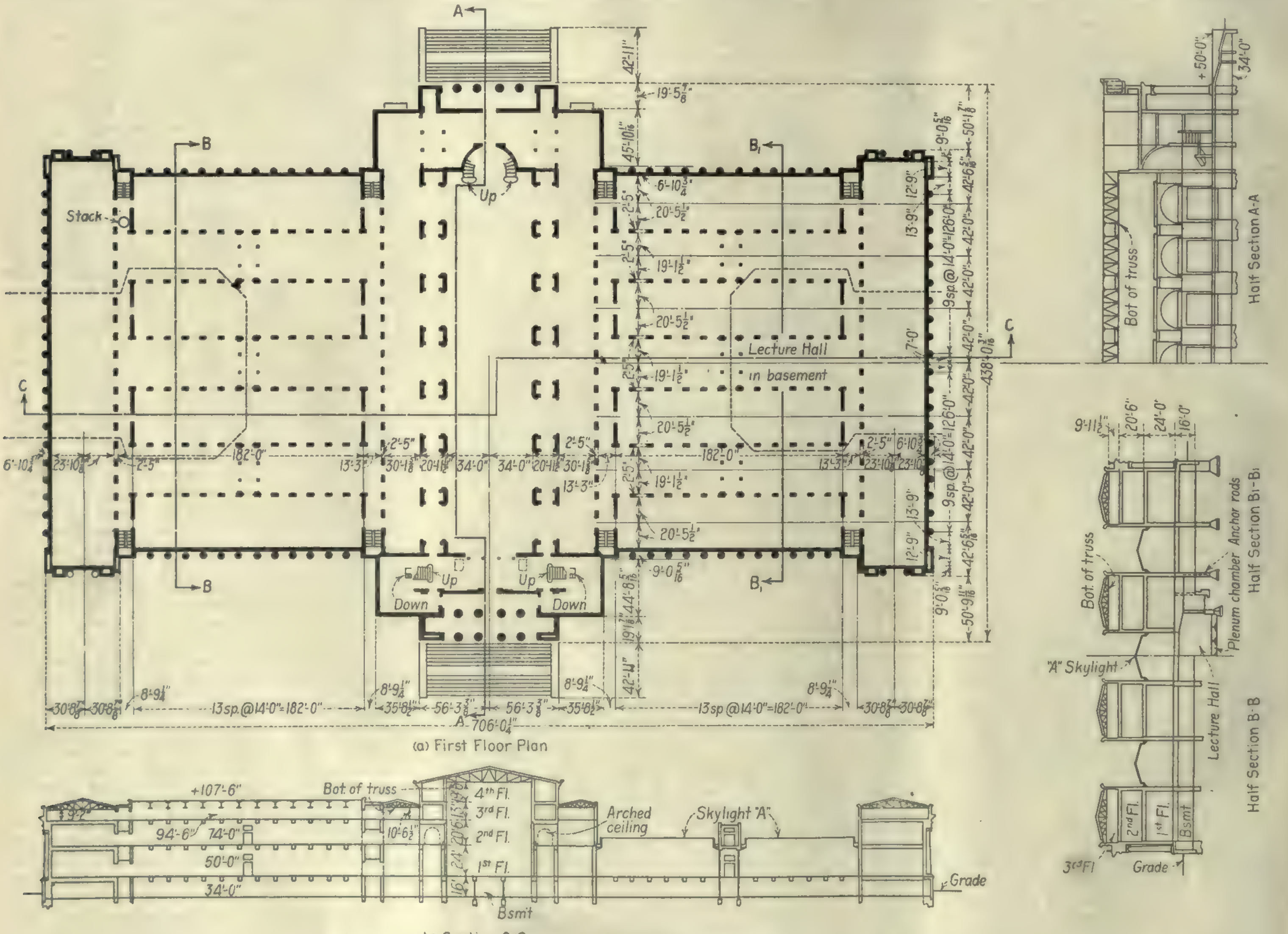
It is expected that the Delaware, Lackawanna & Western R. R. will open to traffic its Clarks Summit-Hallstead cut-off on Nov. 15.

BUILDINGS

Some Structural Features of the Field Museum of Natural History, Chicago, Ill.

(Staff Article.)

The Field Museum of Natural History, which is under construction in Chicago, will be one of the largest and most complete museums in the world. The site of the building is in Grant Park, east of the Illinois Central Railroad and just south of Twelfth St. The site was formerly a part of Lake Michigan, the original depth of water being about 15 ft. The building will be surrounded by a terrace about 40 ft. above the lake level, while the first floor level will be about 50 ft. above the level of the lake. The museum will cover an area of 357 ft. x 706 ft., and will have a floor area of about 670,000 sq. ft., of which about 400,000 will be devoted to exhibition purposes. The exterior of the building will be white Georgian marble, and the floor construction will consist of reinforced concrete on long-span steel beams, the ends of which rest on massive masonry piers, instead of columns. The total cost of the museum will be $5,100,000, and it will require at least two years to build it. The structure will be supported on concrete piers founded on wood piles, the pier bases being about 2 ft. 6 ins. below the lake level.



(a) First Floor Plan

(b) Section C-C

Fig. 1. First Floor Plan and Longitudinal and Cross Sections of Field Museum of Natural History, Chicago, Ill.

GENERAL ARRANGEMENT OF BUILDING.

With the exception of minor features the building is symmetrical about its east-and-west and north-and-south axes. Figure 1 (a), which is the first floor plan, gives the principal dimensions of the structure and shows the arrangement of the entrances and display divisions of this floor. Figure 1 (b) is an east-and-west section of the building. By referring to this drawing it will be noted the alternate bays of the wings are one story high and are provided with a skylight roof; this arrangement provides excellent light for the museum displays. Figure 1 (c) is a half north-and-south section along the center line of the structure; while Fig. 1 (d) is a half section through the east wing and a half section through the west wing and lecture hall. The use of masonry piers instead of interior columns gives the effect of separate rectangular display divisions and at the same time affords passageways between the various divisions.

Figure 2 is a partial section at the east side of the building showing the original lake bottom and the heights to which the site is to be filled. It will be noted that the pile foundations are cut off 2 ft. 6 ins. below the lake level, necessitating the use of tall concrete piers.

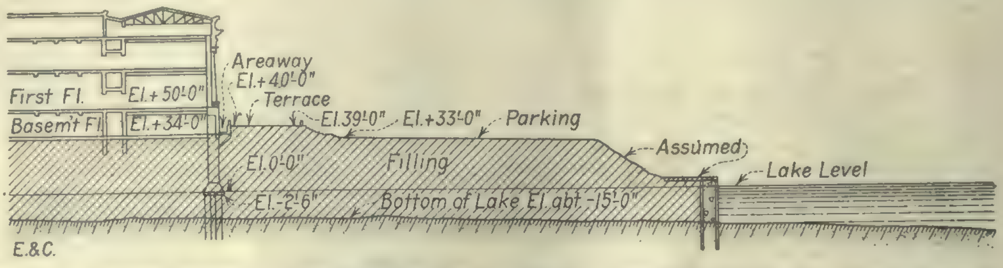


Fig. 2. Partial Section at East Side of Field Museum Showing Original Lake Bottom and Heights to Which Site Will Be Filled.

CANTILEVER GIRDERS OVER LECTURE HALL.

The lecture hall is located in the basement at the west side of the building. To provide sufficient space, unobstructed by piers or columns, it was necessary to use heavy cantilever girders (for location see Fig. 1d). These girders have a total length of 45 ft. Each girder is anchored into a concrete pier at one end and is supported on a steel column at a point 15 ft. 10½ ins. from the other end. Figure 3 shows details of one of the girders and of the anchorage and support for it.

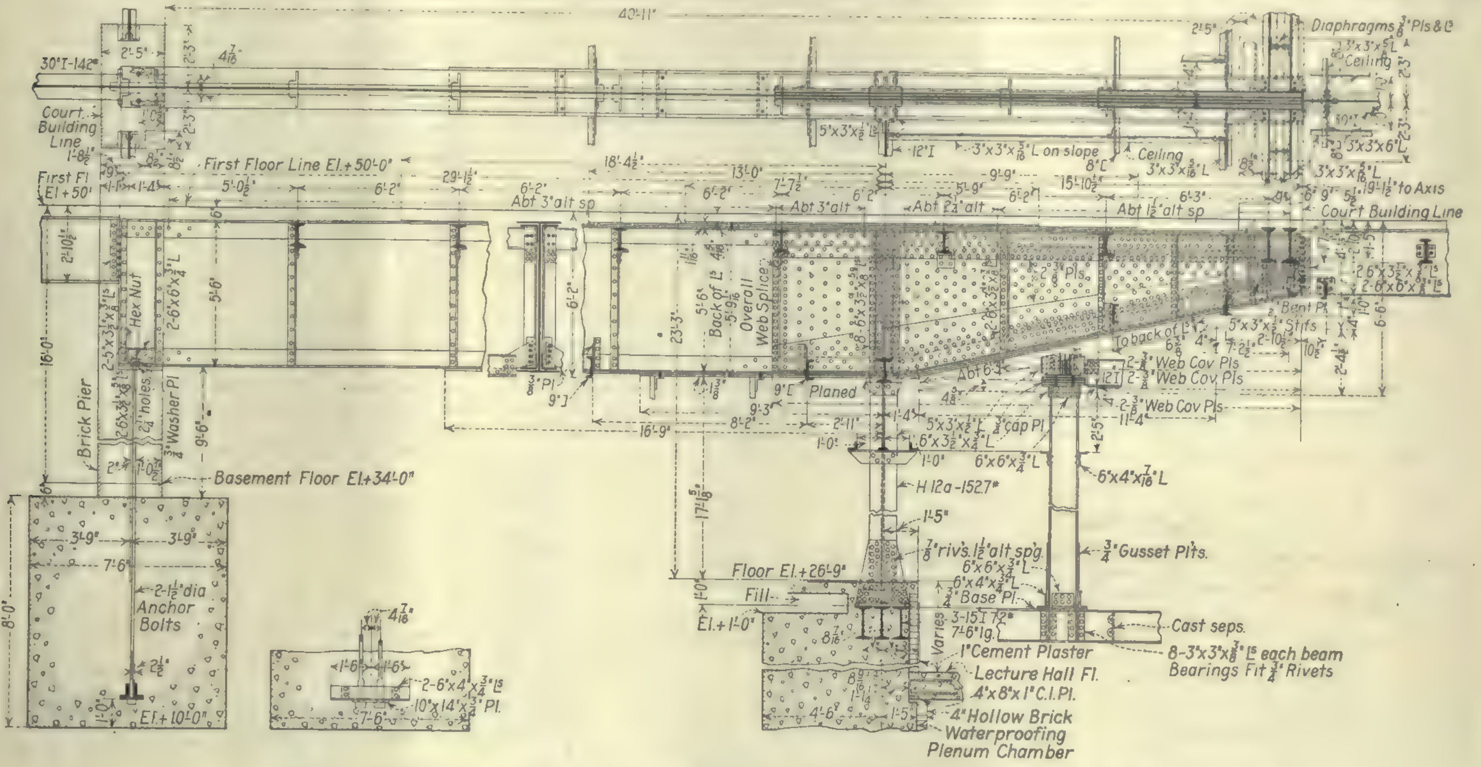


Fig. 3. Details of Heavy Cantilever Girders Over Lecture Hall of Field Museum.

WALL AND GIRDERS OF SHIPPING ROOM.

On account of the difficulty of obtaining adequate foundations for the retaining walls of the shipping room (for location see Fig. 1a) a novel form of reinforced concrete construction was used. These walls are supported on concrete piers and are anchored into reinforced concrete girders formed on top of the piers. Figure 4(a) indicates the type of construction used, and Fig. 4(b) is a detail of the wall and of a portion of the girder at column *T9*. The wall shown has a span of 24 ft. and a height of 17 ft. 11 ins. Counterforts are provided at the girders.

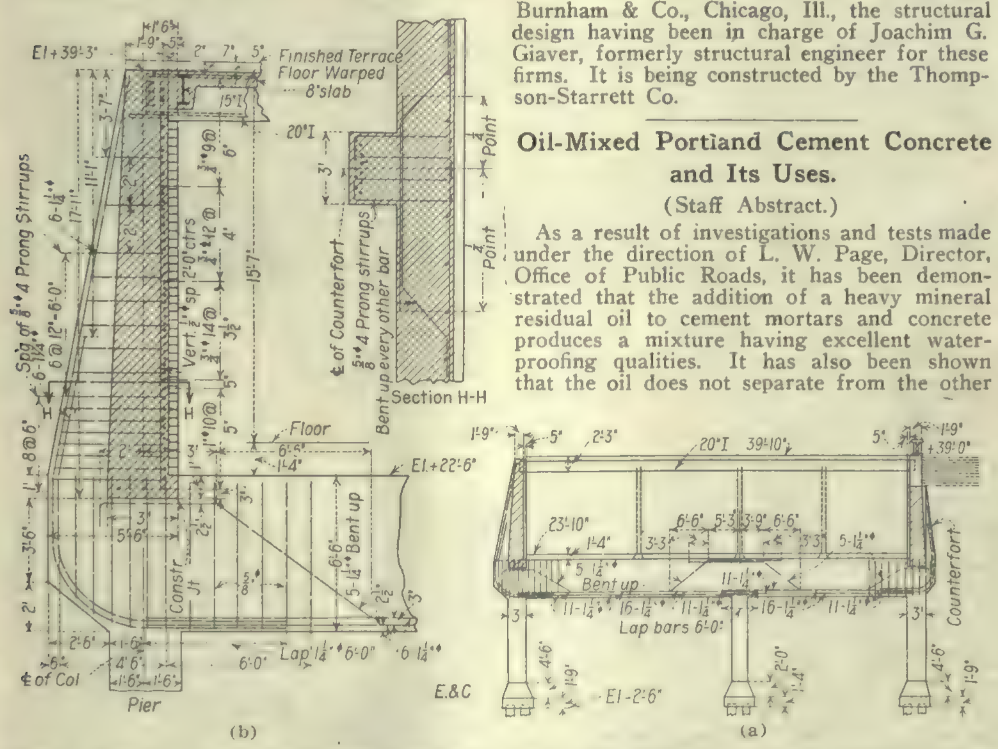


Fig. 4. Details of Shipping Room Retaining Walls and Girders of Field Museum—Note Manner of Supporting Walls on Concrete Piers and Anchoring Walls to Girders.

AREA WALL, FLOOR AND BRACKETS.

As shown in Fig. 2 there is a 6-ft. areaway between the terrace and the building. The terrace fill is held in place by a retaining wall, this wall being supported on cantilever brackets attached to the main concrete piers. Figure 5 (a), p. 228, is a cross section of this wall and of the floor of the areaway showing the manner in which both are supported, and Fig. 5 (b) is a side elevation of the wall and brackets showing the wall reinforcement.

PERSONNEL.

The building was designed by D. H. Burnham & Co. and their successors, Graham, Burnham & Co., Chicago, Ill., the structural design having been in charge of Joachim G. Giaver, formerly structural engineer for these firms. It is being constructed by the Thompson-Starrett Co.

Oil-Mixed Portland Cement Concrete and Its Uses.

(Staff Abstract.)

As a result of investigations and tests made under the direction of L. W. Page, Director, Office of Public Roads, it has been demonstrated that the addition of a heavy mineral residual oil to cement mortars and concrete produces a mixture having excellent waterproofing qualities. It has also been shown that the oil does not separate from the other ingredients after the cement has become hard. For most purposes where damp-proofing is required 5 per cent of oil, based on the weight of cement used, is sufficient. The admixture of oil is not detrimental to the tensile strength of mortar composed of 1 part cement and 3 parts sand provided the oil does not exceed 10 per cent of the weight of the cement used. The compressive strength of mortar and concrete suffers slightly with the addition of oil, although the decrease in strength is not serious provided the oil does not exceed 10 per cent. Concrete mixed with oil requires from 50 to 100 per cent longer to set hard than does plain concrete, but the increase in strength is nearly as rapid in the oil-mixed material as in plain concrete. The bond between concrete and plain-bar reinforcement is decreased by the use of oil in the concrete, but when the deformed bar, wire mesh, or expanded metal is used there is no apparent decrease in the bond.

MIXING PROCEDURE.

In hand mixing, the best results are obtained by adding the oil after the cement and sand have been thoroughly mixed, and then again mixing until no trace of oil is visible on the surface. Particular care should be taken to continue the mixing until the oil is thoroughly incorporated in the mixture. Experience has shown that to obtain the best results the period of mixing should be practically double that required when no oil is used. The oil-mixed mortar is then combined with the stone or gravel previously moistened and the mass mixed until all the stone is thoroughly coated with the mortar.

When the concrete is machine mixed the cement, sand and water are first mixed to a mortar, after which alternate batches of oil and stone are added until the required quantity of oil is mixed, and then the remainder of the stone is added and mixed.

MATERIALS.

Cement.—Portland cement should be used.

Sand.—The character of the sand has a marked effect on the strength of the concrete. The sand should be clean and coarse and graded in size; it should not contain more than 5 per cent of silt or clay.

Stone or Gravel.—The best results are usually obtained with stone graded in size from ¼ in. up to 1½ ins., but for reinforced concrete a maximum size of 1 in. is preferable. (When gravel is used it should be screened through a ¼-in. mesh screen, and the finer particles should later be re-combined with the coarser ones in the correct proportions. Generally it is not wise to use bank-run gravel, as the proportions are not such as to give the densest and strongest concrete.

Water.—The water should be clean and free from all strong acids, alkalies, and vegetable matter.

Oil.—The following specifications (subject to revision) refer to the oil used in oil-cement concrete:

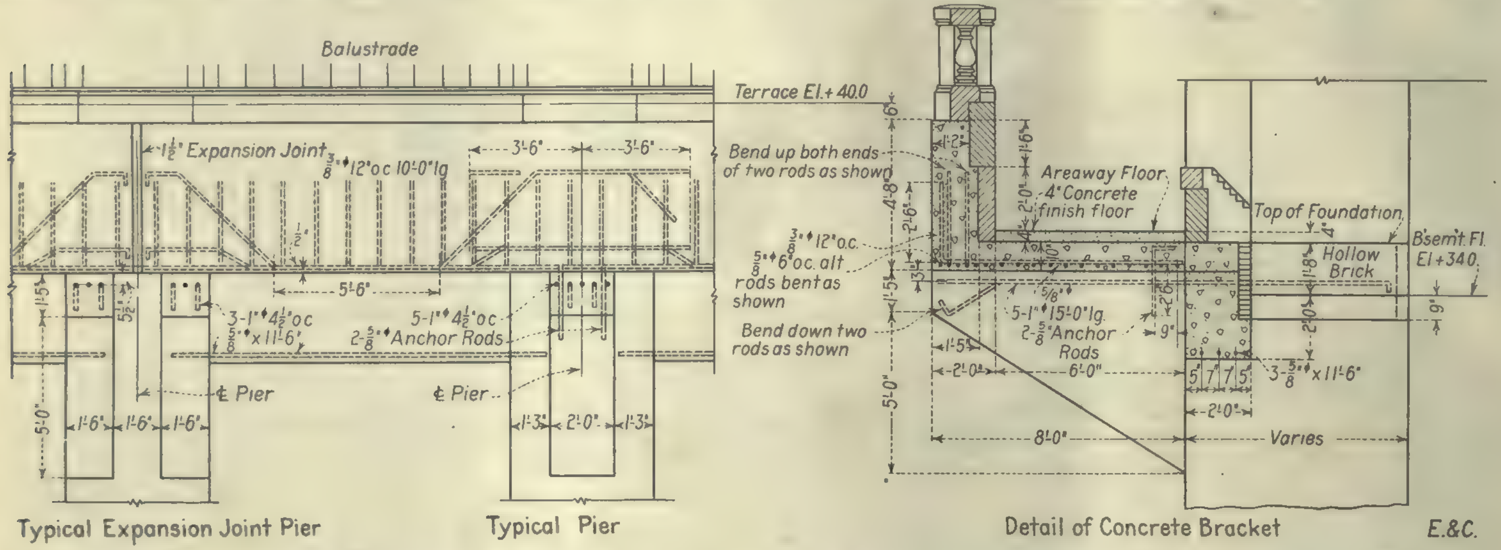
(1) The oil shall be a fluid petroleum product and shall contain no admixture of fatty or vegetable oils.

(2) It shall have a specific gravity not greater than 0.945 at a temperature of 25° C.

(3) It shall show a flash point of not less than 150° C. by the closed-cup method.

(4) When 240 cc. of the oil is heated in an "Engler" viscosimeter to 50° C., and maintained at that temperature for at least three minutes, the first 100 cc. which flows out shall show a specific viscosity of not less than 15 nor more than 30.

(5) When 1 part of the oil is shaken up with 2 parts of hundredth normal caustic soda, there shall be no emulsification, and upon allowing the mixture to remain quiet the two components shall rapidly separate in distinct layers.



(b) (a)

Fig. 5. Details of Areaway Walls and Floor of Field Museum—Note Manner of Cantilevering Walls from Concrete Piers.

MATERIALS REQUIRED PER CUBIC YARD.

Table I gives the proportions by parts and quantities of cement, sand, stone and oil required to make 1 cu. yd. of oil-mixed mortar and concrete:

TABLE I. — PROPORTIONS OF CEMENT, SAND, STONE AND OIL REQUIRED TO MAKE 1 CU. YD. OF MORTAR AND CONCRETE.

Proportions by parts.							
Cement.	Sand.	Stone or gravel.	Oil (per cent).	Cement (bbls.).*	Sand (cu. yds.).	Stone or gravel (cu. yds.).	Oil (gals.).†
1	...	..	3	8.31	....	....	12.1
1	2	..	5	3.32	0.93	....	8.06
1	3	..	5 10	2.48	1.05	....	6.02 12.04
1	4	..	5 10	1.98	1.11	....	4.8 9.61
1	2	4	5	1.57	.44	0.88	3.81
1	2½	5	5 10	1.30	.46	.92	3.15 6.3
1	3	6	5 10	1.11	.47	.94	2.69 5.38

*One barrel of cement equals 4 bags. †Oil weights about 7¾ lbs. per gal.

USES.

Basement Floors.—The following method of construction, using an oil-cement mixture, is suggested as one which will prevent the permeation of moisture through the basement floor, even though the subsoil be very wet:

If the underlying soil is very wet it may be well to lay a 6-in. foundation of sand, cinders, broken stone, or gravel, compacting these materials well by tamping. In addition it will be of advantage to employ drain tiles in this porous foundation, leading them to a sewer if possible. On top of the foundations should be laid a 4-in. layer of concrete mixed in the proportions of 1 part Portland cement, 2½ parts sand, and 5 parts broken stone or gravel. Before the concrete base has hardened a top or wearing coat of mortar mixed in the proportions of 1 part cement and 2 parts sand or stone screenings, and containing 5 per cent of oil (2½ quarts per bag of cement) should be laid. This top coat, because of its non-absorbent character, will give perfect protection from underlying moisture, and moreover it will build a floor which will dry out very quickly after washing, since practically none of the washing water will be absorbed.

It might be thought that the addition of oil to the mortar wearing coat would tend to make the surface slippery. Such, however, is not the case; nor is the appearance very much different from that of an ordinary cement floor. Should joints be provided for expansion and contraction it will be necessary to fill them with a good bituminous filler to prevent the entrance of water.

Many cellar floors now made of Portland cement concrete are giving trouble owing to the permeating moisture. Such a condition may be remedied by the application of an oil-mixed mortar coat to the surface of the old floor. Before attempting to lay the new wearing surface the old floor should be scrubbed thoroughly clean and should be made thoroughly wet. The bond between the old and the new work will be improved if the old surface be roughened with a stone hammer. A wash composed of 1 part hydrochloric acid and five parts of water may be used to clean the surface. This will dissolve some of the cement from the old work, leaving the aggregate exposed. The acid solution should be left on not longer than half an hour, when it should be completely removed with clean water. The surface should then be brushed with a wire or stiff scrubbing brush to remove any particles of sand which may have become loosened because of the dissolving of the cement.

A mortar composed of 1 part cement and 2 parts sand and containing 5 per cent of oil will be sufficiently non-absorbent for the new wearing coat. To strengthen the bond it will be well to apply a wash of grout made by mixing cement with water to the consistency of cream before laying the oil-mixed mortar coat. For the ordinary basement floor a 1-in. layer of mortar will prove of sufficient thickness. It will be necessary to keep the new mortar damp for at least one week in order that it may attain its proper strength.

Basement Walls.—The entrance of moisture through the walls is another common source of damp basements. The water pressure in the soil adjacent to the wall is very seldom of great magnitude, so that a material nonporous and at the same time impermeable under moderate pressures is the logical one to use for this type of construction.

A concrete mixture in the proportions of 1 part cement, 2½ parts sand and 5 parts gravel or broken stone, together with 10 per cent of oil based on the weight of cement in the mixture, should prove amply rich for most situations. A wall of these proportions, 12 ins. thick, and provided with a spread footing, will withstand a pressure of 6 ft. of earth. When supported at the top by floor joists a much thinner wall may be used with safety. A 6-in. wall 7 ft. high may be used to withstand 6 ft. of earth pressure. Generally speaking, such a thin wall should be reinforced by deformed steel rods spaced about 2 ft. apart in both directions. Care should be taken that the earth is not filled in against the back of the wall for at least four weeks after pouring the concrete, unless the wall is braced on the inside by allowing the inner forms to remain in place.

Many basement walls now built of stone, brick or concrete are giving trouble through leakage. The application of a plaster coat of oil-mixed mortar composed of 1 part cement, 2 parts sand, 5 per cent of oil, and enough water to form a rather stiff mortar will prove an efficient remedy for this trouble. The surface to which this mortar is to be applied should be roughened with a stone hammer if the old wall is of concrete, or the mortar joints should be raked out to a depth of ½ in. from brick or masonry walls. The acid wash previously described should be applied to cleanse the surface thoroughly, after which the loose particles must be removed with a wire or stiff bristle brush. It will be impossible to obtain a water-tight coating if it is applied while water is seeping through the wall. It will be well to wait for the dry season, when the ground water is reduced to its lowest level, before attempting to waterproof by plastering. Should water appear to be coming through a well-defined crack in the wall, calking with oakum or cotton may be resorted to in order to stop the leakage until a plaster coat of oil-mixed mortar can be applied. It will be necessary to mix the mortar for plastering to a rather dry consistency, and it should be troweled hard in order to obtain a hard, dense, waterproof surface. A wash of cement and water mixed to the consistency of thick cream and applied before the oil-mixed mortar coat is put on will aid the new mortar in adhering to the old work. The old wall must be thoroughly wet before the new mortar coat is applied.

Roofs.—Portland cement mortar mixed with mineral oil and reinforced with steel-wire mesh may be advantageously used in the construction of slab roofs. These slabs could be assembled in place on the roof after they have attained sufficient hardness. Reinforced concrete tiles may also be advantageously made with Portland cement concrete mixed with a small perecentage of mineral oil residuum.

Stucco.—Portland cement stucco is economical, and, moreover, with it many beautiful effects are possible. The term "stucco" is given to the exterior finish coat, which may be applied to brick, stone, concrete, hollow tile, or frame construction. According to the finish desired and the kind of surface to be covered, the stucco is applied in two or three coats. The first or scratch coat should be mixed in the proportions of 1 part Portland cement and 2 parts clean, coarse sand, with enough water to form a good stiff mortar. If 5 per cent of oil is added to this mixture the scratch coat will be perfectly waterproof. While this coat is still wet it is roughened with a stick or trowel over the entire surface. The second coat, which may be of the same proportions, is plastered on after the first coat has set sufficiently to support it. The use of oil in this coat may be omitted if desired, and it may be given a rough-cast finish by using a trowel covered with burlap or carpet.

The second coat may also be applied by throwing it on with a wooden paddle. This produces a rough surface known as a slapdash finish. A pebble-dash finish surface may be secured by using a wet mixture composed of 1 part cement and 3 parts pebbles ¼ in. in diameter. This mixture is thrown on the second coat while it is still soft, and the result is a very pleasing surface. When a pebble-dash finish is used the second coat as well as the scratch coat may be mixed with oil. In most constructions the second coat will be found superfluous, because a sufficiently thick coating is usually obtained from the first application of oil-mixed mortar.

When stucco is applied to stone or hollow tile care should always be taken to have the surface well moistened, or otherwise a great deal of water will be absorbed from the mortar coat, and so greatly weaken it and cause contraction cracks to form.

Irrigation Ditches.—The results of laboratory tests indicate that the presence of oil tends to retard very materially the action of alkalies on concrete, and suggest that another field for the use of oil-cement concrete may be found in the construction of linings for irrigating canals and ditches. Many of these canals are in localities where the soil is strongly impregnated with alkali salts and where the water carried contains alkali in solution. The destructive action of alkali is undoubtedly due to the crystallization of the salts within the mass of the concrete, or the formation by chemical action of compounds of greater volume than the original salts, or to a combination of both of these actions.

As the admixture of oil will retard the absorption of water into the concrete it should materially lengthen the life of the lining. In the mixing of concrete for this purpose it is, of course, necessary to avoid the use of either water or sand containing alkali.

Concrete Base for Roadways.—The use of this material should also prove of value for damp-proofing the concrete base of roads against the action of ground water, which if allowed to pass through will tend to disintegrate the road surface. Such action as this is particularly noticeable with road surfaces such as asphalt, bituminous concrete, etc. Assuming the usual proportions for the concrete base, etc., 10 per cent of oil should prove sufficient for this purpose.

Engineering Constructions.—There are many important engineering constructions in which oil-mixed mortar or concrete may be advantageously employed. Among them may be mentioned aqueducts, buildings, burial vaults, boats, foundations, gutters, mausoleums, roofs, sewers, troughs, tanks, and wells. In some constructions a coat of oil-mixed mortar is effective, while in others oil-mixed concrete may be used throughout.

It is confidently believed that if carefully-prepared, oil-mixed concrete is used in structures of any kind requiring damp-proofing (and in such structures careful work is a very important factor in the result) there will be no difficulty experienced from leakage and the structures will have been damp-proofed at very little extra expense.

ACKNOWLEDGMENT.

The foregoing data were abstracted from Bulletin No. 230 of the U. S. Department of Agriculture. The bulletin was prepared by L. W. Page, Director, Office of Public Roads.

A Tall Reinforced Concrete Coke House in Rotterdam, Holland.

(Staff Abstract.)

The reinforced concrete coke house here described is a part of the new gas works at Keilehaven, Rotterdam, Holland, and is an interesting example of this type of construction. The structure, which is 20.3x39.4 ft. x 141 ft. high, is founded on piles cut off at a plane 10 ft. 8 ins. below the ground floor. It is located adjacent to the retort house, which contains the coke furnaces.

The coke is discharged from the chamber ovens and falls into open trucks, which consist of a framework of heavy iron bars. These trucks are conveyed by a locomotive to the coke house. On arriving at the coke house the truck is placed on a platform and is then lowered into a concrete trough, where the

Progress Views Illustrating Methods and Equipment Used in Constructing the Midland Warehouse, Chicago, Ill. The Design and Construction Features of This Warehouse Were Described in the Sept. 8, 1915, Issue of Engineering and Contracting. The Warehouse Was Designed by S. Scott Joy, of Chicago, and Was Erected by the Stone & Webster Engineering Corporation.

coke is quenched with water, the resulting steam escaping through a tall concrete shaft (*a*, Fig. 1) and funnel (*b*, Fig. 1), having its opening at the top of the coke house. As soon as the coke is quenched the truck is again placed on the moving platform, which, after being raised to its highest point, is tipped with the truck into the bin marked *e*, Fig. 1. From this bin the coke is elevated into the bunker *d*.

This structure also contains the coke breaking and screening equipment. There are four storage bunkers, each containing coke of a different size. From these bunkers the coke can be discharged in various ways, one of which is by means of tip wagons moving on a platform in connection with the bridges shown in Fig. 1, from which the wagons are emptied from a height of 23 ft. There are also devices for discharging the coke into bags for sale in the city, into railway cars placed under the gate, and into small trucks for use in the water-gas plant.

The lift engine is housed above the shaft, at *g*, Fig. 1, the hoisting motor of which has a capacity of 30 hp. The weight of the lift cage and coke wagon is balanced by counterweights, which move in the shaft *h*, Fig. 1.

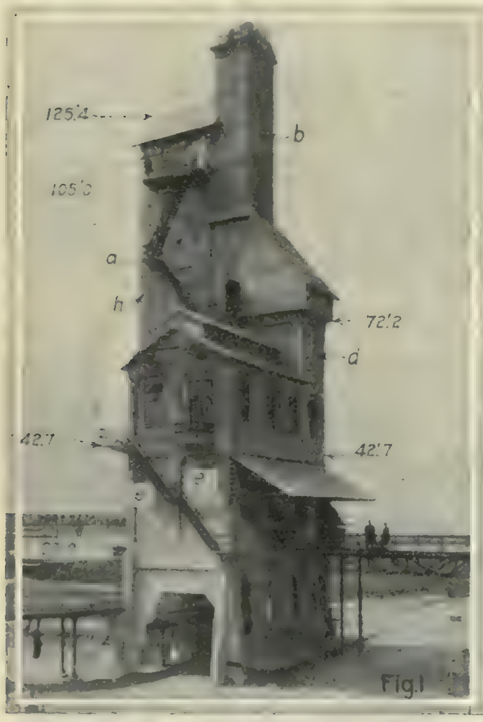


Fig. 1. View of Reinforced Concrete Coke House at the New Keilchaven Gas Works, Rotterdam, Holland.

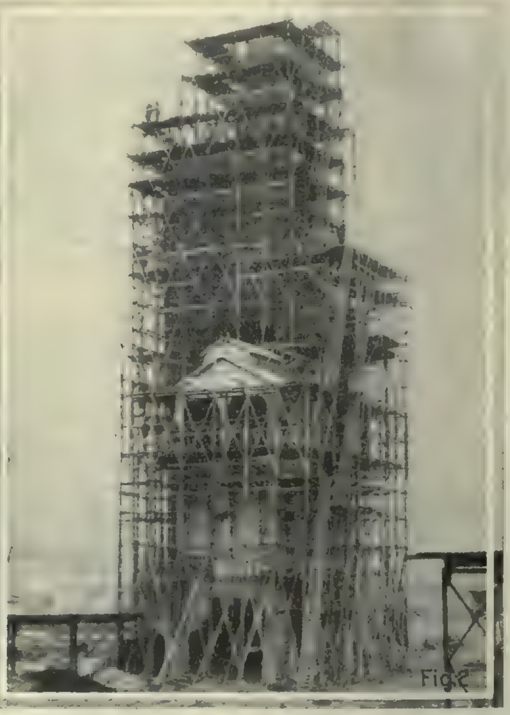


Fig. 2. View of Staging Used in Constructing Reinforced Concrete Coke House in Rotterdam, Holland.

The inclined bottom planes of the bunkers *e* are sheathed with hard tiles, which can easily be renewed when worn out. The bottom planes of the bunker *d*, in which the unbroken coke is discharged, are sheathed with iron plates. The breaking and screening equipment is furnished in duplicate, the capacity of each being 1,200 cu. ft. of coke per hour. Bunker *d* has a capacity of 2,540 cu. ft., while the total capacity of the four bunkers *e* is 16,100 cu. ft. The total weight of the lift cage, wagon and coke in it is about 26,400 lbs.

Figure 2 is a view of the staging used in constructing the coke house. The total cost of the structure, exclusive of its foundation, was about $16,500, the additional cost of the entire mechanical equipment being about $14,000.

ACKNOWLEGMENT.

The foregoing data were abstracted from a paper in *Concrete and Constructional Engineering*. The work was in charge of H. C. Sissingh, director and general manager of the Rotterdam Gas Works.

The Care of Chains.

(Staff Abstract.)

Chain manufacturers, engineers, and others are not agreed as to the value of annealing, in fact there are many prominent authorities that firmly believe such treatment is inadvisable. In this connection the following data taken from *The Travelers Standard* are of interest:

A recent canvass of a considerable number of chain manufacturers shows that those in favor of the annealing process outnumber those opposed to it by about five to one, although the advocates of annealing are not in harmony as to the methods employed, the frequency of annealing, the temperature to which the chains are to be subjected, or the length of time required to insure good results.

All chain manufacturers, and practically all chain users, are aware of the fact that rough usage, shocks, and twists tend to weaken chains. A change gradually occurs in the molecular composition of the material, and the strength of the chain becomes seriously impaired. There may be no visible evidence of this deterioration, although a careful microscopic examination would doubtless disclose a multitude of small cracks; but a person accustomed to the use of chains knows that deterioration is going on, and that eventually the chains will fail. When a chain has been in service for a sufficient length of time to make it unsafe for use at the load for which it was originally designed, it would be desirable to discard it, or at least to use it only for lighter loads; but such a course is not always practicable, nor, according to the views of the advocates of annealing, is it necessary, because the process of annealing counteracts the effects of fatigue and restores the chain to nearly its original strength. It must be acknowledged that it is practically impossible to make any specific recommendations with regard to the proper methods for annealing chains because so many factors enter into the problem. It is the general consensus of opinion that the most satisfactory results in annealing are obtained by the use of a suitable furnace, and by employing a pyrometer to make sure that the temperature is properly regulated and is maintained for the required period. In many places where chains are used, however, no furnaces are available, and other methods are adopted. It is customary under these circumstances to heat the chain to a cherry red in a wood fire, and to maintain it in this condition for a considerable period, after which the fire is allowed to die out and the chain is left to cool in the ashes.

The principal objection to the use of open fires for annealing chains lies in the fact that the temperature attained can only be guessed at, and moreover it is quite difficult to maintain an even temperature during the time necessary to complete the operation. Furthermore, the correct temperature for annealing depends upon the composition of the chain metal, and it is difficult for any one except an expert to determine the grade of iron or steel of which a chain is composed. The Committee on Heat Treatment of the American Society for Testing Materials has recommended the following range of annealing temperatures for steel of varying carbon content, and this conforms approximately to the practice of various chain manufacturers and users:

Carbon Content.	Annealing Temperature. Deg. C.	Deg. F.
Less than 0.12 per cent...	875 to 925	1607 to 1697
0.12 to 0.25 per cent.......	840 to 870	1544 to 1598
0.30 to 0.49 per cent.......	815 to 840	1499 to 1544
0.50 to 1.00 per cent.......	790 to 815	1454 to 1499

Various methods for testing chains are employed by persons who have no faith in the annealing process. The method advocated by the Yale & Towne Manufacturing Co., and also followed by the Brown & Sharpe Manufacturing Co., is to make use of a gage 3 ft. long. Every new chain is marked with a prick-punch at intervals of 3 ft., and at each subsequent inspection of the chain the prick-punch marks are compared with the gage. If it is found that a section of the chain between two of the marks has stretched by an amount equal to one-third of the length of a link, the chain is considered unsafe and is condemned, or is used in some place where it will be subjected only to light loads. It is sometimes found that only a single section of the chain must be discarded. The experience of users of chains who have adopted this method for testing them has been satisfactory, in the main, and accidents from breaking chains have been materially reduced by it. Manifestly, however, it would not apply without modification to chains having unusually large links.

Many authorities on chains, even though admitting that sling chains should be annealed, insist that block chains that pass over sheaves should not be treated in this way. The danger from molecular changes caused by overloading the chains may be greatly diminished by proper annealing, but when distortion of the links occurs in block chains the chains no longer fit the sheaves, and excessive wear results, often accompanied by severe and badly distributed stresses. No amount of annealing can restore the links to their original lengths, and the only practical solution when such distortion has occurred, is to substitute new chains.

Both the advocates and the opponents of the annealing process realize and readily admit that the care of chains is exceedingly important, and all are striving to discover the most suitable and practical method for treating them. Comparative tests have been made of the breaking strength of annealed and unannealed chains that have been subjected to similar loads, but these tests have not been sufficiently numerous or exhaustive to be conclusive in either directly proving or disproving the value of the annealing process. It seems desirable that further tests of this kind be made, and that they be continued until a definite conclusion can be reached.

The practical immunity from chain accidents secured by the railroads and dock yards of Great Britain proves beyond doubt that the methods there employed are exceedingly valuable. Their chains must undergo severe proving and breaking tests; they are also subject to frequent inspections; and are annealed by competent men who keep complete records of their work. The value of these precautionary measures is clearly shown by the experience of a certain firm which had had considerable trouble from chain accidents. They were persuaded to give their chains a thorough overhauling, and found that from 25 to 30 per cent of them were defective. A general system of inspecting, testing, and annealing was then instituted, with the result that no further accidents of this kind have occurred for more than two years.

The care of all the chains used about the plant should be assigned to some competent, experienced, and careful person, whose judgment should be depended upon, regarding the frequency with which the annealing should be done. He should have a general knowledge of all the work done in the plant that requires the use of chains; and all chain slings should be kept by him under lock and key when not in use, only those being given out that are suitable for the work in hand. He should see that the slings are returned to him as soon as the work is finished, and should keep a record showing how often each sling is used and the kind of work for which it is employed.

Every chain sling should be inspected each time it is returned to its storage place, and all other chains should be inspected frequently and at regular intervals. Every chain should be marked or numbered in some way, so that it can easily be identified, and a record should be kept showing the date of each inspection and annealing, as well as the safe working load under which the chain may be used.

ROADS AND STREETS

Excavating Aggregates with Drag Line and Hauling by Motor Truck on Indiana Concrete Road Work.

Contributed by Stanley E. Bates, Assoc. Mem. W. S. E.

Elkhart County, located in Northern Indiana, began building concrete roads last year when bonds were sold and contracts let for two stretches south of the city limits of Elkhart; Indiana Ave. 18 ft. wide and ⅝ mile long, and Oakland Ave. 18 ft. wide and nearly 2 miles long. The Northern Construction Co., Elkhart, Ind., built both of these roads and this year the same company secured the contract for improving a little over 3 miles of Vistula Road, beginning at the east city limits of Elkhart and running in an easterly direction towards Bristol. It is this 1915 work, which is now about completed, which this article will describe in detail.

GENERAL CONDITIONS.

Being the main travelled route from Elkhart, South Bend and other Indiana points to Detroit, Mich., Vistula Road carries a heavy mixed traffic. It runs along the valley of the St. Joseph River, through a gently rolling country where heavy cuts and fills are unnecessary. An interurban electric railroad, known as the St. Joseph Valley Line, runs parallel to and, for a short distance, along the center of the road. Previous to the improvement Vistula Road had a common sand and earth surface.

EXCAVATING AGGREGATES.

The St. Joseph River runs along the northern part of the city of Elkhart and, through this section, has a gravel bed. For last year's work, the Northern Construction Co. purchased a Shearer & Mayer dragline cableway excavator from Sauerman Bros., Engineers and Manufacturers, Chicago. The same equipment, but with a little different design of the plant as dictated by experience, is being used to produce the sand and gravel for the 1915 work.

Fig. 1 shows the general layout of the plant which is located in the city of Elkhart, two blocks west of Main st. The loading bins are on the south side of the river, on a plot of ground purchased by the contractor for this purpose. The essential features of the plant are a bucket and carriage mounted on a slack line cable running between a mast on one side of the river and an anchor on the other, a hoist to operate the bucket, and a screen, crusher and loading bin. Three-phase, 60-cycle alternating current from a 2,200-volt power line, stepped down by three transformers to 440 volts, is used throughout the plant.

From Fig. 1 the operation of the dragline in digging the gravel from the river bed and elevating it to the top of the screening and loading plant, can be followed. The power to operate the cables is supplied by a 50-hp. two-drum electric hoist manufactured by the Thomas Elevator Co., Chicago. It is enclosed in the house shown at the extreme right of Fig. 4.

The hoist is equipped with a friction clutch of the band type and operates the drum at two speeds, high speed being three times as great as low. This two-speed arrangement is particularly adapted to dragline excavation as it furnishes great power at slow speed for digging and then, when the bucket is full, the drum can immediately be thrown into high by means of a single lever clutch, bringing the bucket rapidly to the dumping point.

To the forward drum of the hoist is attached the load cable which passes over a sheave attached to the top of the mast and thence to the bucket. The rear drum operates the tension cable which, through a set of fall blocks also at the mast top, furnishes the means of slackening and tightening the track cable. Both the tension and load cables are of ¾-in. diameter, made by the American Steel & Wire Company. Details of the bucket, which has a capacity of 1 cu. yd. and of the carriage and chain mountings, are shown in Fig. 2.

The mast is 65 ft. high, of an A-frame type, the legs 14 ft. apart at the bottom. Each leg is built up of 6x10-in. timbers spliced through the middle portion to give added resistance to bending. In addition to this, they are trussed on each side with ⅝-in. wire rope. Three guy lines of 1-in. American Steel & Wire Co. cables run from the top of the mast to anchors about 100 ft. back of the base and 75 ft. apart. Two auxiliary guys of ⅝-in. cables lead to anchors close to the river bank. The track cable running across the river is 1½ ins. in diameter and nearly 500 ft. long.

SCREENING.

Figure 3 shows side and end views of the screening and loading plant, some of the details being omitted for the sake of clearness. The bucket drops its contents against a dump board built at an angle of nearly 45° at the top of the structure. The material then slides down into a small hopper, passing out through the 1½x2-in. opening in the bottom directly onto a grizzly. The grizzly is made of diamond shaped steel bars set 1½ ins. apart and held in place by ⅝-in. rods and cast iron spacers. It is placed at an angle of about 30° with the horizontal and is 10 ft. long and 3 ft. wide.

A stone crusher of the jaw type, run by a 20-hp. motor, is located at the bottom of the grizzly and receives all over size material which, after being crushed, rejoins at the entrance of the screen, the material which passed the bars of the grizzly.

The screen, which is designed to separate the material into two sizes, is known as a Telsmith Heavy Duty screen, built by the Smith Engineering Works, Milwaukee, Wis. The main cylinder is 32 ins. in diameter and 10 ft. long made of ⅛-in. steel plates and reinforced by four channels bolted to the end castings. The perforations are 1 in. in diameter. Outside of this there is another cylinder, sometimes called a dust jacket, made of heavy wire mesh 42 ins. in diameter and 9 ft. 4 ins. long. The openings in the dust jacket are ¼ in. in size.

This combination of screens, together with the grizzly and crusher, separates the material into sand ranging from ¼ in. down and gravel from 1½ ins. to ¼ in. Accord-

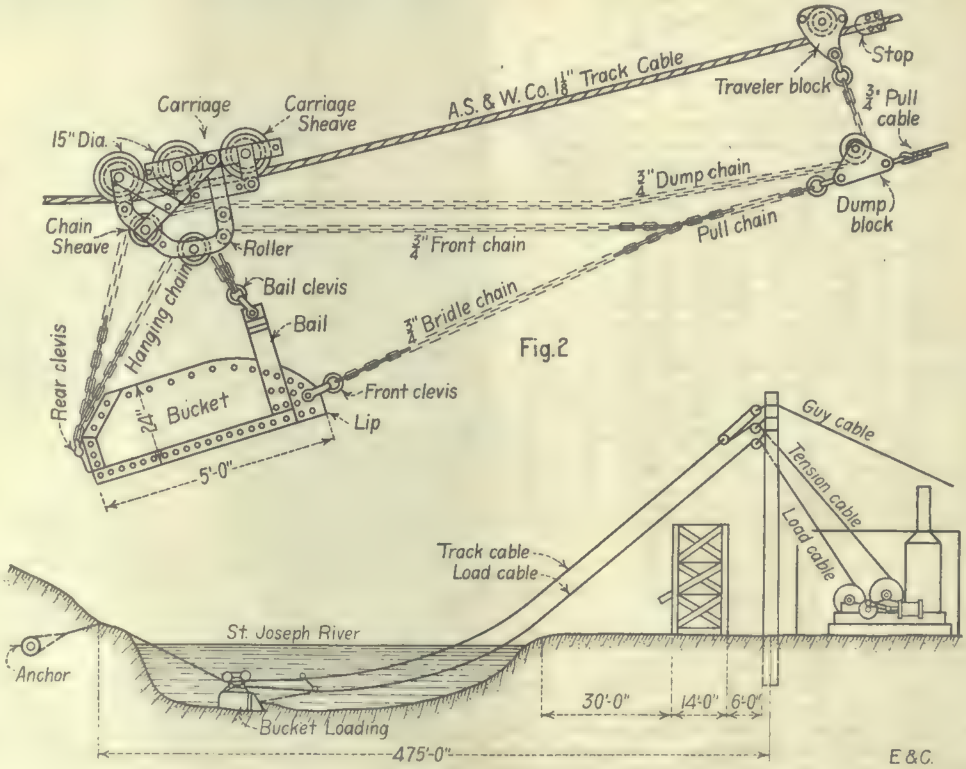


Fig. 1

Dragline Gravel Excavating Plant, Indiana Concrete Road Construction.

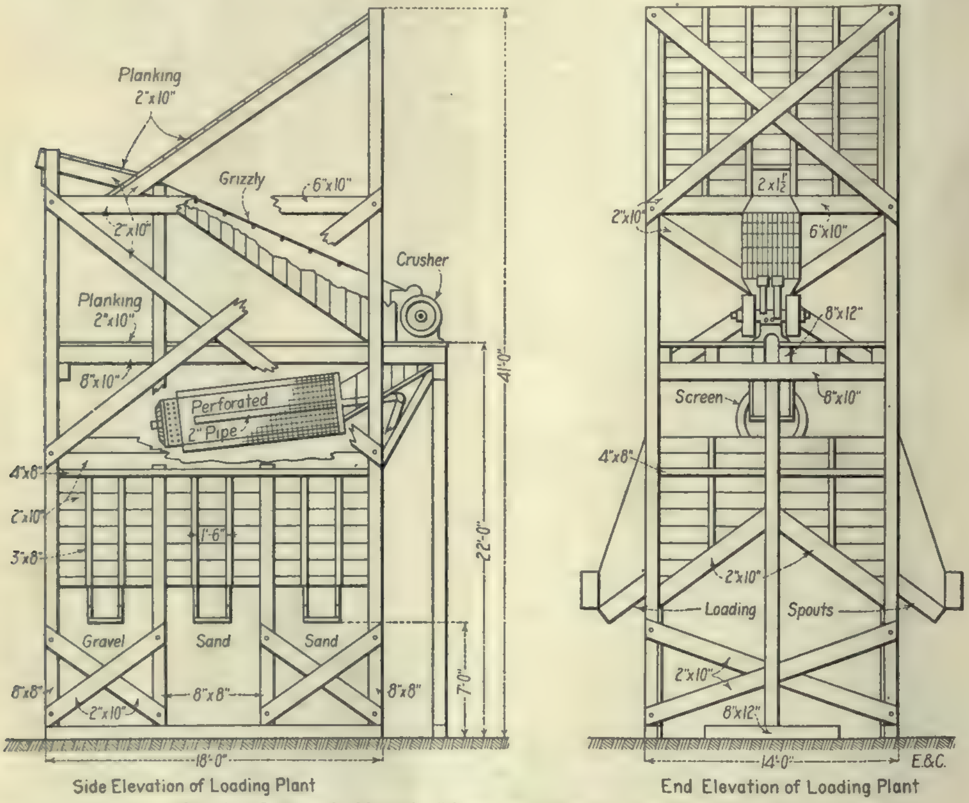
Fig. 1—General Layout of Plant. Fig. 2—Detail of Scraper Bucket

ing to the contractor, the reason for the use of a double screen is not only to insure a good separation, but to allow the use of a heavier and more durable inner cylinder than would be possible if the perforations had to be ¼ in. instead of 1 in. in diameter.

The screen is driven by a 5-hp. electric motor through belt and gears at the discharge end. This end is supported on a shaft with an adjustable thrust bearing to keep the driving gears in proper mesh. The head end revolves on two wide faced rollers. A close view of the screen is given in Fig. 5.

To aid in the separation of the sand and gravel, water is pumped into the cylinder through a 2-in. pipe line from the river by a centrifugal pump driven by a 5-hp. motor. This pipe runs inside and along the axis of the screen and is perforated, thus delivering the water uniformly over the material.

Below the screen are the loading bins, two for sand and one for gravel. Each holds about 15 cu. yds. of material and has two discharge chutes, one on each side. The bottoms of the bins are built in the shape of an inverted V; with a slope of about 30°.



Side Elevation of Loading Plant

End Elevation of Loading Plant

Fig. 3. General Sketch Plans of Gravel Loading Plant.

The amount of material excavated and screened per day has averaged about 125 cu. yds., though if necessary this could be increased nearly 100 per cent. Three men are needed to operate the plant, an engineer and two laborers. One of the latter is located at the grizzly and keeps the material moving freely, seeing that it doesn't clog at any point. The other assists in loading the motor trucks.

The gravel from the river runs about two parts of fine material to one of coarse and as the specifications for the road call for concrete of a 1:2:3 mix, there is a large excess of sand. At present this is stored in piles around the plant and sold locally as there is demand for it. It is clean and sharp, an excellent material for concrete work, and brings about $1 per cu. yd. delivered.

COST OF PRODUCING GRAVEL AND SAND.

Owing to rain delaying the progress of the concrete work, the material plant has not been in continuous operation. Cost figures, therefore, are not representative but the tabulation below is based on the work done so far and will give a fairly good idea of what may be expected of a plant of this type, working under unfavorable conditions. In computing interest, etc., it was assumed that the plant was in operation only 150 days out of the year, and was producing each day only 125 cu. yds. of sand and gravel.

COST OF EXCAVATING GRAVEL WITH DRAGLINE AND SCREENING TO TWO SIZES FOR CONCRETE ROAD WORK.

Item.	Per 10-hr. day.
Labor:	
Engineer	$ 3.25
Two laborers at $2.00	4.00
	$ 7.25
Interest on Investment, etc.:	
Interest on cost of plant, $6,500 at 6 per cent	$ 2.60
Depreciation $6,500 at 10 per cent	4.33
	$6.93
Running Expenses:	
Current for four motors at 2½ cts. to 3 cts. per K. W. hour	$ 4.00
Repairs, renewing cables, etc	1.20
	$ 5.20
Total daily cost	$19.38
Average amount produced in one day, 125 cu. yds.	
Cost per cu. yd	$0.155

HAULING.

The Northern Construction Co. sublet the hauling of the aggregates from their plant to the road to the C. A. Miller Cartage Co., Elkhart. This company used three 7½-ton motor trucks built by the Mack Brothers Motor Car Co., Allentown, Pa., one of which is shown in Fig. 8. Two of the trucks were bought in 1914 and the third is a year older.

The minimum length of haul, which is from the plant to the beginning of the road, is 2 miles, and the maximum 5 miles. Except for a short distance over city pavements, the route which the trucks have to follow is over deep sand roads which cut down their capacity of 125 miles per 10-hour day by about 20 per cent. As an average, for their first and longest haul, the trucks made ten round trips per day, carrying a load of 4 cu. yds. of material each trip.

The working day was from 10 to 12 hours long, five days a week, and on Saturday from 5 to 10 hours. As nearly as could be determined the average came very close to 10 hours for six days; 60 hours a week, and it is on this basis that the cost of hauling is computed in the following table. As the C. A. Miller Co. uses the trucks to haul coal in the winter, they are idle very little of the time. In figuring interest on capital invested, etc., it was assumed that the trucks were in operation 275 full days out of the year.

COST OF HAULING SAND AND GRAVEL BY MOTOR TRUCK.

Length of haul, one way, 5 miles.

Item.	Per 10-hr. day.
Labor:	
Driver at $18 per week	$ 3.00
	$3.00
Interest, Etc.:	
Interest on cost, $5,250 at 6 per cent	$ 1.15
Depreciation, 15 per cent per annum	2.87
Insurance (liability and fire), $56 per annum	.20
Repairs	.38
	$ 4.60
Running Expenses:	
Gas, 25 gals. at 11 cts	$ 2.75
Oil, 2½ gals. at 40 cts	1.00
Hard grease, ½ lb. at 28 cts	.14
Tires renewed once every two years at $400	.73
	$ 4.62
Total cost per truck	$12.22

Cubic yards hauled one mile in one day (return trip empty), 10x5x4 = 200.

Cost per cu. yd. per mile, $0.0611.

Assuming that wet sand and gravel weighs 120 lbs. per cu. ft. or 1.62 tons (3,240 lbs.) per cu. yd.

Cost per ton mile, $0.0377.

SPECIFICATIONS.

Specifications for the pavement call for an 18-ft. concrete roadway, 6 ins. thick at the sides and 8 ins. at the center, laid on a flat subgrade and flanked on each side by 6-ft. earth shoulders. Where the interurban car line runs in the center of the road for 4,000 feet at the Elkhart end, the pavement is devided into two strips, each 9 ft. wide, 7 in. thick, and having a slope from the inner to the outer edge of about ¼ in. to the foot. The inner edge of each strip is located 4 ft. from the rail.

For all sections one-course construction and a 1:2:3 mix are specified. The exact length of the improvement is 16,963 ft. (about 3.2 miles) and the contract price $36,600, making the cost per mile about $11,500.

GRADING.

Very little grading is required for the road, the maximum cut being about 2 ft. The total yardage is as follows: Excavation, 6,781 cu. yds.; fill, 5,514 cu. yds. Dump wagons are used to haul the earth from cut to fill, though there is a Galion Ideal Reversible Road Machine (grader), used on part of the work.

At first a 5-ton Kelly-Springfield brick road roller was used to compact the subgrade, but later on a Buffalo-Pitts 10-ton roller was brought on to the job. Because of its greater weight, the latter machine is better adapted to the purpose.

Care is exercised to keep the prepared subgrade from being cut up. Wherever possible, the aggregates are piled on the sides of the road and not on the subgrade. For convenience, gravel is placed on one side and sand on the other as shown in Fig. 6. Two-inch planks are used for the mixer wheels to run on.

CONCRETING.

From the material piles, the aggregates are brought to the mixer, Fig. 7, in wheelbarrows. As the mixer takes a 2 bag batch, two sets of five wheelbarrows each are used, two for sand and three for gravel, each filled to hold 2 cu. ft. While one set is being filled the other is loading into the skip, so the operation is continuous. The mixer is an Austin Cube with a 20-ft. boom and clam shell bucket. With this equipment the average rate of progress thus far has been about 350 ft. (700 sq. yds.) per 10-hr. day, deducting, however, the time lost on account of bad weather. Though concreting began on June 1st, there had been only 30 days or parts of days that the mixer had been running up to August 6th, at which time 8,500 ft. had been laid. The largest day's run had been 450 ft. (900 sq. yds.).

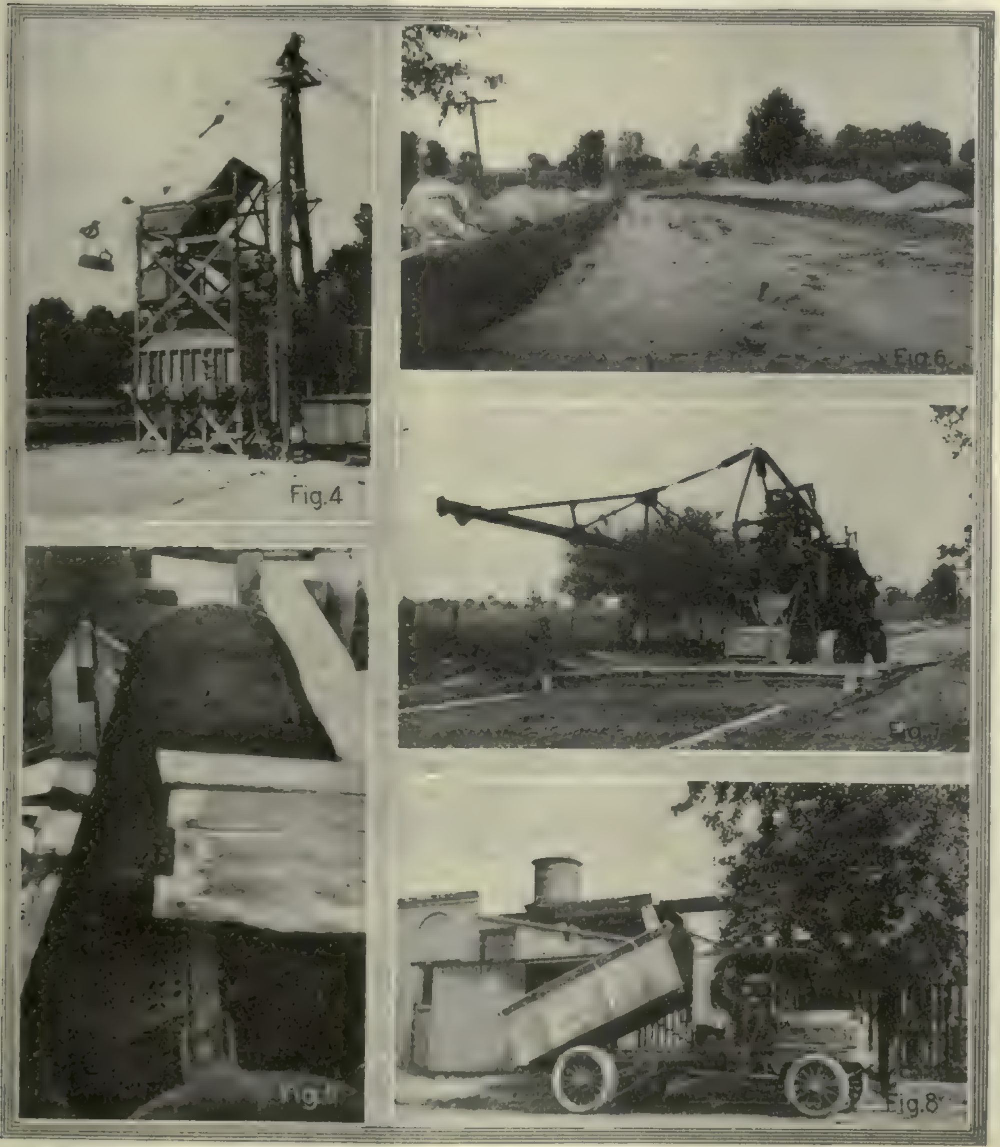
PLACING AND FINISHING CONCRETE.

Steel side forms, manufactured by the R. D. Baker Co., Detroit, Mich., are being used on this work. The transverse joints, which are placed 25 ft. apart, are protected by Kahn plates of the Trussed Concrete Steel Co., Youngstown, Ohio.

On the first 1,200 ft. of road one of the new Baker striking and finishing machines was used but on all subsequent work they have gone back to the old methods of a wooden, steel shod templet and wood hand floats handled by workmen from a bridge spanning the road. The concrete is cured by covering with earth for a period of 10 days, being kept wet by sprinkling during the entire time. Traffic is not allowed on until 20 days after the concrete is laid.

WATER SUPPLY.

The water supply for the mixer is taken from the St. Joseph River at a point close to the middle of the work. A 12-hp. Perkins double cylinder engine drives a single acting triplex plunger pump of the Goulds Manufacting Co., Seneca Falls, N. Y. This pump has a diameter of 3½ ins. and a stroke of 6 ins. and runs at a speed of between 60 and 80 r.p.m. It is built to withstand a working pressure of 200 lbs. and has a maximum capacity of 60 gals. per minute.



Construction Views of Indiana Concrete Road Work.

Fig. 4—Storage End of Gravel Excavating Plant. Fig. 5—Close View of Gravel Screen. Fig. 6—Stock Piles Along Road. Fig. 7—Concrete Mixer. Fig. 8—Motor Dump Truck for Hauling Materials.

As the pump is located midway between the ends of the road, the maximum pumping distance is a little over 1½ miles. Along the pipe line T's are provided every 100 ft. to furnish connection for a 1-in. hose.

Plans and specifications for Vistula Road were prepared by Albert Rieth, Goshen, Ind., county engineer of Elkhart County. Robert Cook represents the county as inspector on the work.

A Uniform System for Highway Statistics and Data.

The necessity for uniformity in highway statistics and data cannot be too strongly emphasized. In spite of the fact that much has been written on the subject, it has nevertheless been considered of relatively minor importance not only by the general public but even by the engineering profession. This may be accounted for by the tremendously rapid development of highways during the past twenty years, which has kept engineers too absorbed in the process and problems of daily construction work to allow them much time for formulation and correlation of a great mass of statistical material. The hour has struck, however, when continued neglect of this important branch of our subject will mean waste of experience, energy and resources. It is hoped that this Pan-American Road Congress may work out some plan according to which important facts shall be recorded to form such statistics and data as shall be of permanent value to the engineering profession and to all those interested in the constructing and maintaining of highways and the enactment of laws relating to them.

The necessity for uniformity is obvious. Under the present system, many different highway departments are doing similar work without any basis for comparison. The records of one are unintelligible to others. Mistakes made in one department are duplicated by many another. Experiments are repeated, often with unsatisfactory or disastrous results, in a dozen different places. Every department, every engineer, has to learn largely through his own experience, and when this process involves the huge sums now being expended upon highways, it is entirely too costly. Were comparative statistics available, every department would be an experiment station; every experiment station an illumination to the whole field. The conscientious engineer, consulting such statistics upon the inception of any new work could determine, far more accurately than he can today, factors making for success or failure in it.

Granted the necessity of having a uniform system for keeping statistics and data, we must consider its scope. The speaker believes that it should be broad and comprehensive enough to be of *relative* worth, without tying itself up into an agglomeration of red-taped detail. *Simplicity* should be its keynote and motif. It should be devised in such a way as to be intelligible to anyone without the department who came thither for information, and it should give to all employes within the department adequate knowledge of the work; its preliminaries, its progress and its results. In such a system, only approximate cost data could be sought, for varying local conditions would so change many items as to make them inconclusive.

As it illustrates an attempt to secure such a system, the writer will describe the method of keeping statistics and data with which he is most familiar—that employed by the Commission of Highways of the State of New York. On July 15 this department had $14,000,000 worth of construction work going on, plus $1,325,000 worth of maintenance work. Its statistical problem, therefore, is large. No attempt has been made to cover the whole field, but for the purposes of this paper this problem has been considered in part under three heads: First, the treatment of maps; second, the tests and tabulation of stone and sand; and, third, the actual highway construction and maintenance data.

THE TREATMENT OF MAPS.

The department has three different styles of maps: a large map of the state shown on a scale of five miles to the inch; 57 county maps on a scale of two miles to the inch; and additional county maps made from the United States Government Geological Sheets on a scale of approximately one mile to the inch. On the large state map projected state highways are shown by two green lines; projected county highways are shown by a single red line; state highways under construction are shown by a black dash line between two green lines; county highways under construction, by a black dash line over a red line; completed state highways by a solid black line and green border; and completed county highways by a plain black line. Finished, this shows the projected State Highway System as prescribed by legislative enactment, and county highways as petitioned for and laid out by legislative enactment and county boards of supervisors. In addition to the information given on the large state map, the county maps show, too, the number of the contract, its length in miles, the year finished, and the type of construction. The topographical map of each county on the mile-to-the-inch scale gives the same information as the county map. Each topographical sheet is cut in six sections mounted on linen ⅛ in. apart so that they may be folded for pocket use. When on inspection tours these maps give the essential information at a glance.

TABULATION OF STONE AND SAND.

The large amount of stone and sand that passes through our testing laboratory makes uniformity in the keeping of accurate data essential in order to avoid duplication of work and to preserve information that will increase economic construction and assist anyone engaged in the building of public highways. In order to handle the work expeditiously and to make it valuable to all the employes of the department, it has been necessary to make a number of comprehensive forms for the correlation of the results of the different tests.

With every specimen of stone submitted for test, the engineer sends with the sample definite information about the location and available supply, giving its exact location on the United State topographic sheet, as well as the character of rock or material in question, the type of construction for which the same is intended, and the results of any former use. In locating our samples, we have found that the government method of locating by quadrangle is very helpful. By it, each quadrangle is divided into nine sections and these sections are numbered from one to nine inclusive, starting at the upper left hand corner and numbering across the sheet from west to east. Each section is then divided into equal spaces, lettered from A to V inclusive from west to east, and numbered from 1 to 32 inclusive from north to south, the numbers and letters serving as co-ordinates for the point in this section from which the samples were taken. As nearly as may be roughly determined, the maximum limit of error would be somewhere in the neighborhood of 800 ft., which is practically inappreciable for the work involved. Such an information slip, Fig. 1, accompanies every stone sample to the laboratory and also accompanies the report of test when the report is made on the specimen. The location of the source from which this sample was taken is then plotted on our office map which shows the highway system, as described above. These maps are very useful, especially in looking up sources of material when we again have construction work in the same vicinity. For all future requirements the record given for this material gives us a service test of the same.

(**FRONT**)

Division Sample No. ....

STATE OF NEW YORK
COMMISSION OF HIGHWAYS

STONE, GRAVEL AND SAND
SAMPLE INFORMATION

BUREAU OF TESTS
Albany, N. Y.
Gentlemen:

.................., N. Y., ..., 191 .

There has this day been shipped Division Sample No. ....of .... taken .... 191.
SAMPLE taken by .... (1) .... from property of ....
Viliage or City of .... Town of .... County of ....
Character of supply is (2) .... Its location by Index No. is Quad ...... Sec. ... Letter .... No. .
General classification of stone is (3) .... The available supply is (4) ....
It has been used for (5) .... Course on Road Nos. .... The results of its use were
....
SAMPLE is submitted for use in (5) .... { Culverts / Course of the (6) .... Road
Pet. No....... Road No...... Repair Contract No...... Route No..... Sec. No...... County of ....
From Sta... to Sta... Haul to nearest point on road which is Sta... is... miles. Road extends from Sta... to Sta...
The kind of stone specified for use on this road for top course is (3) .... and for bottom course is (3) ..
The type of construction of this road is .... Binder to be used is ....
Remarks (7) ....
....
....
....
....
SAMPLE is herewith recommended for use in the (5) .... course. Signed ....
SEE NOTES ON OTHER SIDE OF THIS FORM.
Engineer Division No. ......

(**BACK**)

NOTES.

(1) Give title of person who took sample.

(2) State whether quarry, ledge, or field stone, or in case of sand or gravel whether bank or creek bed.

(3) State whether limestone, trap, syenite, etc., etc.

(4) State whether plentiful or limited. If limited give approximate estimate in cubic yards.

(5) State whether top, bottom or concrete.

(6) State name of road.

(7) Wherever information called for on this form cannot be given, draw a line in the following blank space. Wherever there is insufficient space for information in the form give the additional information under "Remarks," also any information regarding the accessibility of the quarry, character of haul, amount of stripping necessary or other information deemed advisable.

Fig. 1.

In our stone tests the following determinations are made: Gravity, absorption, coefficient of wear, hardness, and toughness. In order to have a figure which will enable one quickly to compare the relative values of two or more stones, we have a figure which we have designated as a weighted value. This is obtained as follows: To each of the items, abrasion, hardness and toughness, we affix a weight, giving 3 to the French coefficient of wear (abrasion) as being the most important; assigning 2 to the hardness test as being second in importance and reliability; while to the toughness the weight of 1 is given. These three weighted results are added together, giving the weighted value of the stone tested. All are tabulated on cards, Fig. 2, for the purpose with the other information mentioned above, as well as the location, owner, available supply, water, where used, etc. Furthermore, these tests are collated on one sheet for each county, listed under headings giving the character of the stone found in the county. The weighted value is placed on our map, it being of great aid when approving or disapproving stone for use from these different localities.

STATE OF NEW YORK
COMMISSION OF HIGHWAYS
BUREAU OF TESTS
ALBANY

Results of Stone Tests

Filed Under ....
....
....
....

B. R. Sample No. .... Taken .... 191.., by .... Div. Sample No. ....
From the property of ....
Village or City of .... Town of .... County of ....
Location .... Index No. ....
Character of Supply .... Cubic yards available ....
Material has been used on Highways No. .... Results of use ....
General classification ....
Stone specified { Top course .... @ .... per cu. yd. ....
Stone specified { Bottom course .... @ .... per cu. yd. ....

RESULTS OF TESTS

Specific Gravity	Weight lbs. per Cubic Foot	Water absorbed lbs. per Cubic Foot	Abrasion		Hardness	Toughness	Weighted Value
			Per cent of Wear	French Co-efficient of Wear			

Type of construction ....
Remarks: ....
....
....
....
....
Sample received .... 191.. Tested .... 191.., by .... *Engr. in Charge Tests*
Sample .... accepted for .... concrete .... 191.., by ....
Sample .... accepted for .... course .... 191.., by ....

Fig. 2.

This information of course is not without its limitations. In many instances the chief in the office is unable to judge by the previous information that he has on hand of tests already made whether sufficient examination has been made on the ground. Often it has been found that a more comprehensive field survey will develop a supply of stone and sand which was not found upon first examination, thus cheapening, in many cases, cost of construction. And, too, the division by county is rather a rough determination, though it is considered fine enough for the work in hand, as we also take into account the geologic formation when taking action on the various tests.

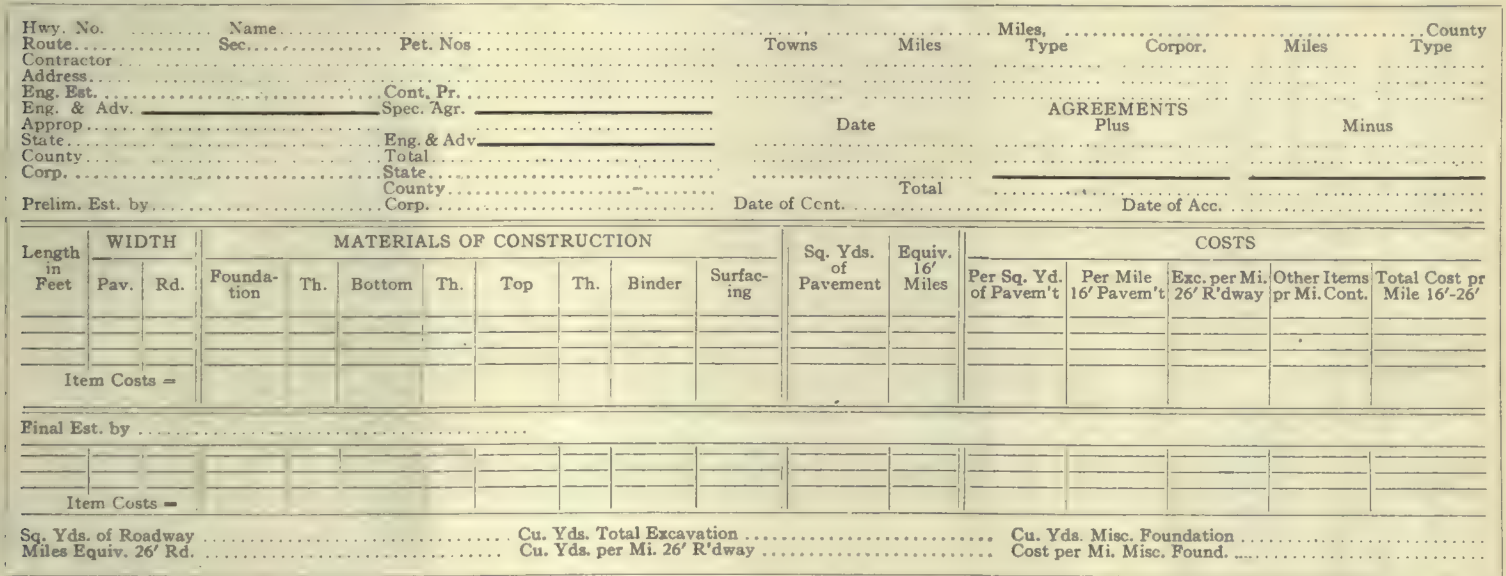
The results of these tests are reported in duplicate to the division engineer in whose territory the sample was taken. This allows him to preserve in his files a copy of the same and also to transmit a copy to the engineer who is in actual charge of construction. By this means a two-fold purpose is attained, as the data are placed in the hands of the division engineer for his use and future reference, and serves as well to educate the engineer in charge of the work by familiarizing him with the various materials which he employs.

The test for sand is not quite so elaborate as that for stone, but as there is great variation in the supply obtained in many cases, we have provided kits for men in the field which enable them to check the loam determination and also to make some of the mesh analyses. With sands the following determinations are made: Per cent of loam and its occurrence, that is, whether it occurs in free state or has a tendency to coat the grains; also the effect of washing upon the sand; percentage of voids by mesh analysis, using the following sieves: ¼, No. 6, No. 20, No. 50, No. 100 and No. 200. The natural and washed sands are also made up into 2-in. cubes for compression tests, using a standard blend of cement. At the same time we make a compression specimen, using the same cement and a 20:30 Ottawa sand. The result obtained on the natural and washed sands at the end of seven and twenty-eight days is compared with results obtained on the specimen made, using the Ottawa sand as a standard, our requirements being that the natural sand, if it is to be used in any of our concrete pavements, shall show a compression at least equal to that of Ottawa sand. It must also be free from organic matter and reasonably free from loam, our specifications stating that 5 per cent of loam will mean rejection. Sand used for other structures such as culverts, foundations, etc., must show a compression strength of at least 80 per cent of that obtained with Ottawa sand.

This elaborate detail test of sand may appear to be useless work, but it has been proven by results obtained that in order to have successful concrete pavements the sand forming the matrix must be as carefully and judiciously selected as the cement that forms a part of the same. Our experience has been that many failures in this type of construction are entirely due to poor sand. Concrete to withstand abrasion and tensile and compressive stresses, is only as strong as the matrix composing it. The inconsistency of present day practice is shown by testing the one important ingredient (cement) with a fine degree of precision, and trusting the other equally important ingredient (sand) to visual guesswork.

HIGHWAY CONSTRUCTION AND MAINTENANCE DATA.

As this is one of the most important items for the consideration of uniformity, I shall endeavor to give a description of our system somewhat in detail, chiefly for the purpose of emphasizing the necessity for uniformity and for the keeping of this kind of statistics. Probably every municipality and state engaging in the improvement of highways and pavements has some form or other which covers this class of data, and some effort should be made to reduce the ultimate results to standardized units flexible enough to cover all constructive and maintenance matter and relative enough to permit an intelligible exchange of this data between different departments. These statistics are outlined with the idea of placing in the hands of the designing engineer a rough relative cost of the types of pavement, giving the kind of material used, the density of traffic carried, its growth invited by the improvement, and the life of the pavement, so that he can in the consideration of a new problem have always before him a service test of magnitude equal to that of the undertaking to be considered. This information should also be of equal value to the maintenance engineer as a record of the results gained from the expenditure of money from year to year on different types, giving him adequate data on which to formulate new kinds of treatment along lines giving the greatest satisfaction and to discard methods proven by use to be unreliable.



Hwy. No. .... Name .... Miles, ... County
Route .... Sec. .... Pet. Nos .... Towns Miles Type Corpor. Miles Type
Contractor ....
Address ....
Eng. Est. .... Cont. Pr. ....
Eng. & Adv. ―――――――― Spec. Agr. ――――――――
Approp .... Date AGREEMENTS Plus Minus
State .... Eng. & Adv ――――――――
County .... Total ....
Corp. .... State ....
County .... Total
Prelim. Est. by .... Corp. .... Date of Cont. .... Date of Acc. ....

Length in Feet	WIDTH		MATERIALS OF CONSTRUCTION								Sq. Yds. of Pavement	Equiv. 16′ Miles	COSTS				
	Pav.	Rd.	Foundation	Th.	Bottom	Th.	Top	Th.	Binder	Surfacing			Per Sq. Yd. of Pavem't	Per Mile 16′ Pavem't	Exc. per Mi. 26′ R'dway	Other Items pr Mi. Cont.	Total Cost pr Mile 16′-26′
Item Costs =																	

Final Est. by ....

Length in Feet	Pav.	Rd.	Foundation	Th.	Bottom	Th.	Top	Th.	Binder	Surfacing	Sq. Yds. of Pavement	Equiv. 16′ Miles	Per Sq. Yd. of Pavem't	Per Mile 16′ Pavem't	Exc. per Mi. 26′ R'dway	Other Items pr Mi. Cont.	Total Cost pr Mile 16′-26′
Item Costs =																	

Sq. Yds. of Roadway .... Cu. Yds. Total Excavation .... Cu. Yds. Misc. Foundation ....
Miles Equiv. 26′ Rd. .... Cu. Yds. per Mi. 26′ R'dway .... Cost per Mi. Misc. Found. ....

Fig. 3.

For the purpose of collating these data, the department has adopted three cards, one of which is designed to show all construction data, both general and specific, giving its information in such manner as will be available and intelligible to the general public as well as to the engineer.

GENERAL DATA.

Under this heading are grouped such general features as Highway Number, Name of Highway, etc. In general we have two classes of highways: State highways, built wholly by the state; and county highways, built by the state and county together, for which the state pays from 65 to 85 per cent of the total cost. In order that they may be distinguished by their numbers, numbers from 1 to 5,000 are used to distinguish county highways, and 5,000 to 9,000 to distinguish state highways. Numbers above 9,000 are used for the purpose of designating roads originally constructed by a county or town for which the burden of maintenance has since been assumed by the state.

Our cards, Fig. 3, are indexed under their highway number and our files are arranged numerically. The name of the highway is generally taken from the city, village or other well known point at each terminus of the road; as for example, Albany-Schenectady Highway. If too long for one contract, it is designated as Parts 1, 2, 3, etc. This name system further serves to locate the highway and, therefore, appears on the card; the length in miles, the name of the county, the route and section number if a state highway, as well as the petition number if a county highway, and the length and type in each town and corporation are given to complete the location. The contractor's name and address are also given, as well as the amount of the engineer's estimate, the estimated engineering and advertising charges, and also the amount of the total appropriation with the respective subdivisions of this amount into state, county and corporation charges. The actual cost placed opposite to the foregoing shows at once how carefully the engineers were estimating. Space has also been provided to show the amount spent in agreements, which is the term used for any extra work or change in type. Finally the date of the contract and the date of acceptance completes the general record. This card probably is of value only to the department, and is used most often by the deputy commissioners, the secretary, and the financial bureau.

SPECIFIC DATA.

The main subdivisions under specific data are widths, materials and costs. Space is provided for three types of pavement, as we often have that number on one road; the length and width of pavement and roadway are shown for each type. Under Materials of Construction are given the kind and thickness of the foundation, of the bottom and top courses and of binder and surfacing used. Under foundation will appear such forms of construction as Telford, sub-base, etc. Binder will show water for waterbound; asphalt and tar for bituminous; grout for brick roads, etc. Surfacing includes wearing course and oil, tar or glutrin treatment, etc. Costs are figured on the per yard and per mile basis, using 16 ft. of pavement and 26 ft. of roadway as the standard in width. The reason for the adoption of these widths is that they are the most general type in use in New York. As the width of pavement many times varies from 12 to 50 ft. where the width of roadway varies from 24 to 50 ft., on account of improvements mainly in villages and cities, the necessity for the above standard for comparison is obvious. Both preliminary and final estimates are shown. The square yards of mileage in a 26-ft. roadway are given as a basis for computing cost of excavation. A total excavation in cubic yards and the number of cubic yards per mile of 26 ft. roadway are given to show whether the excavation was light or heavy. The number of cubic yards for miscellaneous foundation and its cost per mile are given to show the amounts of extra foundation course that are required owing to bad soil conditions. These specific data are of great value in properly forecasting future work and if a system for uniformity can be devised, much may be learned through them of benefit to others engaged in highway work.

DATA SHEETS.

In order that the Commissioner, Deputy Commissioners, Division Engineers and other employes might have reliable data so as readily to compare different highways under the same and varying conditions both in regard to construction and maintenance, the material on the cards as outlined above has been collated and placed upon white print cloth sheets, Fig. 4, according to the type of construction. A legend is placed at the top of the sheet by which the different classes and kinds of material as well as the name of the manufacturers can be distinguished. The data on these sheets is featured mainly in material unit cost per mile and maintenance per year. Each highway occupies one line and is indexed under its number and there is room for 26 highways on each sheet. Inasmuch as some highways are constructed of several different types, a column is provided for the total mileage; another is provided for the mileage of the type under consideration. Complete information such as kind and thickness of material entering into the different courses as well as the binder used, are shown by abbreviations appearing in the legend. A column is provided in which is recorded the unit cost per mile for the pavement only; another for all other items of construction cost lumped together; and a third for the total amount spent for engineering and advertising. These three items are summed up in a column which gives total cost per mile and the equivalent cost per mile of a 16-ft. pavement is computed and tabulated in order to give instant comparison between highways of the same or different types based on this standard of width. The costs per square yard of the entire pavement and of the top course are given, experience having shown that these items are the ones most often required. The cost of the bottom course can be readily obtained by a little calculation. The maintenance per year will be shown for the first and second years and also the total to date. The cost per mile per year and per square yard per year are given, the idea being to furnish unit costs that will allow a rapid comparison.

For better study of the traffic density we are having a traffic census taken each year and if necessary twice during the year, both before and after improvement. A column is provided to show this. This gives a record of the growth of traffic due to the improvement, and further furnishes us with information by which to adapt other types proper to the locality. A column is provided for the date when the highway is completed, for quick determination of its age.

From the above-described sheets we may make rapid comparisons between roads of the

Form B.

STATE OF NEW YORK DEPARTMENT OF HIGHWAYS.

HIGHWAY CONSTRUCTION AND MAINTENANCE DATA.

BUREAU OF STATISTICAL RECORD.

Type—Bituminous.

Age—3½ and 4 years.
Age shown above is computed to December 31, 19...

A (1) Barber Co.
A (2) Texas Co.
A (3) Sun Co.
A (4) Byerley & Sons.
A (5) Union Oil Co.
A (6) John Baker Co.
A (7) Warner-Quinlan Co.
A (8) Johns-Manville Co.
A (9) Indian Refining Co.
A (10) Standard Oil Co.
A (11) Atlantic Refining Co.
A (12) Amer. Asph. & Rub. Co.
A (13) International Asph Co.
A (14) Wadsworth Stone & Paving Co.
A (15) U. S. Asphalt Refining Co.
A (?) Manufacturer unknown.
T (1) United Gas Improv. Co.
T (2) Barrett Mfg. Co.

G.—Granite.
D.—Dolomite.
L.—Limestone.
S.—Sandstone.
Scr.—Screenings.
Gr.—Gravel.
Gn.—Gneiss.
Sy.—Syenite.
Tr.—Trap.
Q.—Quartzite.

			Material							Unit cost per mile							Cost of maintenance per year					Average traffic ton'ge per day.		
			Bottom.		Middle.		Top																	
Total mileage.	Mileage of type.	Highway No.	Kind.	Thick.	Kind.	Thick.	Kind.	Thick.	Binder.	Pavement alone	Other contract items.	Engineering, whole road.	Total, whole road.	Equivalent for 16-ft. road, pavement alone.	Cost of pavem't per sq. yd.	Cost of top course per sq. yd.	First year.	Second year.	Total to date.	Per mile per year.	Per sq. yd. per year.	Before improvement.	After improvement.	Date completed.
2.87	2.87	347	Ap.	3	....	....	Ap.	3	Genasco	$ 7,610	$ 3,330	$ 1,660	$12,600	$ 8,800	$0.9380	$0.6670	$ 12	$1,088	$6,612	$575	$0.0710	....	386	1-1-10
5.74	5.74	412	Ap.	3	....	....	Ap.	3	....	6,680	5,650	1,120	13,450	7,650	.8149	.5899	459	896	2,696	135	.0164	....	644	9-13-10
3.27	3.27	413	Ap.	3	....	....	Ap.	3	....	7,255	4,205	1,575	13,035	8,250	.8794	.6294	1,447	292	2,828	215	.0262	No census		10-11-09
4.19	4.19	423	Ap.	4	....	....	L.	2	....	8,570	2,850	1,200	12,620	11,030	1.1750	.6310	638	536	7,470	450	.0610	No census		1-4-10
5.40	5.40	440	F. S.	8	....	....	Gn.	3	....	6,910	2,470	900	10,280	9,170	.9770	.5870	573	490	3,563	170	.0233	....	224	1-15-10
4.44	4.44	489	Loc.	4	....	....	L.	2	....	5,605	3,910	1,095	10,610	7,275	.7749	.4082	699	628	3,060	170	.0238	....	310	11-20-09
6.43	6.43	547	Trap	3	....	....	Trap	3	....	10,700	2,235	1,275	14,210	10,700	1.1200	.7650	259	4.518	5,684	250	.0266	....	614	11-22-10
3.87	3.87	562	Loc.	3	....	....	Sy.	3	....	10,510	3,950	1,130	15,590	9,610	1.0240	.6990	615	538	2,595	170	.0163	....	505	1-4-10
5.02	5.02	564	L.	4	....	....	Trap or Sy.	2	....	8,080	2,940	1,050	12,070	8,080	.9020	.5470	585	670	2,759	125	.0130	....	833	1-6-10
4.25	4.25	585	Ap.	3	....	....	Ap.	3	....	6,820	4,880	1,490	13,190	7,830	.8340	.5760	602	640	4,754	280	.0342	....	428	12-16-09
3.88	3.88	604	Ap.	3	....	....	Ap.	3	....	8,530	1,890	1,670	12,090	8,530	.9090	.2420	1,023	759	4,229	270	.0276	....	1,084	2-5-10
2.24	2.24	630	Ap.	3	....	....	Ap.	3	....	7,800	3,210	1,940	13,950	8,800	.9380	.6670	678	592	3,379	380	.0402	No census		1-4-10
1.01	1.01	638	L.	4	....	....	L.	2	....	7,980	2,390	1,930	12,300	9,010	.9600	.5100	99	228	327	90	.0110	....	1,254	11-12-10
4.12	4.12	646	Ap.	3	....	....	Ap.	3	A-1-A	8,020	4,240	1,510	13,760	8,010	.8830	.6110	108	282	1,481	90	.0096	....	262	5-28-10
5.66	5.66	650	Loc.	3	....	....	L.	3	A-1-Gen.	9,850	4,770	1,200	15,826	9,135	.9730	.6870	257	1,876	8,361	420	.0417	No census		8-26-10
5.35	5.35	654	Loc.	4	....	....	Sy.	3	Texas	9,510	3,220	1,320	14,050	10,720	1.1420	.7640	430	1,351	3,395	150	.0179	No census		8-1-10
4.25	4.25	690	Ap.	3	....	....	Trap	3	....	6,475	3,025	1,420	10,920	7,560	.8060	.5980	509	403	7,239	450	.0530	....	264	6-22-10
5.56	5.56	719	Ap.	3	Ap.	3	Ap.	2	....	7,665	3,355	1,080	12,100	8,160	.8690	.4200	1,368	843	2,934	150	.0161	....	452	9-24-10
5.46	5.46	745	Ap.	3	....	....	Ap.	3	....	8,360	3,750	1,060	13,170	9,250	.9850	.6790	567	696	3,163	130	.0152	....	497	1-22-09
5.91	5.91	747	Loc.	4	....	....	Trap.	2	....	10,170	4,750	780	15,700	10,170	1.0830	.7500	2,226	1,980	9,079	380	.0409	....	290	2-16-09
10.14	10.14	794	Ap.	3	....	....	Trap	3	....	10,660	1,560	730	12,950	10,550	1.1240	.7490	2,911	5.405	13,317	380	.0395	....	4,848	9-22-10
6.20	6.20	795	Loc.	3	....	....	Ap.	3	....	5,940	6,030	1,395	13,365	6,775	.7220	.5140	718	1,789	3,656	150	.0174	....	512	7-19-10
4.62	4.62	796	Ap.	3	....	....	Ap.	3	....	7,370	3,780	1,280	12,430	7,370	.7850	.5600	2,257	2,696	8,244	450	.0475	....	275	12-16-09
1.00	1.00	808	L.	3	....	....	Trap	3	....	13,160	5,490	1,990	20,640	10,720	1.1420	.8840	8	.....	8	8	.0002	No census		2-23-09
.70	.70	809	L.	3	....	....	L.	3	....	10,330	6,070	2,080	18,480	8,355	.8900	.6190	.....	.....	.....	000	.0000	....	408	11-20-09
4.45	4.45	841	Ap.	4	....	....	Ap.	2	....	6,610	5,740	1,340	13,690	6,610	.7040	.4300	596	712	2,499	190	.0200	No census		1-10-11

Fig. 4.

Engineering and Contracting

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same type. From a comparison of the average cost of construction and maintenance of these various types, facts will be discovered that should tend to more economic consideration and design than has been had heretofore.

As a recommendation to the Pan-American Road Congress, the speaker would like to suggest the appointment of a committee for the further consideration of uniformity for highway statistics and data, in order that each department may, in so far as it is possible, aid all those interested in highways by showing not only its successes but its mistakes as well. The idea of this paper has been to convey what the department of the Commission of Highways of New York state is trying to do along these lines, and to give the present solution of its problems only as one attempt toward a solution of the entire problem.

ACKNOWLEDGMENT.

Reprint of a paper by H. E. Breed, First Deputy Highway Commissioner, New York, before the Pan-American Road Congress at San Francisco, Cal.

The superior jury of awards of the Panama-Pacific International Exposition has made 46 awards to the United States Steel Corporation and its subsidiary companies for the exhibit at San Francisco. Included in this number are a special gold medal for "the best, most complete and most attractive installation," 11 grand prizes, 10 medals of honor, one gold medal of honor, 20 gold medals and 3 silver medals.

7/19-23

The Lighter Side of Engineering and Contracting

The Versatile Promoter.

RAILWAY promoting is not what it used to be. There was a time when a perfect stranger, whose only possessions were a glib tongue, a glass diamond and a four months' unpaid board bill, could go into the rural districts and make a comfortable living building transcontinental hot air lines. Bonuses and free rights of way were as plentiful as bed bugs in a lumber camp. Resourcefulness was the first, last and middle name of these promoters. One promoter, however, set a high water mark for originality in securing cash. This man had a project for building a road through several counties in a southern state. Each county voted a bond issue to aid in the construction, but with unusual cautiousness it was provided that no money should be available until a certain number of miles of track were laid. The promoter nothing daunted marshaled his resources and started in. After he had laid the required trackage in one county he would collect the cash from the officials, pull up the rails and relay them in the next county. After he had done this a few times, collecting the bonus in each case, a hard hearted sheriff came along and arrested the promoter for stealing the rails from one of the big railroads.

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Might Have Broken His Cane.

SOME asphalt pavement repairs were under way in Spokane in the vicinity of Louis Davenport's justly famous new hotel. A couple of perspiring negro laborers drew up beside the curb a moment to enjoy the shade while waiting for the next batch of "hot stuff." A brightly dressed acquaintance, also colored, and carrying a gold-headed cane in true millionaire style, stopped on the sidewalk to pass the time of day with the asphalt men. While bantering the workers about the uselessness of work in general, the gilded one playfully smote one of the rakers a smart blow on the bare head with his cane, which instantly brought the following remonstrance: "Now see he'a, niggah, doan' yo' know bettah than to hit a black man on the haid w'en he's stan'in' on dis ye'a ha'ad pavement?"—C. R. E., Olympia, Wash.

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Nobody Works When Father Is Around.

A SWEDE had just got a job on a new building. After the first day he stopped the foreman and asked him how he liked his work. The foreman told him that he was the best workman on the building. On the strength of this the Swede said: "I've got a brother over home who is just as strong as I am; can you give him a job?" The foreman told him to have his brother come around the next morning and he would set him to work. That evening the two brothers went to the foreman and said: "How do you like us now, that you have seen us work?" The boss assured them they were the best two men on the building. Encouraged by this, one of the boys said: "Can't you give our father a job?" "Is he as good a workman as you?" inquired the foreman. "He can do as much as both of us," was the reply. "Well," replied the foreman, "you tell your father to come to work tomorrow morning —and you two fellows stay at home."

Ode to a Departed Mule.

Farewell! Adieu, my mulish friend!
The jig is up,
But thy dear voice still lingers on the air,
And I shall herald with unfaltering chirp
Thy stainless reputation everywhere.
I fain would chase again the currycomb
With zeal along thy gently arching spine,
And o'er thy spacious sides I'd cause to roam
A flannel rag—if thou wert only in thy prime.
Once you could hump yourself and pull a galling load,
And fiercely stretch a trace or press a collar,
Or strike a pleasing canter on a country road—
But here you lie, a lifeless mule, a stiff—not worth a dollar.
Once you could yank a slip, a wheeler, or a cart,
Without a murmur, and your name appeareth not
Upon the roll, because you bravely did your part
Unrecompensed—to swell the estimate was all you sought.
Farewell again, my braying friend! Farewell, adieu!
May each successive spring with voluntary hand
Plant violets on your grave, where, deeply hid from view,
You rest—a mule, honored, prone to kick, and sure to land.

o

Who Touched Off the Gas?

THE Society for the Prevention of Cruelty to Animals, the beloved friend of the contractor, has a mystery. The kicking off tank of the New York branch of the society blew up recently with a loud bang. This tank was a rectangular steel installation, 5 ft. x 5 ft. x 10 ft. in size, and was used for sending homeless dogs and cats to their happy hunting grounds. The asphyxiation medium was gas from the city mains. A few days ago the tank was charged with back fence roamers and the gas turned on. In some manner the gas-air mixture was ignited and an explosion followed, blowing out some of the windows of the building and damaging badly the contents of the tank. Where did the ignition spark come from? That is the mystery that is perplexing the society. Cat's fur, as is well known, is a source of electric sparks. It is possible the felines in their endeavors to escape rubbed against each other and thus produced a spark that touched off the gas.

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The Perverse Mexican.

SOME years ago when railroad construction was exceptionally active on the west coast of Old Mexico, Pat "Wheelbarrow" McCarty, a veteran sub-contractor, invaded the field. He foreflushed into the Chief Engineer's Office one day, displaying a roll of greenbacks large enough to strangle a sea serpent, this always being his plan to influence work in his direction. McCarty succeeded in securing several good contracts, and hired Ole Olsen, a Swede, to handle the rock work. After one year's struggle with their contracts and contending with Mexican laborers, Pat disgustedly turned to Ole and said, "Well, Olsen, that old saying, that Mexico is a contradictory country, is a fact. These Mexicans climb trees for water and dig holes for wood." Olsen finally looked up and said, "I believe you bane right, Mr McCarty, but dey do one t'ing like us—dat's dig a well." "Yes, by golly, they do," quickly returned Pat, "but these Greasers would start at the bottom and dig up, if they could."

C. A. E., Los Angeles, Calif.

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Looks Bad for Mike.

TWO Irishmen working on subway construction in New York City ceased their labors for a brief conversation. "I heard ye slammed Mike O'Reilly," said one of them. "Thot I did," replied his fellow laborer, "an' I got arristed, too. The judge he said it would cost me $20 the nixt time if I hit that O'Reilly agin. I'm saving me money now so's to get that $20.

o

The Rule Was Too Short.

ON a contract in Oklahoma an Irishman was the butt of all jokes. The foreman gave him a rule to measure a wall. Pat returned with information that the wall was "as long as me rule, me arms and two bricks." He was not sent to take any more measurements.—F. O. K., San Jose, Tex.

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Skinner Mulvey says: I note an inventor claims that anything a man can do with his hands can be done by a machine. I'd like to see him invent an automat to drive a 6-mule team on a rooter plow in fly time.

CURRENT NEWS

The Doings of the Week.

From a financial standpoint the principal development of the past week was the practical conclusion of negotiations for the floating in this country of the $1,000,000,000 loan for the Anglo-French Commission. This loan will enable Great Britain and France to establish credit in the United States and as a consequence the farming sections of the country will derive immense benefits. The main provisions of the transactions favor the producers of food stuffs, and non-military commodities. Business in general continued to show improvements during the past week and in many lines of industry distinct gains were made. In the construction field there has been some falling off in activities. This is due in great measure to the approach of the cold weather season. The paving and road building periods in certain sections of the country are now two-thirds over and as a result new work in these lines is not as abundant as it was. The municipal waterworks and sewerage fields, however, are showing up well and numerous large and small jobs in these lines are now being advertised or will come up for advertisement in the near future. There also is a considerable amount of heavy construction that likely will make its appearance in the near future. In the Metropolitan District of New York City there has been a decided improvement in building prospects. There has been an increase in the number of new operations, indicating that cheaper money is now becoming available. The Iron and Steel trade continues to boom. During the past few days steel mills have been unable to supply enough crude product for the finishing mills. Contracts were placed last week for 200,000 tons of blooms, billets and bars for delivery in the last quarter of 1915 and the first and second quarters of 1916. Rail contracts include 9,000 tons for the Lackawanna R. R., 7,000 tons for the Seaboard Air Line, 5,000 tons for the Southern Ry., and 5,000 tons for the U. S. Government railway in Alaska. Fabricating orders in August reached 85 per cent of the country's capacity. The average for past 6 months has been 73 per cent. In 1912, a big year, it probably was around 70 per cent. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Sept. 15 were as follows:

Finished Iron and Steel.	Sept. 15.	Sept. 6.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill.....	1.25	1.25
Iron bars, Philadelphia.......	1.459	1.459
Iron bars, Pittsburgh..........	1.35	1.35
Iron bars, Chicago............	1.25	1.25
Steel bars, Pittsburgh.........	1.35	1.35
Steel bars, New York.........	1.519	1.519
Tank plates, Pittsburgh.......	1.35	1.35
Tank plates, New York........	1.519	1.519
Beams, etc., Pittsburgh.......	1.35	1.35
Beams, etc., New York........	1.519	1.519
Skelp, grooved steel, P'gh.....	1.30	1.30
Skelp, sheared steel, P'gh....	1.35	1.35
Steel hoops, Pittsburgh.......	1.35	1.35
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.90	1.90
Galv. sheets, No. 28, P'gh.....	3.60	3.60
Wire nails, Pittsburgh........	1.65	1.65
Cut nails, Pittsburgh..........	1.60	1.60
Fence wire, base, P'gh........	1.50	1.50
Barb wire, galv., P'gh.........	2.50	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.35c.

Railways.—There has been some signs of a bit of coming activity in the railway construction field. Several companies are understood to have decided to undertake work this fall. The Erie R. R., which has had a prosperous season, is stated to have set aside $2,000,000 for completing its double track work in Indiana. The Delaware, Lackawanna & Western R. R., now that its Clarks Summit cut-off is practically completed, may soon take up the building of a new cut-off. Additional contracts on the new 85-mile line from Charleston to Savannah, Ga., for the Seaboard Air Line Ry., have been let. The Southern Ry. also has awarded contracts for 26 miles of double tracking, H. J. Dunavant & Co. securing 11 miles from Greenville, S. C., to Easley, and M. M. Elkan, Macon, Ga., 15 miles from Easley to Central.

Roads and Streets.—No particularly large undertakings in the State highway field reached the call for bids stage during the past week. Washington is asking proposals on about 24 miles of work. Pennsylvania awarded contracts for two sections of state highway at an aggregate bid of about $120,000. Beaumont, Tex., is asking bids on 90,000 sq. yds. of street paving and Seattle, Wash., is calling for proposals on a grading and filling job estimated to cost $300,000. San Antonio, Tex., let paving work amounting to $75,000; Tallahassee, Fla., awarded a $67,500 contract; Bethlehem, Pa., awarded contract for 45,000 sq. yds. of amiesite.

Bridges.—Philadelphia & Reading Ry. is asking bids on several bridge jobs at Philadelphia, Pa. That city also is advertising a considerable amount of work in this line. The Strobel Steel Construction Co., Chicago, Ill., at $184,700 was low bidder for reconstruction of Chicago St. viaduct for Buffalo, N. Y. Toole & Sunderlin, Bridgeport, Conn., at $468,570 were low bidders for the Stratford Ave. bridge at Bridgeport. Canton Bridge Co., Canton, O., was awarded a $66,700 contract for bridge over Canadian River at Canadian, Tex.

Drainage and Irrigation.—The U. S. Reclamation Service is calling for bids on two new contracts. One of these calls for canals and structures on the Shoshone Project, Wyoming, and involves 560,000 cu. yds. of excavation and 1,400 cu. yds. of reinforced concrete. The other job provides for 10 miles of laterals near Dixon, Mont., and requires 43,000 cu. yds. of excavation. New drainage undertakings advertised the past week are small, most of them running from 60,000 to 100,000 cu. yds. in quantity.

Waterworks.—A number of small cities are asking bids on municipal waterworks or on improvements and extensions. Coatesville, Pa., opens proposals Oct. 7 on a high service system requiring 250,000 gal. steel tank and 15,000 ft. of mains. South Charleston, O.; Luverne, Ia.; Miller, Ind., and Lumberton, N. C., are taking bids on waterworks. Benton, Ark., and Leslie, Ark., are asking proposals for materials and equipment for waterworks. Craig, Colo., awarded a $40,000 contract for waterworks; Villa Grove, Ill., let a $32,285 job.

Sewerage.—Atlantic City, N. J., is asking bids for extension of its storm water drainage system; Lake Village, Ark., opens proposals Sept. 25 for material for sewer system; Philadelphia, Pa., is calling for bids on sewers to cost several hundred thousand dollars; North Chattanooga, Tenn., opens bids Oct. 7 on a sewer system requiring 11.27 miles of pipe. Decorah, Ia., awarded a $101,000 contract for sewer system; Clinton, Ia., let sewer contracts amounting to $125,000; Milwaukee, Wis., let a $160,000 contract for a tunnel sewer; Albany, N. Y., let a $172,000 contract for sewage pumping stations.

Buildings.—A considerable amount of public building construction reached the call for bids stage during the past week. New Jersey is asking proposals for several buildings at the State Village for Epileptics, Spillman, N. J. Illinois opens bids Oct. 18 for four buildings at the State Colony for Epileptics near Dixon, Ill. Proposals also are being asked on several good sized educational buildings.

Rivers and Harbors.—The Quebec Streams Commission awarded a $100,000 contract for a concrete dam for water storage purposes. Lower Coast Construction Co., New Orleans, La., secured a 500,000 cu. yd. levee job. Bids are to be asked at once on the second unit of the wharf, dock and terminal project of Beaumont, Tex.

Information in Proposals.

City officials are beginning to show a pleasing tendency to make the most of their official advertisements of public work lettings. They are commencing to realize that definite information in the call for bids notice regarding the advertised work will result in increased competition from outside contractors. As a consequence many proposals, even when inserted in the local papers, now give outsiders some idea of the magnitude of the work to be done. Some officials, however, look upon the insertion of the notice as a mere step in the legal requirements for carrying out the improvement, rather than as a means for securing bids. If non-resident bidders are interested enough to inquire they can obtain the necessary information. Local contractors, of course, are familiar with the undertaking and know whether or not it is worth figuring on. This is all right in periods of construction dullness for then there are plenty of prospective bidders. But when work is plentiful the outside contractor does not pay much attention to blind advertisements. The printing in an official call for bids notice of the approximate quantities or even the estimated cost or the amount of money available will increase the cost of the advertisement a few cents but the increased competition will bring about a saving of many dollars.

Hydro-Electric Development.

A most encouraging development of the last few weeks is the large number of power companies that have taken steps for carrying out construction work. In all parts of the country there appears to have been a revival of interest in hydro-electric developments. Public utility companies have had hard sledding the past two or three years and even their most needed improvements and extensions have been held in abeyance. There has been no market for their bonds and stocks and as a consequence it has been extremely difficult for them to carry out any new financing. Electric companies, in particular, have undertaken little work. In the last few weeks there seems to have been a decided revival of interest in hydro-electric developments. Numerous new companies have been organized and older companies have announced plans for extensions and betterments. Some fair sized contracts already have been let and a number of other big jobs are in prospect.

Bidding for a Job.

An interesting method of filling a municipal office is indicated by the following official call for bids, clipped from a paper published in a Texas city of 5,000 population:

> For City Health Officer.
>
> Bids will be received September 1, 1915, 9 a. m., from physicians for the position of city health officer. For further particulars see City Secretary.

The duties of this position are not stated but presumably they are defined in the plans and specifications. The scheme will appeal to economically minded statesmen for by it they can get the cheapest man.

INCREASED WATER SUPPLY FOR YONKERS, N. Y.

Reservoir Construction and Filtration.

Proposed Expenditure About $3,000,000.

Preliminary steps have been taken by the city of Yonkers, N. Y., to secure an increased water supply. Yonkers adjoins New York City on its northerly line and is the sixth city in the state in respect to population. It extends from the Hudson River, on which it has a frontage of about 4½ miles, easterly to the Bronx River and occupies the southwesterly corner of Westchester County. The estimated population in 1915 is 101,000.

The present supply is obtained from three separate sources: (1) The Grassy Sprain supply, (2) the Saw Mill River or filter supply, and (3) a tube well supply. The amount of water obtained from this last source is very small. The project for an enlargement of the supply has been under consideration for several years. In December, 1910, a Joint Water Supply Committee was appointed to consider the matter. This committee retained Hazen & Whipple, Consulting Engineers, New York City, to examine and report on an increased water supply. The report was submitted in November, 1911.

In general the plans submitted by the engineers and adopted by the Joint Water Supply Committee provide for obtaining an increased supply from the Saw Mill River. This is to be accomplished by (1) control of flood flows of that river, by enlarging the present Grassy Sprain storage reservoirs and the construction of two additional reservoirs. (2) By the filtration of all water used by the city. The following description of the proposed work is taken from a paper by D. F. Fulton, City Engineer of Yonkers, presented before the American Water Works Association and printed in the Journal of the Association of March, 1915.

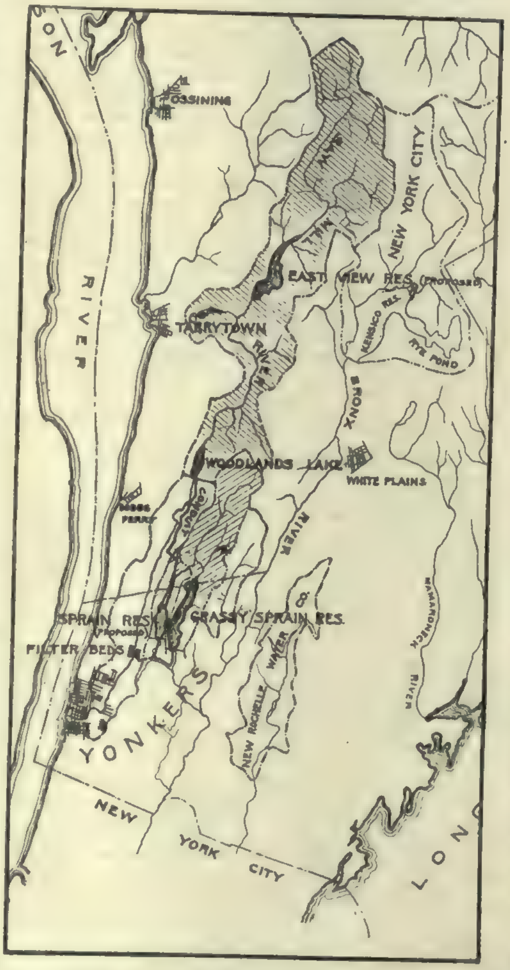
The accompanying map shows the location of a proposed reservoir at East View. The catchment area behind this site is about 12 square miles. It is proposed to build here an earth dam, 20 ft. wide on top, with a maximum height of 47 ft., 400 ft. long at the flow line and provided with gate house and overflow. With the flow line of the reservoir at elevation 230 and with a maximum capacity of 560,000,000 it is proposed to arrest the floods of the upper area and by means of regulating gates pass this stored water down the stream to Woodlands Lake, an existing artificial lake with spillway at elevation 155, where an intake is to be constructed.

From Woodlands Lake a 72-in. aqueduct and tunnel will conduct the flowage through the ridge into the Upper Sprain. The water of the Saw Mill River, a tributary of the Hudson, is to be diverted to the Sprain, a tributary of the Bronx. In the lower Sprain Valley it is proposed to form a reservoir by constructing an earth dam 50 ft. high and 350 ft. long. The reservoir will have a flow line at elevation 147 with the top of the dam at elevation 155. The Sprain reservoir will lie directly west of the Grassy Sprain reservoir. The latter is to be enlarged by the construction of an earth dam 40 ft. higher than the present one and about 350 ft. downstream from it. This dam will be about 24 ft. wide on top and 1,070 ft. long.

Underlying the present dam preliminary borings indicate rock at a depth of 90 ft. below the brook. The Rock Valley is wide, so there is a large section of material overlying it. This material largely is sand of varying degrees of coarseness. Much of it is so coarse as to carry water freely. A cut-off for the underground flowage is proposed for the new dam. It has been suggested that this can be done by driving steel sheet piling to rock or in the deeper part of the valley by sinking a connected series of caissons and filling them with grout or concrete.

A 6-ft. tunnel is to be driven through the ridge between the two reservoirs. This will permit filling by gravity the Grassy Sprain reservoir up to elevation 147. The flow line of the enlarged reservoir, however, will be at elevation 170. To fill the upper 23 ft. it is proposed to install a pump at the entrance of the tunnel to be operated by an electric motor, the current for which will be furnished by a generator at the filter bed pumping station. Water will be drawn by gravity from either or both of these reservoirs through 48-in. lines to the filter bed. Under ordinary conditions the supply will be drawn from the Grassy Sprain reservoir. By this arrangement no raw water will be taken to the filters, as the water will not be admitted to them until after a considerable period of settling, storage and blending both in the Sprain and Grassy Sprain reservoirs.

The filtered water will be pumped directly into the mains and also to the Fortfield reservoir. This is an open reservoir of about 60,000,000 gals. capacity, divided into two equal parts by a masonry wall. It is part of the general scheme to raise and cover this reservoir. The completion of the works outlined above, with a total catchment area of about 24 square miles, will, it is estimated, give a supply of about 18,000,000 gals. per day in an ordinary dry year. In other years it is expected from 20,000,000 to 22,000,000 gals. daily will be obtained. With all reservoirs filled the city will have 5,700,000,000 gals. of water in storage, distributed as follows:



Water Supply of Yonkers, N. Y.

	Gals.
East View reservoir	560,000,000
Sprain reservoir	380,000,000
Grassy Sprain reservoir	4,700,000,000
Fortfield	60,000,000

The estimated cost of the works by which it is proposed to obtain an additional 10,000,000 gals. per day is $3,073,000; this includes $1,000,000 for land.

The Pennsylvania R. R. on Sept. 11 began service on its electrified main line between Broad St. Station, Philadelphia, and Paoli. The work of electrification has been underway for two years and cost approximately $4,000,000.

LEVEES AND DITCHES TO COST $350,000.

Work Proposed for Green Bay District, Lee County, Iowa.

1,412,240 Cu. Yds. Embankment—419,000 Cu. Yds. Ditches.

A levee and drainage development calling for an estimated expenditure of nearly $350,000 is proposed by the Green Bay Levee and Drainage District of Lee County, Iowa. An interesting feature of this project is that the work is to be done for the protection of reclaimed lands. The general boundaries of this district are the Mississippi River on the east and southerly portions, the bluffs on the west and Skunk River on the north. The Chicago, Burlington & Quincy R. R. passes along the west boundary of the district. The town nearest to the district is Weaver. The total amount of land in the district that will be benefited is 14,356 acres.

The plan of reclamation provides for the construction of levees, a diversion channel and a system of main and lateral ditches and tile drains. In addition a pumping station is proposed.

To prevent the overflow from the Mississippi River, Skunk River and Lost Creek a continuous levee will be constructed along the east bank of the last mentioned stream, the west bank of the Mississippi River and the south bank of Skunk River. The waters of Lost Creek, which at present are flowing through the district, will be diverted by a channel and carried to the Mississippi River outside of the levee.

The levee will have a crown of 5 ft. and combining slope of 4 to 1. If the height of the levee is more than 10 ft. a muck ditch will be required. This will be not less than 5 ft. deep and 10 ft. bottom width. The diversion channel for the deflection of Lost Creek directly to the Mississippi River is located along a center line beginning at the center of the C., B. & Q. R. R. bridge over Lost Creek and continues parallel to and 85 ft. to the right of the center line of the levee to station 140+70 of the levee. From her it runs south 1,700 ft. to the Mississippi River. The ditch will have a bottom width of not more than 30 ft., with side slopes of 1 to 1. The material excavated will be used in constructing the levee. The edge of the diversion channel will be not less than 20 ft. from the toe of the slope of the levee.

For interior drainage a system of main and lateral ditches and tile drains has been planned. This will collect and conduct the run-off and seepage to the suction bay and sluiceway of the pump house, where an outlet is to be provided for all waters of the district, during all stages of the Mississippi River. Details of the interior drainage system follow:

	Bottom width, ft.	Average depth, ft.
Main A	10	8
Main B	10	8
Main C	10	7
Main D	30	10
Main E	10	8
Submain F	6	6
Submain I	10	6

The side slopes for the above ditches will be 1 to 1. The tile drains will be constructed of second-class vitrified clay, the lengths and the dimensions being as follows:

Size pipe—	Submain G. Ft.	Submain H. Ft.	Submain J. Ft.
10-in.	3,000	2,045	.....
12-in.	2,000	1,440	2,500
15-in.	.....	1,980	2,500
18-in.	2,000	.....	2,000
20-in.	2,420	.....	2,320
Average depth, ft.	6.5	5	5.5

The estimated cost of the construction of the levees, ditches and drains is as follows:

Preliminary surveys and organization cost	$ 7,500
Plat and profile (topographic map)	3,500
Permanent location levee and ditches	1,000
Excavation:	
Levees, 1,412,240 cu. yds. at 12 cts.	169,469*
Muck ditch, 260,160 cu. yds. at 8 cts.	16,015*
Ditches, 219,000 cu. yds. at 8 cts.	17,520*

Drains:	
Tile and laying (8,000 ft. 8-in., 8,000 ft. 10-in., 10,000 ft. 12-in.)	4,498
Riprap, 9,000 cu. yds. at $2.50	22,500
Piling, 3,000 lin. ft., 12-ft., at $55 per M	16,500
Moving 3 bridges, etc.	3,000
Right-of-way for levees and ditches.	35,000
Engineering and supervision	14,000
Legal fees, court costs, publication, etc.	7,500
Contingencies	30,000
Total cost	$348,000

*Including clearing.

The establishment of a pumping station as part of the drainage system is proposed. The estimated cost is $47,000. Of this total $22,000 is for pumps and other equipment and $17,000 for the building.

The Supervisors of Lee County on Sept. 20 considered the petition for the organization of the district. Edmund T. Perkins, Chicago, Ill., is Chief Engineer of the Green Bay Levee and Drainage District.

Rapid Transit Construction at Philadelphia, Pa.

Construction has been started on the new rapid transit development for the city of Philadelphia, Pa. Formal commencement on the Broad St. subway took place on Sept. 11. Work on the Frankford elevated line was started a few days previously. Bids on these two contracts were opened Aug. 16. The Keystone State Construction Co., Philadelphia, Pa., secured the Broad St. work at $1,737,000. James D. Dorney, Philadelphia, Pa., was awarded the contract for the work on the Frankfort elevated. This called for column supports for about 26,000 ft. of line, the contract being about $149,000.

About $3,000,000 is available for additional contracts and bids are now being asked by A. Merritt Taylor, Director of Transit, on several of them. The work advertised for letting Oct. 19 is as follows:

Contract No. 511—Steel superstructure and appurtenant work for 2-track elevated railway in Front St. from Callowhill St. to south of Girard Ave., comprising about 4,074 lin. ft. of structure.

Contract No. 512—Steel superstructure and appurtenant work for 2-track elevated railway in Front st. and Kensington Ave., from south of Girard Ave. to north of York st., comprising about 7,128 lin. ft. of structure.

Contract No. 513—Steel superstructure and appurtenant work for 2-track elevated railway in Kensington Ave., from north of York St. to north of Ontario St., comprising about 7,769 lin. ft. of structure.

Contract No. 514—Steel superstructure and appurtenant work for 2-track elevated railway in Kensington Ave. and Frankford Ave., from north of Ontario St. to south of Unity St., comprising about 7,653 lin. ft. of structure.

Grade Crossing Elimination at Cleveland, O., by Nickel Plate R. R.

Grade crossing elimination work involving interesting construction features has been started at Cleveland, O., by the New York, Chicago & St. Louis R. R. (Nickel Plate). The project calls for the doing away with 25 grade crossings in the West Side, the total expenditure involved being in the neighborhood of $3,000,000.

About 2½ miles of double track line from Fulton Road to Detroit Ave. will be depressed. Walworth Run south of the railroad will be filled in. This latter work will require about 750,000 cu. yds. of earth fill. It is proposed to place this by the hydraulic method. Bridges will be constructed at grade over 12 streets, and 13 other thoroughfares are to be vacated where there are now grade crossings. Foot bridges will be built over the tracks at five streets.

It is estimated the work will require two years for completion. About 100 dwellings now on the new right of way are to be sold by the railroad and must be removed within a few weeks.

Highway Construction in Florida.

Florida at the present time seems to offer an excellent field for the road contractor. A large amount of highway construction is now underway or in contemplation in this state. The improvements are carried out by counties or districts of the counties, the funds being provided by bond issues. Some idea of the extent of the work in this state is shown by the following tabulation of bond issues voted or proposed recently:

County and County-Seat.	Amount of Issue.
Lafayette, Mayo	$ 300,000
Palm Beach, West Palm Beach	†800,000
Pinellas, Clearwater	715,000
Polk, Bartow	1,000,000
Seminole, Sanford	*450,000
Taylor, Perry	500,000
Leon, Tallahassee	200,000
Broward, Broward	150,000
Volusia, DeLand	*350,000
Clay, Green Cove Springs	150,000
Lee, Fort Myers	350,000
Putnam, Palatka	208,000
Sumter, Sumterville	*250,000

*Authorized; †Sold.

Various types of construction are employed. In some counties modified asphalt pavement is being constructed. In Southern Florida most of the road improvements consists of brick laid flat on a sand foundation with sand filler and concrete curb. In some of the recent work in Orange County grout filler has been used. Other types of surfacing include concrete, rock, shell and asphalt.

The $350,000 bond issue of Volusia County is to be expended on the construction of 36 miles of road, consisting of 9 ft. of brick, asphalt, concrete or other permanent surfacing, with 3-ft. shell shoulders. Pinellas County already has awarded a $616,578 contract under its $715,000 bond issue. This calls for 56 miles of brick roads, the Edwards Construction Co., Tampa, Fla., being the contractors.

$11,500,000 of Bonds Proposed by Pittsburgh and Cincinnati, O.

Many cities will vote at the coming November election on the issuance of bonds for municipal improvements. The voters of Pittsburgh, Pa., probably will pass on an $8,000,000 issue. Of this total improvements aggregating $4,277,000 already have been approved by the Council. The projects approved include the following:

Widening East Ohio St.	$ 360,000
Mt. Washington Blvd	416,000
Widening Grant Blvd	300,000
Widening Chartiers Ave.	51,000
Widening East Carson St.	75,000
Surface water drain, Nine Mile Run Basin	200,000
Beechview Bridges	275,000
Street raising, Federal St. to Manchester St. Bridge	300,000
Monongahela Blvd., from Court House to Schenley Park	1,000,000
Sixth Ave. Extension to 10th St. Bridge	800,000
Widening Warrington Ave.	150,000
Widening West Carson St.	200,000

Cincinnati, O., also is considering the submission to the electorate of a large bond issue. The total proposed is $3,500,000. The improvements under this issue include:

Park Department	$1,500,000
High pressure fire service	400,000
Convention hall	350,000
Hamilton Ave. Improvement	251,250
Public landing	180,000
Madison Road	150,000
Eastern Ave.	458,250
Quebec Road	172,500
Ludlow Ave.	140,000
Fairbanks Ave.	151,500

Lincoln Highway in Motion Pictures.—C. W. Thomas, the moving picture operator made more than 14,000 ft. of film on the recent official ocean-to-ocean tour of five automobiles over the Lincoln Highway. Arrangements have been made to show this film to nearly 20,000,000 persons throughout the country, to educate the American motoring public as to what the United States has in the way of scenery and to advertise the assurance with which the transcontinental trip can be made over the Lincoln Highway. The film includes many of the most notable features of the Panama-Pacific Exposition.

Grading and Other Work at Kansas City, Mo., to Cost $290,000.

Grading and other work estimated to cost $290,000 is being advertised by the Board of Park Commissioners of Kansas City, Mo. One contract provides for grading Meyer Blvd. from the west line of Swope Parkway to the east line of The Paseo. The estimated cost of this job is $75,000.

The other contract calls for the grading and other improvements of The Paseo. The approximate quantities are as follows:

Earth embankment, 337,000 cu. yds.
Rock excavation, 31,900 cu. yds.
One concrete bridge at 77th St.
One culvert on service roadway, 347.2 ft. south of the center of 63rd St.
One culvert on northeasterly roadway 410 ft. south of the center of 63rd St.
One extension of concrete culvert on service roadway at 66th St.
36-in. drain pipe, 380 lin. ft.
30-in. drain pipe, 250 lin. ft.
24-in. drain pipe, 165 lin. ft.
18-in. drain pipe, 400 lin. ft.
15-in. drain pipe, 295 lin. ft.
12-in. drain pipe, 225 lin. ft.
16 manholes, raised or lowered.
Rubble masonry retaining wall, 130 cu. yds.

The street railway tracks of the Kansas City & Westport Belt Ry. Co. are laid on a portion of The Paseo that is to be graded. These tracks are to be relocated or moved to another location of The Paseo at the new grade. In the grading the contractor will be required to so conduct his work as not to interfere with the continued operation of the street cars.

The bridge at 77th St. will consist of two parts connected by a concrete stairway and earth fills. Each part will be composed of a reinforced concrete arch span, 60 ft. in the clear, and two reinforced concrete abutments with parallel wing walls. The space over the arch and between the wing walls will be filled with earth to support a street railway track, one driveway 35 ft. wide between curbs and one sidewalk. Between the inner wing walls of the north abutment there will be a concrete stairway and earth fill extending from a plane between the grades of the upper roadways in The Paseo to the grade of 77th St. There also will be an earth fill between the inner wing walls of the south abutments extending to the grade of 77th St. at its south line. A reinforced concrete handrail will extend from end to end of the abutment wing walls on roadside.

The arch spans will be elliptical in shape and will have projecting ribs on the intrados face. The extrado surfaces of the arches and the spandrel walls will be waterproofed. The concrete stairways will be 8 ft. from the sidewalk space on the north end of 77th St. to a landing extending between the inner walls of the north abutment. From this landing the concrete stairway will be 12 ft. wide.

Bids for the improvement of The Paseo and for grading Meyer Blvd. will be received until 2 p. m., Sept. 28, by T. C. Harrington, Secretary Board Park Commissioners, Kansas City, Mo.

PERSONALS

Mr. H. N. Legreid, county highway engineer, Humboldt county, Iowa, was admitted to associate membership in the Western Society of Engineers in July. Mr. Legreid is also a member of the Iowa Engineering Society.

Mr. R. O. Wynne-Roberts has opened an office as consulting engineer at 310 Temple Building, Toronto. Mr. Wynne-Roberts is well known throughout Canada as an engineer and a contributor to the technical press. Until recently he was consulting engineer to the city of Regina, Sask., and also to the Saskatchewan provincial government in the matter of lignite resources.

Mr. James Burton, civil engineer, has resigned as superintendent of water works at Fort Scott, Kans., and has opened an office in that city for a general engineering practice. He will specialize in the design, construction and management of water works. Mr. Burton has been superintendent of the

Fort Scott plant for eleven years, for one year under private ownership, and for ten years under municipal ownership. Prior to that he had served for ten years as county engineer of Cloud county, Kansas.

Mr. Otto A. Steller has formed a partnership with Mr. W. L. Schwalbe for a consulting civil engineering practice under the firm name of Steller Engineering Co., engineers and contractors, 73 Loan & Trust building, Milwaukee, Wis. The firm will specialize in grading and excavating contract work. Mr. Steller has formerly served on the engineering staffs of the Chicago, Milwaukee & St. Paul Railway, the Milwaukee Bridge Co., and the Wisconsin Highway Commission. Latterly he has been associated with Mr. H. H. Smith under the name of Smith & Steller, consulting engineers, and dissolved that partnership to enter into his present firm. Mr. Schwalbe is a civil engineering graduate of the University of Wisconsin, class of 1910. He was for a time on the engineering staff of the Milwaukee Electric Railway & Light Co., and was later assistant division engineer with the city of Milwaukee.

Dr. J. A. L. Waddell announces that his son, Mr. N. Everett Waddell, C. E., has become his partner under the firm name of Waddell & Son, consulting engineers, with offices at 800 Graphic Arts Building, Kansas City, Mo. Dr. Waddell is well known in the engineering profession, with a record of forty years' practice in this and foreign countries and the authorship of many technical books and articles. He has been a member of the firm of Waddell & Harrington for eight years past. That firm was dissolved in July. Mr. N. E. Waddell graduated from Rensselaer Polytechnic Institute in 1908 and entered the service of Waddell & Harrington on field work in Vancouver, B. C., on the Granville and Westminster avenue bridges. In 1909 he was employed as draftsman with the McClintic-Marshall Construction Co. at Rankin, Pa. The following year he was engaged on special bridge work under Mr. H. G. Kelley, chief engineer of the Grand Trunk. Later in that year he was again employed by the McClintic-Marshall Co. on the erection of the Missouri River bridge at Kansas City. In 1911 he re-entered his father's office. For several years he has been assistant to the resident engineer on the 12th Street Trafficway at Kansas City, Mo., for the city under Waddell & Harrington. Since last June he has been engaged in helping his father in writing a book on bridge engineering. As in the previous years of Dr. Waddell's practice, the field of activity of the new firm will be mainly bridge work of all kinds and its allied branches of construction, but general consulting practice along other lines is projected. Mr. Robert C. Barnett and Mr. Shortridge Hardesty will be associate engineers with the firm.

CONTRACTORS.

Mr. W. C. Jucksch, a well known railroad contractor of Little Rock, Ark., has entered the county road building field for the time being. He is at present engaged on a contract at Russellville, Ark., for the building of 26 miles of macadam roads at a contract price of $110,000. He is also building 40 miles of gravel and sand clay roads in Robertson county, Texas, and has just completed 40 miles of gravel roads with rock base in McLennon county, Texas. Mr. Jucksch has previously specialized in timber trestles, pile driving and concrete construction, on new railroad work, and carried on an extensive business in that line in the South. Some of the jobs which he handled were the White River extension of the Iron Mountain Railway in Arkansas; the Gurdon & Ft. Smith Railroad in Arkansas; the St. Louis Valley in Illinois; the Cotton Belt Railroad from Gatesville, Texas, to Comanche, Texas; the Port Bolivar & Iron Ore Railroad, Longview, Texas; Southern Traction Lines, and Eastern Traction Lines in Texas; the Rock Island from Malvern to Camden, Ark., and the Rock Island from Amarillo, Texas, to Tucumcari, N. M.; Mr. Jucksch says that he will resume in that field as soon as railroad construction begins to pick up.

OBITUARIES

J. Edward Bering, who constructed the horseshoe bend and the first long tunnel on the Pennsylvania Railroad in western Pennsylvania, was killed in an automobile accident in Decatur Ill., Aug. 19. Mr. Bering was 86 years old. He began his professional career in 1848 on the engineering forces of the Pennsylvania.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examinations:

Junior Civil Engineer; Interstate Commerce Commission; $720 to $1,680 per annum; Oct. 20.

Junior Architect; Interstate Commerce Commission; $1,200 to $1,680 per annum; Oct. 20.

Junior Structural Engineer; Interstate Commerce Commission; $720 to $1,680 per annum; Oct. 20.

Junior Telegraph and Telephone Engineer; Interstate Commerce Commission; $720 to $1,680 per annum; Oct. 20.

Junior Signal Engineer; Interstate Commerce Commission; $720 to $1,680 per annum; Oct. 20.

Junior Mechanical Engineer; Interstate Commerce Commission, $720 to $1,680 per annum; Oct. 20.

Junior Electrical Engineer; Interstate Commerce Commission; $720 to $1,680 per annum; Oct. 20.

NEW CATALOGUES

Concrete Mixers.—Paper folder. Atlas Engineering Co., 777 30th St., Milwaukee, Wis.

Shows a number of views of the Atlas mixers and of their main constructional features. Briefly describes the various sizes and points out their special qualifications.

Steam Shovels and Dredges.—Paper folder. The Osgood Company, Marion, Ohio.

"Picture Folder," No. 12, illustrating the various types of steam shovels and dipper dredges manufactured by the company, and showing their operation on several kinds of work.

Motor Trucks.—Paper folder. Sterling Motor Truck Co., West Allis, Milwaukee, Wis.

Describes Sternberg motor dump trucks and shows a number of these "dumpers" at work. Gives extensive specifications and interesting cost estimates comparing operation of Sternberg truck with tractors and teams.

Tractors.—Paper folder. Knox Motors Associates, Springfield, Mass.

Folder entitled "A Land Tug Boat," showing the advantages of the Knox tractor in hauling materials. Enclosed letter and mailing card call attention to the company's catalogue.

Paving Joint.—Paper folder. The Philip Carey Company, Elastite Department, Lockland, Cincinnati, Ohio.

Describes Carey Elastite Expansion joint for paving and sidewalks, with views showing method of construction and finished appearance.

Locomotives.—Paper, 9x6 ins.; 32 pp. The Baldwin Locomotive Works, Philadelphia, Pa.

Record No. 82, "Locomotives for Export," shows views of twenty-seven locomotives built for export by the above company. Gives details of design and data as to capacity and dimensions. The list includes a variety of types for use under varying conditions in foreign countries.

Quartz Mill and Crusher.—Paper, 9½x6 ins.; 22 pp. The Denver Quartz Mill & Crusher Co., Denver, Colo.

Catalogue No. 12, showing various types of Denver quartz mills and crushers. Gives data on size, weights and power required, repair costs, costs of crushing and grinding machinery and sectional diagrams of the mill and crusher. Also briefly describes and shows view of the Denver ore feeder.

Steel Building Products.—Paper, 8½x11 ins.; 12 pp. Trussed Concrete Steel Co., Youngstown, Ohio.

Briefly describes the line of products, with cuts, tables of dimensions, etc. Line includes "Hy-Rib," rib lath, diamond lath, pressed steel studs, corner beads, base screeds, etc. Shows structures using Hy-Rib in roofs, siding or ceiling.

"Armco" Iron Products.—Paper, 6x9 ins.; 64 pp. The American Rolling Mill Co., Middletown, Ohio.

Illustrated and descriptive catalogue of Armco rust-resisting iron products, including corrugated sheets, roofing of various types, siding and ceilings, shingles, expanded metal lath and reinforcing, rainwater pipes and gutters, etc.; also portable buildings, fencing and posts, culverts, flumes and crates.

Concrete Atomizer.—Paper, 8½x11 ins.; 4 pp. Harold P. Brown, 120 Liberty St., New York City.

Describes and illustrates the "Concrete Atomizer," a machine which will mix cement, sand, broken stone or pebbles and water in any desired proportion, and will project the wet concrete upon the work. Lists numerous purposes for which it can be used and describes operation in detail.

CATALOGUE REVIEWS

Road Construction and Maintenance.—Paper, 6x9 ins.; 128 pp. E. I. du Pont de Nemours Powder Co., Wilmington, Del.

The du Pont Company has recently issued a book for free distribution on the subject of "Road Construction and Maintenance," which is intended to aid in the spreading of knowledge relative to the cheaper and simpler methods of road building and repair. A large portion of the work is devoted to the use of explosives in road work, but a great deal of other useful information is included.

The following chapter heads will sufficiently indicate the scope of this book: Location and Maintenance; Clearing the Right of Way; Road Drainage; Reducing Grades; Subgrade and Surface; Road Equipment; Upkeep of Country Roads; Explosives and Blasting Supplies. Other Books (issued by the company on the subject of road work): Digging Post and Pole Holes; Handling a Misfire; Road Building Terms.

The book is well illustrated with halftones and sketches, showing the good and bad methods used in road work and the advantages of certain types of culverts, headwalls, ditches, etc.

Elevating and Conveying Machinery.—Cloth, 6x9½ ins. Link Belt Company, 39th St. and Stewart Ave., Chicago.

General Catalogue 110, showing the elevating and conveying machinery and accessories, power transmission machinery and other appliances handled by the Link-Belt Company. The list includes the various styles and sizes of Link-Belt chain, of which full details are given, with price lists of attachments, cuts showing construction, etc.; sprocket wheels, bearings, couplings and collars, pulleys, belting, rope gearing, safety clutches, levers, buckets, bucket elevators, conveyor troughs and flights, drag conveyors, screen conveyors, bins and hoppers, chutes, apron conveyors, crushers, screens, weigh boxes, dump cars, and many other similar appliances. Data as to sizes, weights and other pertinent details are given in tabular form, and much general information accompanies the cuts.

The book is well arranged, printed on heavy cream paper and is handsomely illustrated. Many halftone views of typical installations are included, particularly coal and ash handling machinery, power plant conveyors, belt conveyors, locomotive coaling stations, locomotive cranes, circular storage systems, the Dodge system, bridge tramways, loading and unloading equipment and numerous general merchandise and industrial plant conveyors.

RAILWAYS

BIDS ASKED.

Pennsylvania:

Philadelphia, Pa.—Until noon, Oct. 19, by A. M. Taylor, Director, Department of City Transit, 754 Bourse Bldg., for contract No. 511, steel superstructure and appurtenance work for two-tracked elevated railway in Front St. from Callow Hill St. to south of Girard Ave., comprising about 4,074 lin. ft. of structure; also for contracts Nos. 512, 513 and 514, calling for similar work in Front St., Kensington Ave. and Frankford Ave.

Philadelphia, Pa.—Philadelphia & Reading Ry. is asking bids until noon, Sept. 27, on following work in connection with opening of Tulip and Emerald St.: Contract No. 1, bridge abutments and removal of core at Emerald St.; Contract No. 2, superstructure of bridge at Emerald St., ready for concrete encasement; Contract No. 3, waterproofing of bridge over Emerald St. Samuel T. Wagner is Chief Engineer.

PROSPECTIVE WORK.

Arkansas:

Crossett, Ark.—The Arkansas, Louisiana & Gulf R. R., a 61-mile steam line has been purchased at a court sale by Alfred Cowle, 140 W. Van Buren St., Chicago, for $102,000. The line runs from Monroe, La., north to Bascot and Crossett and Hamburg, Ark.

Delaware:

Wilmington, Del.—Wilmington Southern Traction Co. and Wilmington, New Castle & Delaware City R. R. have been purchased by E. Clarence Jones, of New York. J. P. Hampleton, Wilmington, is general manager.

Georgia:

Sylvania, Ga.—Property of Southern Seaboard Lumber Co., including franchise for railroad to be built from Newington, has been bought by G. Roy Muller, Baltimore, Md., for $50,000.

Indiana:

Ft. Wayne, Ind.—The New York, Chicago & St. Louis R. R. will expend about $12,000 for opening Coombs St. with a grade separation.

Huntington, Ind.—Erie R. R. is stated to have allotted $2,000,000 for double-track work and elimination of surface crossing in Porter County. A considerable part of this sum will be spent between Griffith and Lomax.

Kansas:

Hutchinson, Kan.—Anthony & Northern Ry. has surveys under way for extension from Trouseale to Kinsley and Larned.

Newton, Kan.—State Public Utilities Commission has approved stock and bond issue of $1,400,000 for surveying and construction of Newton, Kansas & Nebraska Ry. Company proposes line from Newton to Alba.

Kentucky:

Pikeville, Ky.—Yellow Poplar Lumber Co. has purchased timber land on Shelby Creek and will construct narrow gage railroad.

Maryland:

Baltimore, Md.—Board of Directors of the Baltimore & Ohio R. R. has authorized the construction of a coal pier at the Curtis Bay terminal, which is to have an estimated capacity of 10,000,000 tons a year and cost approimately $1,500,000. Plans of Francis Lee Stuart, Chief Engineer, have been approved.

Montana:

Great Falls, Mont.—Great Falls & Southwestern Ry. Co., incorporated recently with capital stock of $750,000, has completed preliminary surveys for its proposed line, from Ulm to mouth of Hound Creek, 60 miles in all. J. H. Ehlers is interested. J. R. Villars is engineer in charge of location.

North Carolina:

Newton, N. C.—Carolina & Northwestern R. R. will expend several thousand dollars for improving its roadbed; work includes straightening line and raising tracks. J. W. Fletcher, Jr., Chester, S. C., is engineer.

Topton, N. C.—Graham County Lumber Co. is considering building railroad to cost $150,000 and to extend from Topton to Robbinsville.

Goldsboro, N. C.—Virginia Lumber & Box Co., W. L. Muser, Pres., Petersburg, Va., will at once begin construction of railroad from Sevensprings to Goldsboro, where company proposes to erect plant.

Texas:

Denison, Tex.—Southwestern Power, Light & Ry. Co., W. T. Croslen, President, according to reports, is to start construction Oct. 1, on its electric railway from Denison to Oklahoma City, by way of Sulphur.

Galveston, Tex.—The railroads entering this city have announced that the Galveston causeway will be rebuilt at an estimated cost of $1,500,000. It is planned to extend the archway 1,000 ft. Engineers have been instructed to prepare plans.

Washington:

Tacoma, Wash.—Tacoma Ry. & Power Co. has applied for franchise for extension of line into Steilacoom.

Wisconsin:

Madison, Wis.—It is reported here that Minneapolis, St. Paul, Sault Ste. Marie R. R. will take steps in the near future for extending its branch line now running between Stevens Point and Portage to join the main line south of Milwaukee and possibly to include Madison.

Racine, Wis.—Milwaukee Light, Heat & Traction Co. will extend its line on Asylum Av.; work to be started at once.

BIDS OPENED; CONTRACTS LET

Georgia:

Savannah, Ga.—The Gadsden Contracting Co., Savannah, has been awarded contract for first 10 miles of line out of Savannah, for Charleston Southern Ry., the new 85-mi. branch line of the Seaboard Air Line Ry.; it is reported that the work will cost $50,000 per mile.

Kansas:

Fowler, Kan.—Cameron, Joyce & Co., Midland bldg., Kansas City, Mo., has been awarded the contract by the Cudahy Packing Co. for grading, bridging and track laying for 8 miles of line from Fowler to silicate beds. Work is to begin at once.

Maryland:

Hagerstown, Md.—Baltimore & Ohio Ry. probably will take steps in the near future to construct 4-mile line from its Hagerstown branch to plant of Security Cement Co.

Montana:

Three Forks, Mont.—Clifton, Applegate & Co., Spokane, Wash., have been awarded contract for railroad between Three Forks and Radersburg, 25 miles.

New York:

New York City, N. Y.—Public Service Commissioners, First District, have awarded contracts for ballast for new rapid transit line as follows: 200,000 cu. yds. of hard limestone to Upper Hudson Stone Co. at $228,000; 32,500 cu. yds. of trap rock to Haverstraw Crushed Stone Co. at $26,525.

Ohio:

Cleveland, O.—Lathrop & Henwood Co., Buffalo, N. Y., is reported to have been awarded contract for 35 miles of line from Cleveland, O., to Wooster for Cleveland & Ohio Central Electric Ry.

South Carolina:

Greenville, S. C.—Southern Railway Co. has awarded the following contracts for double-track including masonry, concrete and other work, Greenville to Easley to H. J. Dunavant & Co., Knoxville, Tenn., 11 miles in all; Easley to Central, 15 miles to M. M. Elkan, Macon, Ga.

Charleston, S. C.—L. S. Wood, Gaffney, S. C., has sub-contract for construction on Charleston Southern Ry., now building line from Charleston to Savannah.

Charleston, S. C.—Seaboard Air Line Ry. awarded contract to W. Z. Williams & Co., Fourth National Bank Bldg., Macon, Ga., for filling in trestle work on its new line between Charleston and Savannah. Contract is reported to amount to about $250,000.

West Virginia:

Huntington, W. Va.—Virginian Ry., H. Ferstrom, Ch. Engr., Norfolk, Va., is reported to have started work on a 60-mi. extension from Mullen to Mann, W. Va.

ROADS STREETS

BIDS ASKED.

Arkansas:

Lake Village, Ark.—Until 9 a. m., Sept. 25, by Commissioners for street improvement, Dist. No. 1, for furnishing paving materials for either concrete or brick pavement. J. B. McCrary Co., Engineers, Atlanta, Ga.

California:

Ontario, Cal.—Until 5 p. m., Sept. 27, by R. O. Brackenridge, City Clerk, for 345,000 sq. ft. of concrete paving, 152,000 sq. ft. of macadam and 56,000 sq. ft. concrete gutters, etc.

Illinois:

Chicago, Ill.—Until 11 a. m., Sept. 27, by Board of Local Improvements, for nine contracts for street improvements.

Indiana:

Logansport, Ind.—Until Oct. 9, by Wm. Pickett, City Clerk, for 43,540 sq. yds. of pavement.

Muncie, Ind.—Until 10 a. m., Oct. 2, by John R. Kelly, City Clerk, for improvement of alley, between Adams St. and Charles St.

New Albany, Ind.—Until Sept. 23, by City Clerk, for 1,030 sq. yds. macadam roadway, 270 sq. yds. brick gutters and crossings, 935 lin. ft. of streets (counting both sides) also 966 ft. of limestone curb, 4,600 sq. ft. cement walk; 1,854 cu. yds. excavation. Estimated cost $2,795. S. T. Mann, City Engr.

Michigan City, Ind.—Until 10 a. m., Sept. 27, by Alex. Spychalski, City Clerk, for paving Charles St.

Tell City, Ind.—Until 7:30 p. m., by Louis Siebert, Jr., City Clerk, for combined concrete curb and gutter on Tenth St.

Vincennes, Ind.—Until 4 p. m., Sept. 27, by E. G. Meyer, City Clerk, for grading and paving on Second St.

Franklin, Ind.—Until 2:30 p. m., Oct. 20, by H. L. Knox, County Auditor, for ⅝ mile gravel road.

Noblesville, Ind.—Until 10 a. m., Oct. 9, by W. O. Horton, County Auditor, for concrete road in Noblesville Twp.

Franklin, Ind.—Until 2:30 p. m., Oct. 8, by County Auditor, for county line road.

La Porte, Ind.—Until 10 a. m., Oct. 7, by F. A. Hausheer, County Auditor, for road in Dewey Twp.

Muncie, Ind.—Until 10 a. m., Oct. 6, by F. M. Williams, County Auditor, for gravel or macadam road in Center and Liberty Twps.

Shelbyville, Ind.—Until 10 a. m., Oct. 6, by F. W. Fagel, County Auditor, for three gravel roads in Shelby Twp.

Monticello, Ind.—Until 10 a. m., Oct. 5, by A. G. Fisher, County Auditor, for gravel road in Liberty Twp.

Washington, Ind.—Until 2 p. m., Oct. 5, by L. S. Core, County Auditor, for pike road in Washington Twp.

Crawfordsville, Ind.—Until 10 a. m., Oct. 5, by B. B. Engle, County Auditor, for road in Ripley Twp.

Brazil, Ind.—Until 10:30 a. m., Oct. 5, by Wm. O. Graeser, County Auditor, for gravel road between Jackson and Cass Twps.

Bedford, Ind.—Until 1 p. m., Oct. 5, by E. W. Edwards, County Auditor, for concrete road in Shawswick Twp.

Winamac, Ind.—Until noon, Oct. 5, by County Auditor, for gravel road in Tippecanoe Twp.

Covington, Ind.—Until 2 p. m., Oct. 5, by H. W. Newlin, County Auditor, for gravel road in Troy Twp.

Rockport, Ind.—Until 1 p. m., Oct. 4, by John T. Stevenson, County Auditor, for road in Ohio Twp.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS
H. P. Gillette   C. S. Hill   C. T. Murray   S. C. Hadden   C. W. Malcolm   C. R. Thomas

Volume XLIV.   CHICAGO, ILL., SEPTEMBER 29, 1915.   Number 13.

A Future for the Water Works Operator.

For many years the appointment and removal of water works superintendents for considerations of political expediency has rendered the tenure of that office both short and uncertain. On this point we need not enlarge. There is now, however, an encouraging tendency to appoint men to this office because of their special fitness for it, both as regards training and experience. We have commented on this trend and are pleased to note that a trained observer who, during the past year, has mingled with water works men from coast to coast, has found that there is an unmistakable trend toward appointment and promotion on merit in the water works field. Addressing the New England Water Works Association, at its recent annual meeting in New York City, President Leonard Metcalf said:

> There is manifest throughout the country a tendency toward progressive development, based upon a policy of placing in charge of large works men whose abilities have steadily been proved in smaller tasks. This policy of promotion on merit augurs well for the future of the water works profession.

That Mr. Metcalf has had unusual opportunity to make a broad survey of conditions in the water works field, during the past year, will readily be appreciated when it is recalled that he maintains offices in Boston and Chicago, and that he has spent several months in Denver and San Francisco on water works valuation cases, and that he attended the latest annual meetings of the American and New England Water Works Associations. Such an opportunity for observation of conditions is rare and it is distinctly encouraging to learn that this survey shows that the need for competent water works operation is becoming better understood throughout the country.

We believe the time has arrived when the ambitious young man can enter the field of water works operation with as much assurance of advancement as can be found in other lines of work.

Dust Suppression in Street Cleaning.

One thought brought out in the very excellent paper on street cleaning which we publish this week and another thought contained in another part of the same paper which we have deleted for lack of space, deserve emphasis above other things considered. The first thought is that engineers lack greatly effective street cleaning appliances. One expects to hear protest against this assertion, and protest seems warranted until the condition is analysed.

The first conception of street cleaning today is dustless cleaning. Dustless cleaning comprehends two requirements. One is that loose dirt shall be so thoroughly removed in each cleaning that no appreciable remainder is left to be fanned up as dust. The other is that in the process of cleaning, dust shall not be fanned up to float and choke and befoul and finally settle again. When we review the old line of sweepers and brooms and scrapers we see how few were either thoroughly dust removing or dustless in operation. Of late years there has been improvement and of its nature it is interesting to think for a moment.

Sweeping is being replaced by scrubbing as a means of street cleaning. Dustless sweeping was the first step and mechanical sweepers with pre-sprinkling attachments are among the common tools of the street cleaner. Then came flushers and mechanical squeegees bringing the complete change from sweeping to scrubbing. The advance in sanitary cleaning was notable, and it deserves praise. However, scrubbing is not the perfect process. In northern latitudes for considerable yearly periods it is not practicable because it coats the pavement with ice. In these seasons there is nothing but resort to the old dust raising sweeping process.

There is then a street cleaning machine needed for dustless cleaning without water and the writer of the article which we publish evidently considers that this machine is the pneumatic cleaner. As in the home the pneumatic cleaner supersedes and excels in cleaning perfection, the duster and the broom, but does not replace the soap and water scrub, so in street cleaning the flusher and machine squeegee will still be needed after the pneumatic cleaner comes into general us. But withal the pneumatic cleaner will work a distinct advance in sanitary street cleaning as it has in sanitary housecleaning.

The second thought brought out by the part of Mr. Connell's paper which we do not reprint is this, that dust suppression in street cleaning is not now an engineering problem but is chiefly a financial problem. The engineer street cleaning expert today is at no trouble in bringing about practically complete suppression of dust in street cleaning when popular desire loosens the public purse enough to provide adequate funds. The responsibility for unsanitary and annoying methods of street cleaning belongs entirely with the people; if they desire more perfect methods of street cleaning enough to pay their cost the engineer can provide them.

Making Sewage Disposal Plants Less Unattractive.

That the average sewage disposal plant is neglected, or but indifferently cared for, is the most positive bit of knowledge we have pertaining to sewage disposal. Moreover, such plants are generally regarded as such unclean things that the public has a smug sense of personal cleanliness in their total neglect. In seeking a means to bring about better maintenance and operation of disposal works engineers are turning to more attractive structural design and to the beautifying of the plant's surroundings by seeding and plantings. In this issue we publish an illustrated description of the means employed in giving a general sightly appearance to the disposal plant at Harrison, N. Y. At that plant canna lilies are planted in tiles set in the broken stone of the sprinkling filters. The lilies have done well and certainly have made the plant less unattractive during the summer months—the period during which complaints of sewage disposal plant nuisance are likely to be most numerous. Attention was also given to attractiveness in designing the exposed structural features of the plant. The success attained at Harrison should lead other engineers to adopt similar measures.

That this subject is one of considerable importance is indicated by the following quotation from the report of the committee on works operation and analytical methods to the Sanitary Engineering Section of the American Public Health Association at its latest meeting:

> A reason for the lack of interest on the part of the public in the proper handling of sewage disposal works lies in the fact that sewage works are frequently objectionable and untidy; this is due to the lack of appropriation of sufficient funds for maintenance, and sometimes to carelessness.
>
> With modern processes and proper operation it is possible to reduce objectionable sights and odors to such a point that only a prejudiced visitor will be dissatisfied. A reasonable amount of money spent in laying out flower beds, shrubbery and trees, and in taking care of the grass and walks will be more than returned in the added interest in the plant by its operators and by the citizens.
>
> Your committee begs leave to call the attention of designing engineers to the importance of including the sodding or seeding of slopes and planting of trees and shrubs in the contracts for the construction of sewage treatment works, for new works are too often left in a very unsightly condition with respect to landscape embellishments.

Clearly, engineers will be acting in the public interest by insisting upon such slight additional expenditures as are necessary to beautify sewage disposal plants.

"A Seven Years' Cruise of Prosperity."

Signs and prophecies multiply that America is entering an era of general prosperity. In a recent interview Thomas A. Edison said:

> I am satisfied this country has embarked upon a seven years' cruise of prosperity. Bad times will follow that, but not so bad as we have seen before, because the banking systems of the country are really sound. People can be confident of good times, but they must learn to save and avoid extravagances. The war will likely continue another year, and at its close many survivors will come here to escape the terrible taxes certain to be levied upon them.

While it is generally conceded that a boom in American industries is at hand, not a few students of the broader phases of economics believe that immigration to this country will be less after the war than before. It is argued that the rebuilding of industry in Europe will keep Europeans at home, and that capital will flow from America to Europe rather than the reverse.

American engineers and contractors are particularly concerned in these predictions, but primarily in the forecast as to the flow of money capital to or from Europe, for where money goes, there go men. It is not generally realized that the vast numbers of European workmen have come to America in past years primarily because European money came first and forced them to follow. Money, after all, is merely a ticket ordering men to work. Hence the possessor of money is the director of workmen.

Money is attracted in greatest volume to those places and those industries where total profits are greatest in the long run. This is axiomatic, yet how many who are prognosticating the financial aftermath of the war give due thought to the probable rates and amounts of profit in America as contrasted with Europe? Is it likely that industries that have been greatly disorganized by the war will show as great a rate of profit as industries that have escaped such disorganization? Will devastated farms show as great a rate of profit as farms that have not been harmed? Will mines that have been flooded and abandoned show as great a rate of profit as those that have been kept open? Will railways that have fewer producers to serve show as great a rate of profit as those that have lost none of their patrons? These are the question that should be asked and answered before any sort of rational prediction can be made as to the flow of money and of workmen.

It seems self-evident that the war will make America more than ever the money Mecca. Certainly our enormous trade balances are having that effect now, but we must look beyond the present and the remaining months of the war. Whither will money flow after the war? To the spots of maximum prospective profit. And where will those spots be? Certainly the increased taxes in Europe will act greatly to reduce average profits there. Effective as higher taxes will be in driving capital out of Europe, there is another force that is apt to be far more effective. We refer to the higher wages, unaccompanied by corresponding efficiency of workmen, engendered by the war. The demands of labor guilds, particularly in England, have been met under the stress of war conditions, but we hear nothing of a corresponding increase in labor output. It is a reasonable inference that the guilds that have so long held English industry by the throat will simply tighten their grip and show no inclination to favor the introduction of new labor-saving machines or methods. If so, the war will have served in another way to reduce the average rate of profit in England.

Military rule is socialistic to a high degree, the individual giving way to the organization, government seizing the functions of industry. There is ample evidence already that European industry will emerge from the war changed in great measure, socialized even more than ever, and therefore anti-capitalistic. Business men of imagination and daring are likely to find the industrial atmosphere of Europe more stifling after the war than before. Their eyes will turn searchingly toward the Americas, and, unless we entirely misjudge the spirit of such men, their capital will seek the new world in greater abundance than ever. With the greatest of reluctance have European holders of American railway securities sold out their interests. Yet our railways have been among the least attractive of investments for years past. With saner regulation of their rates, apparently in sight, American "rails" will gain in attractiveness. But we look for the maximum flow of European capital into our "industrials" and into our agricultural lands. The possibilities of profits there are limited by no government enactments and by no trades union restrictions of serious moment.

The relative rate of prospective profit is a theme that cannot be discussed satisfactorily in a single article. We can do no more than indicate its far-reaching importance. Upon the rate of profit depends the direction of the flow of capital, and upon the amount of capital that can secure the higher rate depends the volume of its flow. Both as to rates of profit and as to amounts of capital that can be used America seems assured of continued superiority over Europe, a superiority that increases with every added day of war.

Unfairness in Rates Charged by Certain Municipal Lighting Plants, and the Remedy.

The municipal lighting plant of Seattle has been exceptionally well managed. Good management coupled with low cost of hydro-electric power, and at the same time a free hand to make cut-throat prices for business and residence service, have made it possible for this municipally-owned plant to lead all others of its class in America. But if other cities will continue to keep an eye on Seattle's plant during the next few years they are likely to see some of the roses of municipal ownership fade.

Although the Seattle plant has long charged the city an exorbitant rate for street lighting, it is now apparently about to raise the rate to 4.5 cts. per kilowatt hour, which is but slightly below the charge for residence lighting. Yet a fair rate for residence lighting, based on the load factor and other factors that determine cost, should be at least three times the rate charged for the wholesale lighting of the streets of a city. This statement is not a matter of personal opinion; it is demonstrable and has been demonstrated wherever a careful cost analysis has been made. To be equitable, the lighting rates of the Seattle plant should be, say, 2.5 cts. for street lighting and 7.5 cts. for residential lighting. Since the cluster lights in the streets of Seattle were paid for by direct taxes, and are not charged as part of the street lighting plant investment, a rate below 2.5 cts. might be justified. Doubtless the proposed 4.5-ct. rate is about double what it should be. Why, then, does the city plant raise its street lighting rate instead of lowering it? Because the city plant needs the money and it is more readily secured through a tax than through a direct charge to the residence and business customers.

Knowing nothing about costs of electric service, the public accepts any superficial explanation as to rates charged by a public lighting plant, so long as the residence lighting rate is made low enough. Seattle is not alone in its ignorant complaisance. Cleveland, with its 3-ct. residence rate, has gone Seattle one better. Indeed, there is no apparent limit to the unjust discrimination in lighting rates that a municipally-owned plant will foster, particularly where it has to meet the competition of private company plants.

One of the clever sophistries by which a public is deceived as to the equity of the rate schedule is this: No patron should pay more than the average cost of generating and transmitting the current. The big shipper of freight by rail pays the same rate as the small shipper. To permit anything else is to permit discrimination. So, too, in electric lighting charges the small user should pay little, if any, more than the large user of current.

This sophistical doctrine has actually received the support of an organization of electric users in New England, and they have been diligently circulating their printed propaganda, including therein a letter from Louis Brandeis in seeming support of their argument.

It is contended by those who advocate the "average cost" theory that engineers who consider load factors and the like are pure theorists. The public itself is incompetent to pass upon the question—and there you are!

Of course the logical procedure on the part of the public would be to put the entire matter of rates charged by municipal plants in the hands of a disinterested commission, such as the State Public Utility Commission. But when this is suggested the local city politicians and socialists unite in a cry for "home rule." This has been the experience in most of the states, and the results are as we see them today in Seattle, for example.

For several years the private company that serves Seattle with electricity has had its hands tied by the State Public Service Commission, whereas the municipally-owned plant has been free to make such cut-throat rates as suited its purpose. Then, acting after the manner of the old-fashioned trust, the city has raised the rates where it had no competition, namely, the street lighting rates. A public monopoly is evidently quite as ruthless as the worst private monopoly, and resorts to the very same methods when not curbed.

If we are to continue experiments in municipal ownership, by all means let there be not only fair play but full publicity as to the economic results. Both these ends are accomplished where the control both of municipal rates of charge and of accounting methods is placed in the hands of a State Public Service Commission, as in Wisconsin. The general public is incompetent to prescribe accounting practice or to judge the cost of different classes of service rendered by a municipally-owned plant. The managers of such a plant often do not want a full cost statement made public, and even where they do not object to such publicity they are often tied to the chariot of local politics. No thoroughly honest, thoroughly competent manager of a municipally-owned plant should object for a moment to the same sort of rate regulation and uniform accounting that State Public Service Commissioners impose on private plants. Indeed, if a manager of a municipal plant actually believes in the economic efficiency of his management he should court investigation and rate control by such an independent public agency as a state commission is presumed to be.

ROADS AND STREETS

Dust Suppression and Street Cleaning Practice in Philadelphia.

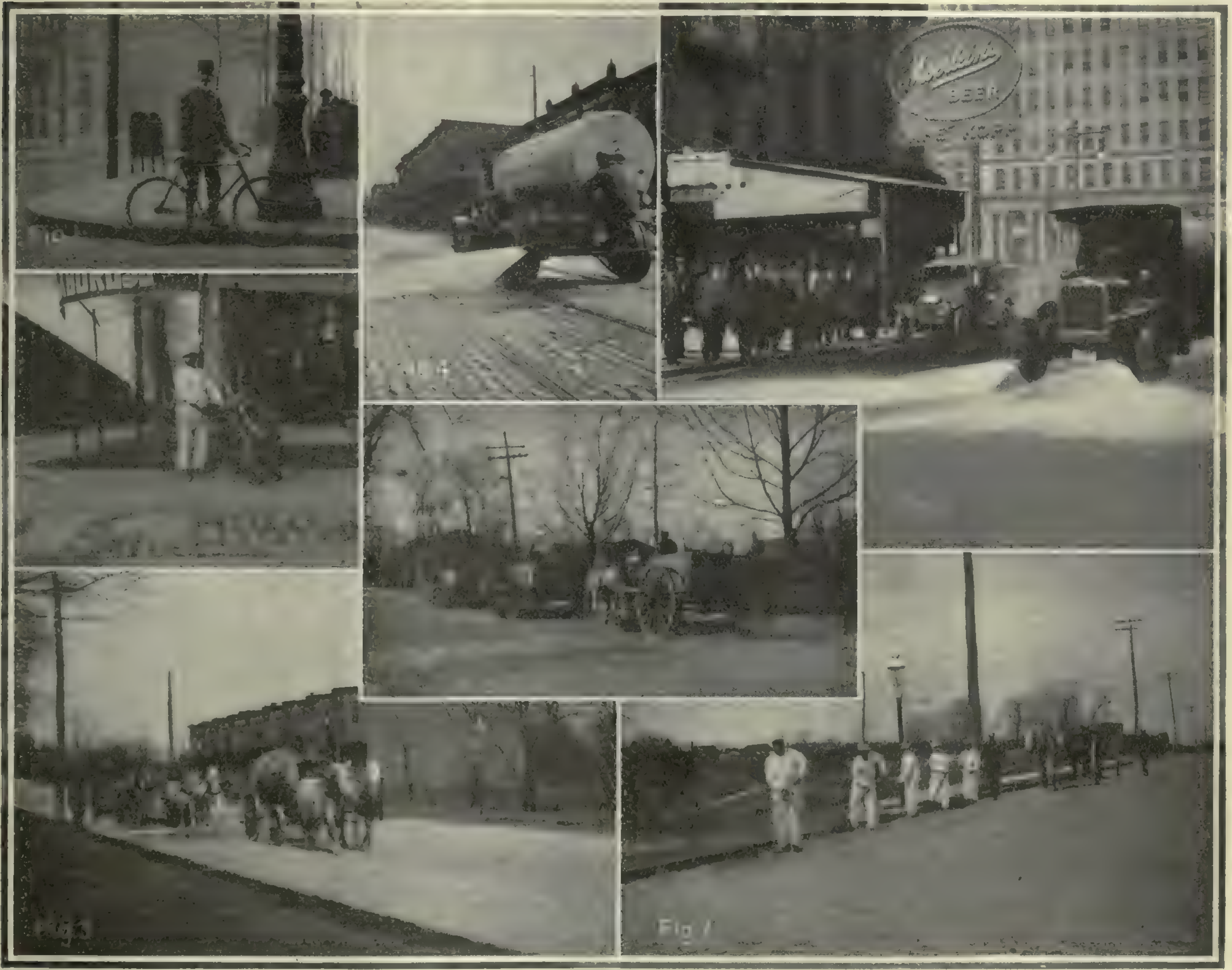
(Staff Abstract.)

The street cleaning problem grows in importance, depending upon the area of paved streets under control, the traffic and population of the community and how apportioned. In a small community it is a somewhat simple one, but very complex and difficult in a large city. It might be said that it grows in magnitude with the density of the population, as traffic naturally increases in proportion and advances with the population.

No hard and fast rules can be laid down as to the number of times streets should be cleaned, except that it should be done often enough to not only have them appear cleanly, but to prevent the dust from becoming a nuisance between cleaning periods. The number of cleanings the respective streets require in order to accomplish this purpose depends upon the general cleanliness and habits of the people and the volume and character of traffic. In a neighborhood where the people are uncleanly in their habits and litter the streets with papers, fruit skins, etc., it is necessary to clean more frequently than in a locality where even though the traffic is the same, the streets are not constantly being littered with rubbish.

The two important considerations in street cleaning work are: First, to secure the co-operation of the public, and if necessary to enact and enforce laws compelling the people to do their part by refraining from littering the streets with rubbish and store sweepings. Unless this can be effected by public co-operation or through the enforcement of the law, it will be impossible to keep the streets clean no matter how often they are cleaned. Secondly, the actual cleaning of the streets, and in order to give a general idea of how this work is carried on in a large city, the following outline of the manner in which this work is performed in Philadelphia, will represent the general methods used.

The street cleaning work is under the jurisdiction of the Highway Bureau, which also has charge of the construction and maintenance of all classes of streets and roads, and the collection of ashes, rubbish and garbage. It is directly supervised by division and district engineers, who are also in charge of all classes of work in their respective districts. The street cleaning force is uniformed; the methods of cleaning are by horse-drawn flushers, automobile flushers, squeegees, machine brooms and hose flushing. In addition to these methods of cleaning, which are carried on in accordance with a fixed schedule stipulating that each street shall be cleaned at stated intervals, blockmen, whose duties consist of pick-up cleaning, are stationed throughout the city. This work is supplemental to the regular schedule of machine cleaning. The area covered by these blockmen varies from 4,000 sq. yds. in the central business section to 20,000 sq. yds. per blockman in the outlying sections, and depends upon the amount of cleaning required in the different sections of the city. Flushers are used almost exclusively on stone block pavements, the water being applied under a pressure of 40 lbs. to the square inch; the purpose of the flushing is to remove the dirt from between the blocks. Machine brooms are also used on block pavements, and smooth pavements that are in bad repair and cannot be satisfactorily cleaned with the rubber squeegees. The most efficient method of cleaning smooth pavements, such as wood block and sheet asphalt, appears to be with the rubber squeegee. This may be demonstrated by thoroughly cleaning a pavement with a machine broom and after it has had a chance to dry out, observing the dust rising from the street when an automobile passes over it. On the other hand after cleaning a pavement with a squeegee, it will be observed that there will be no dust rising from the street as the automobile passes over it. This is due to the thorough scrubbing of the pavement with the rubber squeegee, while the broom leaves streaks of dirt which though very slight and only to be disclosed by close observation, create a certain amount of dust. The disadvantage of cleaning with squeegees, and in fact with most of the present-day methods of cleaning, is that in freezing weather they cannot be used, since it is necessary to sprinkle first and this results in coating the pavement with ice.



Views of Street Cleaning Methods and Appliances, Philadelphia, Pa.

Fig. 1—Street Cleaning Foreman in Uniform. Fig. 2—Blockman with Bag-Carrier, Broom and Pan. Fig. 3—Machine Broom Cleaning. Fig. 4—Automobile (Kinney) Flusher Flushing Granite Block Street. Fig. 5—Squeegee Cleaning. Fig. 6—Automobile (Sauer) Flusher Flushing Asphalt Street. Fig. 7—Method of Gang Cleaning Following Machine Broom and Squeegee Cleaning.

The solution of the street cleaning problem would, therefore, appear to be some sort of vacuum cleaner that would make it unnecessary to wet the streets in the winter. No vacuum cleaners are used now in Philadelphia, but before very long this method of cleaning will supplant many that are in use at present. The mechanical contrivances used today in the cleaning of streets are very crude, which is directly attributable to the lack of engineering supervision in this class of work. It is only within the last few years that in some sections of the country this phase of the situation has been seriously considered and studies are being made with a view to improving upon the present-day equipment.

The schedule under which this work is done is a result of studies made to determine the frequency of cleaning required on each street, with a view to eliminating the dust nuisance on the 1,165 miles of paved streets in the city of Philadelphia, and the country road bituminous surface treatments have accomplished the same results on the 242 miles of macadam and 204 miles of dirt roads.

Street cleaning in the city of Philadelphia is done under annual contracts, the city being divided into eight districts and the work is under the supervision of the district engineers of the Highway Bureau and their corps of inspectors.

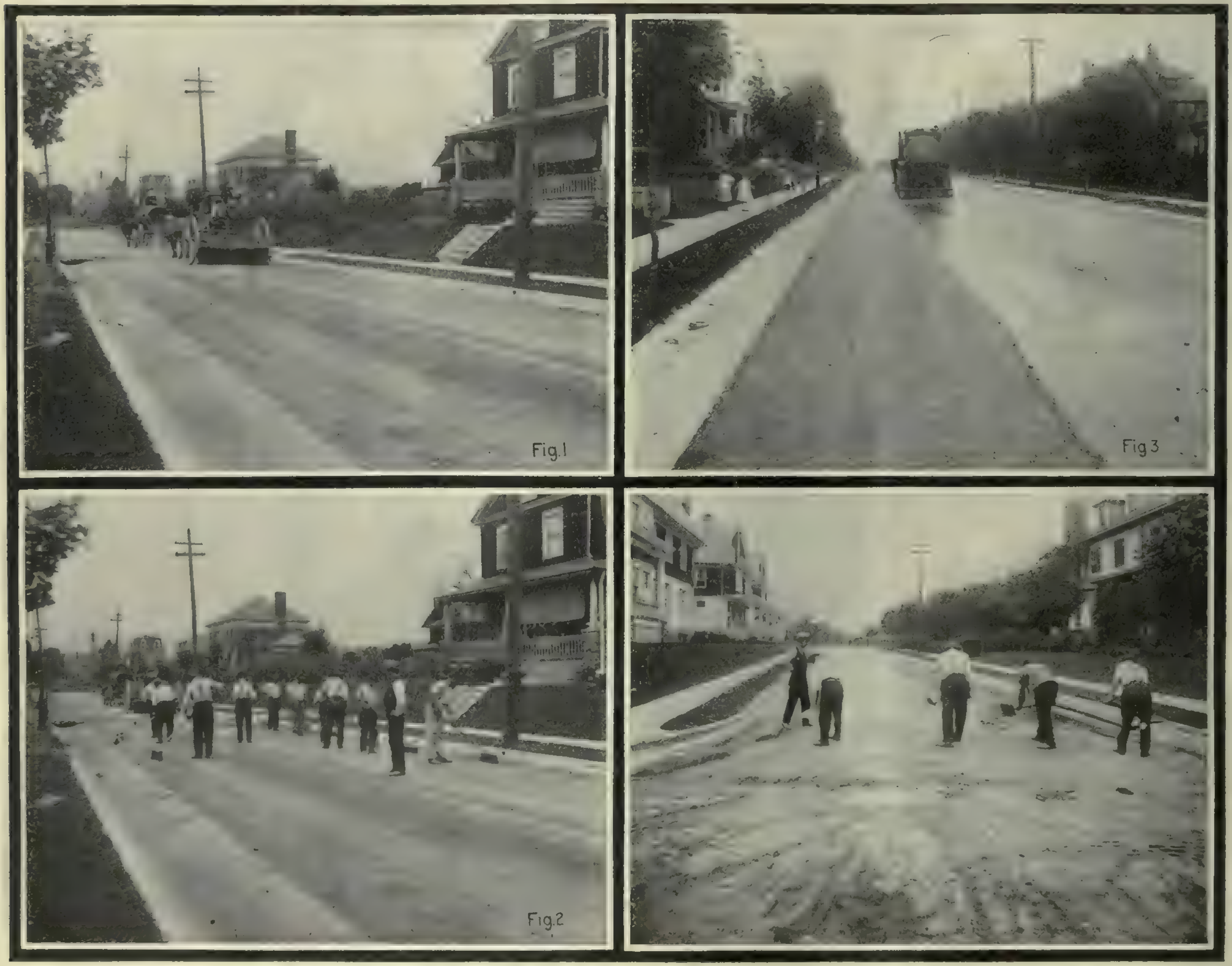
The specifications provide for the cleaning of all streets 6 ft. 6 ins. in width or over, either by machine brooms, squeegees or flushers, and the equipment to be operated in accordance with a schedule which specifies the streets in the order in which they are to be cleaned with the various types of equipment. Squeegee machines, high pressure flushing machines and sprinklers are not used when the temperature conditions are such as to make their use undesirable, due to causing slippery streets in freezing weather. During the winter when this work cannot be done, additional machine brooms and gangmen must be provided to clean the streets with the frequency called for.

The total amount of yardage cleaned every day is 1,354,364 yards; cleaned every two days, 9,955,031 yards; cleaned every three days, 5,712,118 yards; and cleaned once per week, 441,110 yards; which makes an average cleaned per day of 8,309,437 yards. The total yardage of streets to be cleaned in this manner is 17,413,101. In addition to this the specifications provide for the cleaning of suburban and country streets and roads, of which there are 523 miles, and of alleys from one to six times per week, depending upon the necessity.

There are approximately 12,000 alleys in the city under 6 ft. 6 ins. in width.

The specifications also stipulate that the contractor must furnish a certain number of blockmen for each district, fully equipped with the necessary bags and bag carriers, scrapers, brooms, sprinklers, etc. The number of blockmen ranges from 45 to 140 per district. A certain number of hand machine brooms, squeegees and flushers are also specified for each street cleaning district.

All blockmen and gangmen wear white uniforms with white helmets in the summer months and white caps in the winter months. All drivers and helpers wear khaki uniforms with khaki canvas hats in the summer and caps in the winter. Superintendents and foremen wear dark gray uniforms and caps.



Views of Dust Suppression Methods on Suburban and Country Roads, Philadelphia.

Fig. 1—Sweeping Road with Horse-drawn Machine Broom Preceded by Sprinkler. Fig. 2—Sweeping Roads with Hand Brooms After Horse-drawn Machine Broom Sweeping. Fig. 3—Applying Bituminous Material with Auto Pressure Distributor. Fig. 4—Spreading Gravel After Application of Bituminous Material.

Inlet gangs are uniformed in khaki with hats in the summer and caps in the winter.

The following is a description of the methods of handling this work, which is divided as follows: 1. Hand Patrol. 2. Machine broom cleaning. 3. Squeegeeing. 4. Flushing. 5. Alley cleaning. 6. Country road cleaning.

Hand Patrol.—The blockmen are assigned to sections designated by the Chief of the Bureau of Highways and Street Cleaning, the area to be covered by each blockman depending upon the character and amount of traffic and ranges from 4,000 to 20,000 sq. yds. per day. The duties of the blockmen consist of patrolling these areas, gathering all paper or other refuse, and sweeping street dirt as it accumulates and placing it in dustproof bags or metal cans, after which these bags or cans are collected and loaded into special wagons and hauled to a collection station or dump. The equipment used in the hand patrol work consists of hand machines, bag carriers, burlap sacks, push brooms, pan scrapers, sprinkling cans and shovels. The dirt collected is placed in sacks and left at convenient points to be taken away by special wagons to the dump, the sacks being returned to the drivers. Sacks are generally used in preference to cans because of the weight, bulk and noisiness of the latter.

Machine Broom Cleaning.—All machine broom cleaning is done in batteries of two or three, preceded by sprinklers, the number of brooms in each battery depending upon the width and character of the streets to be cleaned, the average gang consisting of two machine brooms, one sprinkler, four to seven gangmen, and a sufficient supply of carts or wagons to remove the sweepings, the number depending upon the length of haul to the dumps and the season of the year, together with the amount and character of traffic.

Squeegee Cleaning.—Squeegee cleaning is used on smooth pavements. The operation consists of batteries of two and three squeegee machines preceded by sprinklers to soften and loosen the material on the streets, the sprinklers using as much water as possible without flooding the pavement; the squeegees using just enough water to create a wash. The idea of sprinkling in advance of the squeegees is to soften the dirt and enable the squeegees to cleanse the streets of all slime as well as the coarser materials. The squeegees are followed by two men, who immediately sweep up the windrows of dirt into piles, and a sufficient number of carts follow to remove the dirt from the streets.

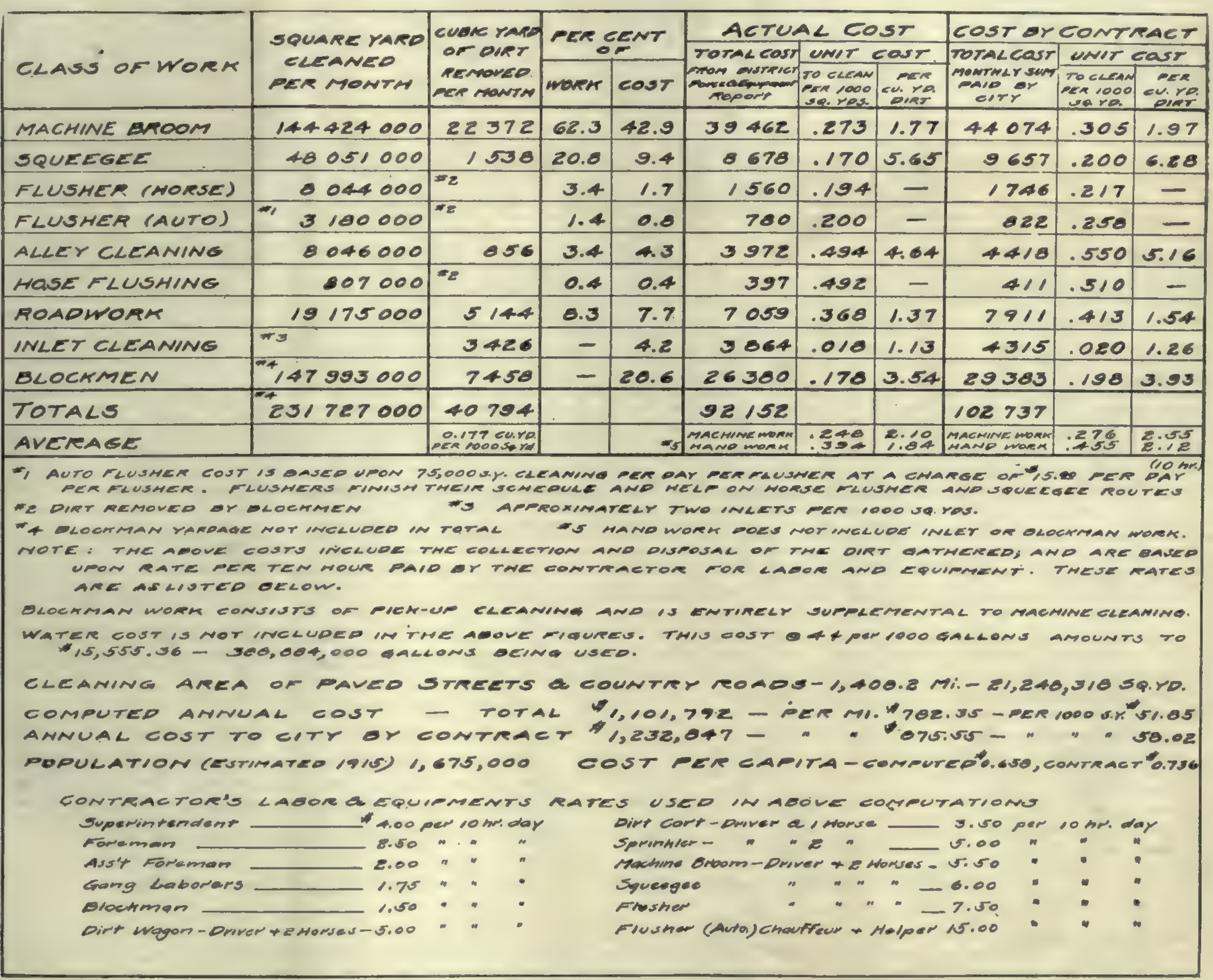
Flushing.—Flushing machines are used only on the poorly paved streets and block pavements. The high pressure flushing machines, two of which are mounted on auto trucks, are usually operated singly, as most of the districts have but one flusher.

Alley Cleaning.—All alleys and streets whose width between curbs is to narrow to permit the use of machine brooms are cleaned once each week with a hose. When such streets or alleys are required by schedule to be cleaned more than once a week, the additional cleaning is done by hand brooms.

Hose Flushing.—A hose flushing gang comprises a foreman and eight men, and operates in the heavy traffic business section of the city. The work is supplemental to the regular gang cleaning and to the blockmen cleaning and is done at night. The work is slow but thorough, the main object being to remove the fine dust and pavement detritus. Approximately 30,000 sq. yds. can be cleaned in 10 hours by each gang. A gang is equipped with hand brooms and 150 ft. of hose with necessary attachments. One man operates the hose, the remaining men scrub the surface of the street, clean out the depressions and the gutters.

Inlet Cleaning.—All inlets on paved streets and alleys are cleaned as often as necessary to keep them at all times free from obstructions, this work being done by special inlet gangs consisting of three men and a sufficient number of carts.

Country Road Cleaning.—The cleaning of suburban and country streets and roads is taken care of by gangs, each consisting of 1 foreman, 10 laborers and 2 carts. The work consists of pick-up cleaning, trimming the shoulders, opening and keeping the gutters clean, cleaning inlets, removing all refuse, rubbish and debris from the streets and such other work as may be necessary to keep the streets and roads in "spick-and-span" condition. The respective streets and roads are cleaned at least once every two weeks, and where necessary once or twice a week. The yardage of waterbound macadam, bituminous and concrete streets and roads, cleaned by the country road gangs is approximately 3,835,217 sq. yds.



CLASS OF WORK	SQUARE YARD CLEANED PER MONTH	CUBIC YARD OF DIRT REMOVED PER MONTH	PER CENT OF		ACTUAL COST			COST BY CONTRACT		
			WORK	COST	TOTAL COST FROM DISTRICT Force & Equipment Report	UNIT COST TO CLEAN PER 1000 SQ. YDS.	UNIT COST PER CU. YD. DIRT	TOTAL COST MONTHLY SUM PAID BY CITY	UNIT COST TO CLEAN PER 1000 SQ. YD.	UNIT COST PER CU. YD. DIRT
MACHINE BROOM	144 424 000	22 372	62.3	42.9	39 462	.273	1.77	44 074	.305	1.97
SQUEEGEE	48 051 000	1 538	20.8	9.4	8 678	.170	5.65	9 657	.200	6.28
FLUSHER (HORSE)	8 044 000	*2	3.4	1.7	1 560	.194	—	1 746	.217	—
FLUSHER (AUTO)	*1 3 180 000	*2	1.4	0.8	780	.200	—	822	.258	—
ALLEY CLEANING	8 046 000	856	3.4	4.3	3 972	.494	4.64	4418	.550	5.16
HOSE FLUSHING	807 000	*2	0.4	0.4	397	.492	—	411	.510	—
ROADWORK	19 175 000	5 144	8.3	7.7	7 059	.368	1.37	7911	.413	1.54
INLET CLEANING	*3	3426	—	4.2	3 864	.018	1.13	4315	.020	1.26
BLOCKMEN	*4 147 993 000	7458	—	28.6	26 380	.178	3.54	29 383	.198	3.93
TOTALS	*4 231 727 000	40 794			92 152			102 737		
AVERAGE		0.177 CU. YD. PER 1000 Sq Yd		*5	MACHINE WORK HAND WORK	.248 .334	2.10 1.84	MACHINE WORK HAND WORK	.276 .455	2.55 2.12

*1 AUTO FLUSHER COST IS BASED UPON 75,000 S.Y. CLEANING PER DAY PER FLUSHER AT A CHARGE OF $15.00 PER DAY (10 hr.) PER FLUSHER. FLUSHERS FINISH THEIR SCHEDULE AND HELP ON HORSE FLUSHER AND SQUEEGEE ROUTES

*2 DIRT REMOVED BY BLOCKMEN *3 APPROXIMATELY TWO INLETS PER 1000 SQ. YDS.

*4 BLOCKMAN YARDAGE NOT INCLUDED IN TOTAL *5 HAND WORK DOES NOT INCLUDE INLET OR BLOCKMAN WORK.

NOTE: THE ABOVE COSTS INCLUDE THE COLLECTION AND DISPOSAL OF THE DIRT GATHERED; AND ARE BASED UPON RATE PER TEN HOUR PAID BY THE CONTRACTOR FOR LABOR AND EQUIPMENT. THESE RATES ARE AS LISTED BELOW.

BLOCKMAN WORK CONSISTS OF PICK-UP CLEANING AND IS ENTIRELY SUPPLEMENTAL TO MACHINE CLEANING.

WATER COST IS NOT INCLUDED IN THE ABOVE FIGURES. THIS COST @ 4¢ per 1000 GALLONS AMOUNTS TO $15,555.36 — 388,884,000 GALLONS BEING USED.

CLEANING AREA OF PAVED STREETS & COUNTRY ROADS — 1,408.2 MI. — 21,248,318 SQ. YD.

COMPUTED ANNUAL COST — TOTAL $1,101,792 — PER MI. $782.35 — PER 1000 S.Y. $51.85

ANNUAL COST TO CITY BY CONTRACT $1,232,847 — " " $875.55 — " " " 58.02

POPULATION (ESTIMATED 1915) 1,675,000 COST PER CAPITA — COMPUTED $0.658, CONTRACT $0.736

CONTRACTOR'S LABOR & EQUIPMENTS RATES USED IN ABOVE COMPUTATIONS

Superintendent	$4.00	per 10 hr. day
Foreman	8.50	" " "
Ass't Foreman	2.00	" " "
Gang Laborers	1.75	" " "
Blockman	1.50	" " "
Dirt Wagon — Driver + 2 Horses	5.00	" " "
Dirt Cart — Driver & 1 Horse	3.50	per 10 hr. day
Sprinkler — " " 2 "	5.00	" " "
Machine Broom — Driver + 2 Horses	5.50	" " "
Squeegee " " " "	6.00	" " "
Flusher " " " "	7.50	" " "
Flusher (Auto) Chauffeur + Helper	15.00	" " "

Fig. 12. Street Cleaning Cost Data, Philadelphia, Monthly Statement, 1915.

Snow Removal.—The street cleaning specifications also provide in case of snow for the entire forces of the contractors to be used in removing the snow, when and where directed. In order to remove the snow quickly from the central and business section of the city, separate contracts are also entered into, in which removal of snow is paid for on the cubic yard basis and in most cases it is dumped into sewer manholes at convenient locations or in the rivers.

DUST SUPPRESSION ON SUBURBAN AND COUNTRY ROADS.

The methods adopted to suppress the dust on the suburban and country macadam streets and roads in the city of Philadelphia are as follows:

The country and suburban streets and roads receive bituminous surface treatments of the character best suited to the respective roads, which are selected only after making a study of the type of construction, the traffic and social and local conditions in each instance. Generally speaking, two methods of treatment are used on the roads to suppress the dust. For convenience they are divided. First, into bituminous surface treatments, intended to eliminate the dust nuisance and preserve the roads, and, secondly, a cheaper method of bituminous surface treatment, used simply for the purpose of laying the dust on macadam, cinder, and dirt roads, and not intended to preserve the road.

The first method of treatment is used only on macadam roads that have been put in good condition, as it is a waste of money to put a high-class bituminous surface treatment on a road that is full of ruts and pot holes and not properly shaped up. The bituminous materials used in the city of Philadelphia, consist of coal tar treatment, hot application, known as Tarvia A coal tar treatment; cold application, known as Tarvia B; water gas tar treatment, hot application, known as Ugite No. 2; water gas tar treatment, cold application, known as Ugite No. 1, and asphalt cut-back treatments which consist of a mixture of 60 per cent to 65 per cent of 80 to 100 penetration asphalt, conforming to specifications adopted by the Association for Standardizing Paving Specifications at Pittsburgh in 1913, and 35 per cent and 40 per cent of 53 to 60 commercial naphtha. All of these materials are applied in quantities just sufficient to paint the road and to avoid possibilities of building up a pad. In other words, the purpose is simply to have a film coat of bituminous material on the surface of the road and to re-treat the road as often as is necessary to maintain the film coat, and in this way eliminate the pushing and rolling under traffic, which occurs with bituminous pads.

The method of applying these bituminous materials, when the road is in proper condition to receive such a treatment and the material to be used on the respective roads has been selected, is as follows: The roads are first lightly sprinkled with water and then swept with a horse-drawn broom. They are then swept with hand brooms until the surfaces of the stone are free from dust. This sweeping, however, should not be done in such a manner that the stone dust or binder will be removed from between the stones. The bituminous material is then applied with a pressure distributor at a certain rate per gallon, which varies on different roads, depending upon their condition, and also whether it be a first, second or third treatment. The bituminous material is then allowed to remain on the road for about 12 hours or over night, after which fine washed gravel—

	Per cent
Passing ½-in. screen	100
Passing No. 4 screen	50 to 60
Passing No. 6 screen	20 to 30
Passing No. 10 screen, not over	10

is spread over the road at the rate of 13 to 18 lbs. to the square yard, depending upon the amount of bituminous material applied.

In some cases clean trap rock chips passing a ⅝-in. ring and maintained on a ⅜-in. ring are used.

The theory of using fine washed gravel in place of stone chips is twofold; first, to use a covering that will not grind up and pulverize before the bituminous material has set up, and thus incorporate with it and build up a pad, such as is the case with the stone chips as they pulverize very quickly under any appreciable amount of traffic; second, it only contains 10 per cent of the fine sand and the pebbles constituting the rest of the material are so hard that they do not grind up and pulverize for from three weeks to two months, depending upon the traffic. The process of pulverizing is so slow that the fine material is washed off the road after each rain, thus doing away with the necessity of sweeping the road to eliminate the dust, which is necessary where stone chips are used.

These treatments last for a year and have proved to be not only the most economical method of preserving roads of this character, but the cost is less than the cost of sprinkling, provided the roads are sprinkled three times a day, and this, by the way, is not sufficient to lay the dust, and, of course, it must also be understood that the sprinkling with water will not preserve the roads under automobile traffic.

The second class of treatment geserally used consists of asphaltic road oil from 18° to 23° Beaume gravity. This material is applied to all of the macadam roads that are not in fit condition for the first-class bituminous surface treatment and to all dirt roads, and is applied at the rate of 2/10 to ¼ gal. to the square yard. On some roads, depending upon the amount of traffic and whether or not the road is shaded, it is necessary to treat the road in May and treat it again in September. Such roads, however, are the exceptions. In most cases this method of treatment will last for one season. The roads as a rule are not swept before the application, nor is any covering put over this bituminous material, as it is applied in such small quantities that there is scarcely any necessity for covering. The purpose in putting on this small quantity is to insure its disappearing from the road before the winter sets in, in order to avoid the mushy condition that prevails when there is too much oil on the road in this season of the year.

The paint coat method of tar bituminous surface treatments on first-class macadam roads has been a success for seven or eight years in this country, and it has also been used to a very great extent for a number of years in England.

The asphalt cut-back paint coat treatments are somewhat new, and have been largely developed is Philadelphia during the last four years. The successful results in Philadelphia have led to its use in other localities in the east this year, notably by the Highway Department of the state of Pennsylvania, where a large mileage of roads have been treated using this method.

The asphalt cut-back bituminous surface treatment was evolved through research work carried on with a view to finding some way to utilize an asphalt in the paint coat method of treatment which had been so successful with the tars. In order to do this it was necessary to use a comparatively stiff asphalt so that it would set up quickly on the road. This necessitated cutting back an asphalt of about 100 per cent penetration with from 35 to 40 per cent of naphtha. The purpose of the naphtha is to make the material of such a consistency that it can be applied to the road when it is moderately warm. In other words, the naphtha simply acts as a carrying agent and after it has done its work it evaporates and leaves the paint coat of asphalt on the road.

This material has proved to be a success under a four-year test, re-treating, of course, every year or two, or as often as is necessary, as is also the case with the tars.

The methods of bituminous treatments described, however, are not applicable to all conditions. The roads treated must be built of comparatively hard stone, and the traffic conditions must be taken into consideration.

It is impossible in the limited time allotted to this subject to go further into the details of street cleaning and dust suppression, but the accompanying tables, Figs. 12 and 13, will give an idea of the cost of cleaning the 1,425 miles of paved streets and country roads under the different methods in use, and of applying the bituminous treatments of different characters for the suppression of dust on the 242 miles of waterbound macadam and earth roads in the city of Philadelphia.

ACKNOWLEDGMENTS.

Extract from a paper before the Pan-American Road Congress by W. H. Connell, Chief Bureau of Highways and Street Cleaning, Philadelphia, Pa.

	TREATMENT	SQ. YDS. TREATED 1915	AVERAGE PER SQ. YD.		AVERAGE LABOR COST PER SQ. YD.					AVERAGE MATERIAL COST PER SQ. YD.			AVERAGE TOTAL COST PER SQ. YD.	AVERAGE TOTAL COST PER SQ. YD. FIRST & RETREATMENTS		
			GALLONS BITUMINOUS MATERIAL	POUNDS COVERING MATERIAL	SWEEPING		CHIPPING	CLEAN UP	TOTAL LABOR	BIT. MATERIAL	COVERING MATERIAL	TOTAL MATERIAL		1915	1914	1913
					HAND	MACHINE										
REFINED COAL TAR – HOT APPLICATION – Tarvia A.	1ST.	206,680	.278	17.6	.00304	.00068	.00538	.00114	.01024	.0236	.0175	.0411	.0513	.0495	.0641	.0824
REFINED COAL TAR – HOT APPLICATION – Tarvia A.	RE.	41,910	.201	15.5	.00265	.00036	.00483	.00078	.00860	.0169	.0154	.0323	.0409			
REFINED COAL TAR – COLD APPLICATION – Tarvia B.	1ST.	429,360	.417	18.9	.00470	.00092	.00460	.00150	.01170	.0289	.0188	.0477	.0594	.0487	.0566	.0658
REFINED COAL TAR – COLD APPLICATION – Tarvia B.	2ND.	326,911	.307	16.5	.00348	.00052	.00480	.00116	.00996	.0213	.0164	.0377	.0477			
REFINED COAL TAR – COLD APPLICATION – Tarvia B.	3RD.	470,000	.235	14.7	.00284	.00035	.00421	.00126	.00866	.0163	.0146	.0309	.0396			
REFINED WATER GAS TAR – HOT APPLICATION – Ugite.	1ST.	40,460	.278	18.0	.00304	.00068	.00550	.00114	.001036	.0222	.0179	.0401	.0505	.0505		
REFINED WATER GAS TAR – COLD APPLICATION – Ugite.	1ST.	58,570	.417	18.9	.00470	.00092	.00460	.00150	.01170	.0250	.0188	.0438	.0555	.0501	.0509	.0698
REFINED WATER GAS TAR – COLD APPLICATION – Ugite.	2ND.	14,800	.307	16.5	.00348	.00052	.00480	.00116	.00996	.0184	.0164	.0348	.0448			
REFINED WATER GAS TAR – COLD APPLICATION – Ugite.	3RD.	18,578	.235	14.7	.00284	.00035	.00421	.00126	.00866	.0141	.0146	.0287	.0374			
ASPHALT CUTBACK	1ST.	194,396	.293	18.0	.00470	.00092	.00460	.00150	.01170	.0231	.0175	.0406	.0523	.0468	.0738	.0868
ASPHALT CUTBACK	RE.	108,090	.201	15.0	.00209	.00049	.00310	.00071	.00639	.0158	.0146	.0304	.0368			
ASPHALT ROAD OIL – DUST LAYER – 21°–23° BEAUME.		1,167,790	.230							.011		.011	.011	.011	.012	
TOTAL SQ. YDS. TREATED.		3,077,545														

	1915	1914	1913
Torpedo Gravel, per 2000 Lbs. delivered on road	$1.99	$2.14	$2.50
Trap Rock Chips, per 2000 Lbs. delivered on road	1.94	2.30	2.30
Tarvia A, per gallon applied	.085	.085	.085
Tarvia B, per gallon applied	.0693	.07	.07
Ugite Hot, per gallon applied	.08	.09	.09
Ugite Cold, per gallon applied	.06	.08	.08
Asphalt Cutback, per gallon applied	.0788	.11⅔	.12
Asphalt Road Oil, per gallon applied	.0484	.0523	—
Laborers, per 8 hr. day	2.00	2.00	2.00
Foremen, per 8 hr. day	4.00	4.00	4.00
Assistant Foremen, per 8 hr. day	3.00	3.00	3.00
Teams, per 8 hr. day	4.50	4.75	5.20

ALL CLASSES MATERIALS, 1915
Total Gallons Applied 847,606 gals.
Total Amount Covering Material 16,089 tons.
Total Cost $86,598.71

Average Labor Cost per Sq. Yd. for hand and machine sweeping, chipping and clean-up—during 1914 $.02030
Average Labor Cost per Sq. Yd. for hand and machine sweeping, chipping and clean-up—during 1915 $.01007
Reduction in Labor Cost per Sq. Yd. during 1915 over 1914 $.01023

Fig. 13. Detail Costs of Bituminous Surface Treatment Work, Philadelphia, Season of 1915.

Oiled Earth Roads.—The oiled earth road has proven generally satisfactory in Kansas, according to W. S. Gearhart, State Engineer of that state. In the construction of these roads, the earth from a strip in the center of the roadway, from 16 to 18 ft. wide is thrown to one side and the subgrade carefully crowned and rolled. Oil at a temperature of 250° F. is then applied at the rate of from 1¼ to 1½ gals. per sq. yd., and enough earth to absorb the oil (usually a layer about 4 ins. deep) is graded back on to the road. The roadway is then thoroughly sprinkled and the earth, oil and water mixed by means of a disk harrow and a drag. The roadway is then compacted by a tamping roller, after which a second application of hot oil is made at the rate of about 1½ gals. per sq. yd. Another layer of about 4 ins. of fine earth is graded on to the road and the mixing and tamping repeated. On completion the wearing surface is from 5 to 6 ins. thick.

Motion Pictures Seen by Cleveland Engineering Society.—A series of three industrial motion picture films, illustrating the manufacture of "National" pipe from iron ore to finished product, were shown before the Cleveland Engineering Society, Tuesday evening, September 28. These pictures were taken under the direction of the National Tube Co., Pittsburgh, Pa., after eight months' work and considerable expense. They are distinctly educational, showing the ore being mined on the Mesaba ore range in Minnesota and all succeeding steps until it is shipped out as finished "National" pipe.

WATER WORKS

Popularizing the Water Meter at Columbus, O.

(Staff Article.)

The editor is in receipt of an interesting communication from Mr. Prentiss R. Crall, chief clerk of the Columbus, Ohio, water works; he writes, in part, as follows:

Many words, spoken and written, have been used in popularizing the water meter—with water works officials.

Why not let the consumer in on some of this information? Why not educate him as to its value and possibilities? A lot of nerve-racking and time-consuming kicks might thus be eliminated. At least it would help to do away with that time-worn phrase: "There must be something wrong with my meter," with which all water works employees are familiar.

It has been the policy of the Columbus water works to aid consumers as much as possible in preventing wastage of water and the circular herewith was prepared by the writer in an effort to help the consumer and indirectly benefit the department.

A METER
in working order registers no more water than passes through it.
IT IS FAIR TO THE CONSUMER.

A FRIEND OF THE WATER CONSUMER
The Meter
WATCH IT **HEED IT**
READ IT
A PERPETUAL INVOICE

A METER
out of working order registers less water than passes through it or stops altogether.
IT FAVORS THE CONSUMER

Fig. 1. Heading of Circular Used by Columbus, Ohio, Water Department in Popularizing the Water Meter with Consumers.

The point Mr. Crall raises is a good one. Of course the water works official is the first one to convince as to the value of meterage and there must be a great deal of repetition of the arguments favoring meterage in gatherings of water works men and in the columns of journals addressed to the workers in this field. This repetition is essential because there are many changes of personnel in a considerable number of water departments from year to year. When the water works operator is convinced as to the value and fairness of meterage he must become the advocate of meterage in his community. He must continue to be the advocate until all services are metered, for that is the only fair way to sell water. Mr. Crall's plan possesses many advantages in popularizing the meter with the man who has installed one somewhat unwillingly and without really understanding the great merit of the meterage system.

We publish the circular used in Columbus herewith. In Fig. 1 is shown the heading of the circular and Fig. 2 shows the meter dial used in illustrating how to read a meter. While the information given is familiar to water works men the use made of it and the form in which it is worked up are of considerable interest. The text of the circular, rearranged somewhat for our use here, follows:

SOURCES OF WASTAGE.

By "wastage" it is meant that water is permitted to pass through the meter without ultimate use. This may occur by deliberate or negligent wastefulness or by reason of leakage due to defective plumbing. Faucets indoors or hydrants in the open are frequently turned on to prevent freezing of pipes. This is done without reference to the cost of water consumed for such purpose, or the cost of repairs to plumbing is given greater consideration than the amount of water wasted.

The water closet may be out of repair and wasting water either in the process of flushing or when not in use.

Motor pumps frequently and silently waste water and motor washers may work overtime. The faucet in the kitchen or bath room may not shut off tightly. The hydrant in the yard or barn may be worn or carelessly allowed to run. A pipe underground leading from the meter may be bursted, permitting an unseen leakage. The lawn or garden, garage or stable hose may be uselessly pouring out water after it has served its purpose.

The urinal, gas engine, soda water font, fish tank, cooling apparatus, drinking fountain or any device requiring constant or periodical flow of water may be turned on or left turned on to a wasteful degree.

RESULT OF WASTAGE.

Bills for water referred to, usually, as "outrageous," or "large beyond reason," are generally the result of wastage in one form or another. That very large bills will result from continued wastage of water through openings in the plumbing may be better realized by referring to Table I.

RATES AND MISCELLANEOUS INFORMATION.

Rate.—25,000 cu. ft. or less per month, 90 cts. per 1,000 cu. ft. In excess of 25,000 cu. ft. per month, 85 cts. per 1,000 cu. ft. In excess of 200,000 cu. ft. per month, 80 cts. per 1,000 cu. ft.

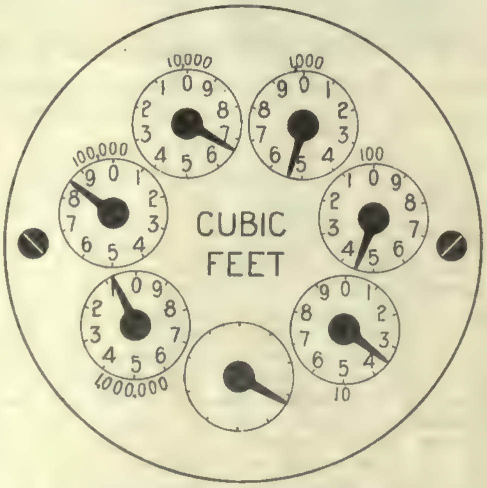


Fig. 2. Setting of Dial Type of Meter Used in Illustrating Method of Reading Meter in Columbus Meter Circular.

Service Charge.—When meter is in service, requiring the attention of the water department, a charge of not less than 22½ cts. per month will be made, whether water is used or not. Service charge discontinued only after water is turned off by water department.

Meters.—If meters are set in conformity to rules of the department, or are not rendered useless by reason of water freezing in them, or hot water backing into them, no charge will be made for repairs up to 50 per cent of cost of new meter.

TABLE I. — QUANTITY AND VALUE OF WATER FLOWING THROUGH ORIFICES OF VARIOUS DIAMETERS UNDER 50 LBS. PRESSURE.

Diameter of opening in fraction of an inch.	Gals. discharged per day.	Value per day at 90 cts. per 1,000 cu. ft.	Value per year at 90 cts. per 1,000 cu. ft
1/32	285	$ .034	$ 12.41
1/16	1,150	.138	50.37
⅛	4,600	.552	201.48
¼	18,500	2.22	810.30
½	74,000	8.88	3,241.00
¾	160,000	19.20	7,008.00

Bills Due.—Semi-annual bills are regularly collected during the months of April and October, and if not paid by the last days of these months, water may be shut off without notice, and an additional payment required for the resumption of service. Monthly bills become due first day of each month, and must be paid by the 15th day of the same month.

Office Hours.—8 a. m. to 5 p. m.

Close at 12 o'clock, noon, Saturdays.

Phones—Ohio State 2194. Bell—Main 194.

HOW TO READ DIAL WATER METERS.

(Referring to Fig. 2.)

The 10 dial reads	3
100 dial reads	40
1,000 dial reads	500
10,000 dial reads	6,000
100,000 dial reads	80,000
1,000,000 dial reads	0
The meter reads	86,543

Dials are numbered from 1 to 100,000 on small or domestic meters and from 1 to 100,000,000 on larger meters. These figures indicate the value, in cubic feet, of one complete revolution of the pointer.

Numbers within the dial indicate the tenths of value. If pointer rests between two numbers, take the lesser one for reading, so long as the hand on the lower dial is not past zero mark.

In reading disregard dial "one." Begin at dial "10" and proceed as illustrated above.

If above is not fully understood, further information will be cheerfully given at water works office.

DETECTION OF WASTAGE.

Shut off the flow of water from all fixtures supplied by the meter. Note where pointer on lowest denomination dial is, and meter being in proper working order, pointer will move, if water is escaping through defective plumbing. If leakage cannot be located at any known point, such as hydrant, faucet, motor pump or water closet, ask water works office for "Inspection for Leakage." It costs you nothing. Call in two days for result.

If water cannot be conveniently shut off long enough to make test for leakage, institute regular periods for inspections of all plumbing, at the same time take readings for comparison. Compare the use of water at night by that of day. Compare readings at regular intervals.

Watch outside hydrants. Place ear to same for detection of underground leaks. Leaks may be detected, at times, by placing nail or knife between teeth and holding against pipe or hydrant, plugging ears with fingers. Trickling water may be heard in this manner.

Small streams of water show faintly on porcelain water closet bowls. Bend stiff paper and hold against bowl, allowing water to run down curve. The amount of water escaping will be surprising at times.

Don't guess at how much water you are using for any specific purpose. Let the meter tell you.

PREVENTION OF WASTAGE.

Read your meter or have it read regularly, using the following form for recording meter readings:

Date of reading.	Index of meter.	Consumption.	Remarks.
9- 4-15	86543		
9-11-15	87125	582	O. K. Normal
9-18-15	89065	1940	Hydrant leaking
9-25-15	89735	670	Hydrant repaired

Establish a normal consumption for a given period, and, if consumption for a like period exceeds it at any time, trace and stop the cause at once.

Preserve the slips, showing the reading of meter left on premises by meter reader, for comparison.

If readings are excessive ascertain the cause as soon as possible.

Keep meter in accessible condition for reading.

If water is permitted to run to prevent freezing, let the meter tell you how much you are using for that purpose.

If service is to remain in disuse for an indefinite period, have water shut off by the water works. (No charge.) If for a short time only, shut off at stop and waste back of meter, drain pipes and close faucets tightly.

Watch hydrants and faucets, in winter especially. Protect them from freezing.

Keep flushing apparatus in water closet in good condition.

The water meter is a perpetual invoice.

It won't tell you, at the collection period, how water was used; but it will tell you, if consulted, at any time, how much is being used.

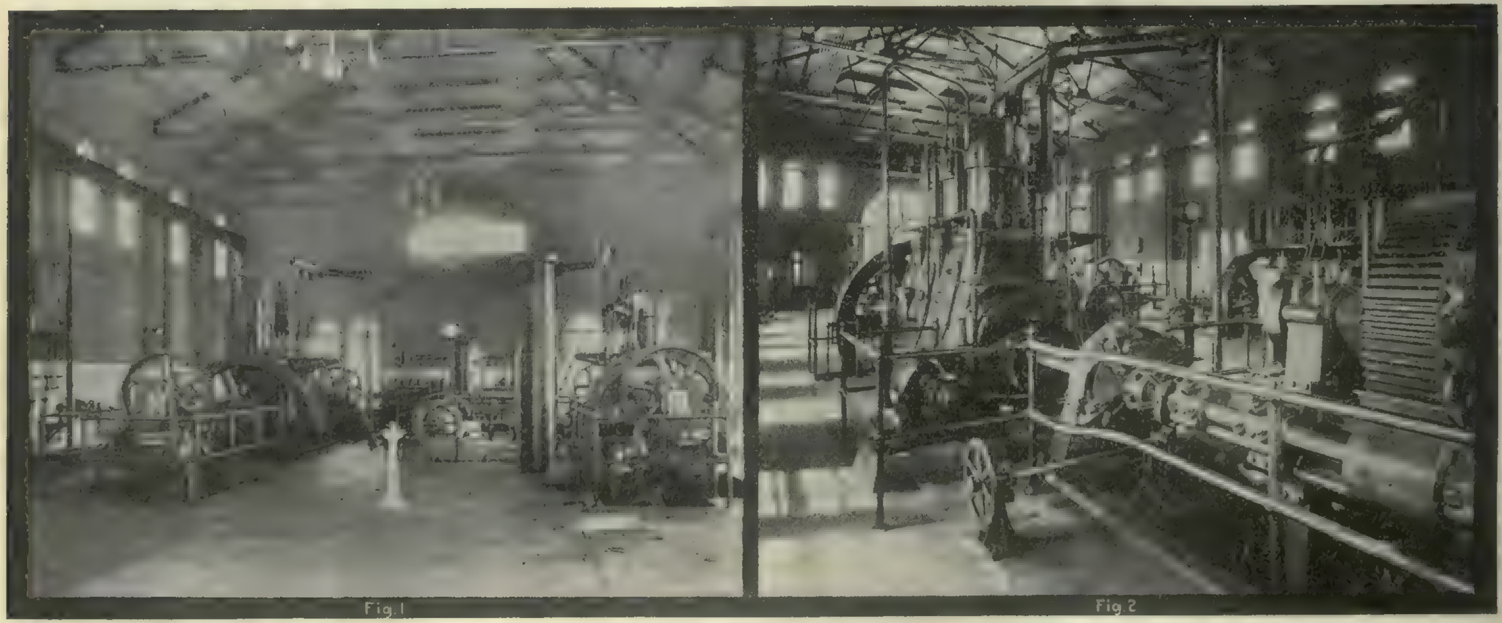
Performance of Diesel Engine Pumping Equipment of the Appleton, Wisconsin, Water Works.

(Staff Article.)

Since the city of Appleton purchased its public water supply works, for the sum of $255,000, extensive improvements have been made. Prominent among these improvements was the installation of two 225 brake horsepower Diesel engines which are directly connected to four Dean 2,000,000-gal. double-acting triplex pumps—one at each end of each engine shaft.

Figure 1 shows an interior view of the pumping station and the general arrangement of the pumping equipment. Figure 2 shows the Diesel engines and the means employed to connect them directly to the pumps. The view shows one of the friction clutches between the engines and pumps and one of the two 15-kw. generators driven by silent link-belt chains. Figure 3 shows a plan and an elevation of the pumping equipment.

The other major improvements to the water works system are the 500,000-gal. elevated water tank and tower, illustrated and described in this journal of Aug. 18, 1915, and a modern, rapid sand water filtration plant of 4,000,000 gals. daily capacity. The present article relates to the pumping equipment and its performance.



Interior Views of Appleton, Wis., Water Works Pumping Station, Showing Triplex Pumps Driven by Diesel Oil Engines.

Fig. 1. General Interior View of Station Showing Both Pumping Units. Fig. 2. View of One of the Engines and the Friction Clutch Between it and One of the Pumps.

The pumping station is a brick building 50 by 100 ft. in plan. Figure 1 gives a good idea of the design of this building.

The Diesel oil engines, manufactured by the Busch-Sulzer Bros.-Diesel Engine Co. of St. Louis, are of the three-cylinder, four-stroke cycle type. Each engine, as stated, is direct connected to two triplex pumps. Thus in each unit there is one engine and two pumps, one pump on each end of the engine shaft. The units are set opposite each other with the engine shafts parallel. The air compressors can be run by either engine.

DETAILS OF OPERATION.

Attention has already been called to the 15-kw., 110-volt direct current generator connected by link-belt chain to the engine, shown in Fig. 2. There are two of these generators, one at each engine. They were installed after the plant was placed in operation because the cost of lighting the pumping and filtration plants had proved to be excessive. After the generators were installed there was no advance in the consumption of fuel oil. The electric power thus generated is also used to drive the booster-pump in the filtration plant and three small motors in the power plant. The booster-pump mentioned is a 4,000,000-gal. De Laval centrifugal pump, operated by a 15-HP. variable speed motor. It was installed after the plant was completed as a safeguard against low water. It is controlled by a float. Raw water runs by gravity from the Fox River through a 24-in. cast iron pipe to the filtration plant.

The population of the city is 18,000 and the average daily consumption of water is 2,250,000 gals., or 125 gals per capita. When the plant was first placed in operation there was no storage reservoir to pump against. At that time two pumps were run all the time, the excess supply being by-passed to the suction line through a Ross regulating valve which was set to control the pressure. The consumption fluctuated so much that it was necessary to run both pumps to hold the pressure at the desired point. This was an uneconomical system of operation and led to the construction of the elevated tank previously mentioned.

Since the installation of the tank the station has been operated, on an average, 18 hours per day. The engines are shut down at 8 o'clock in the forenoon and pumping is resumed at 2 o'clock in the afternoon. No water is pumped during this period and there is no fuel consumption during the stand-by period. After the tank is filled only one pump is run at night. By running at night the station generates its own lighting current. Although the consumption of water is a minimum at night, it was found that the lighting cost alone during the shutdown was greater than the cost of the fuel required to run one pump and generator. This was the reason for adopting the daytime shutdown.

A pressure of from 70 to 86 lbs. is maintained at the station—this gives an average domestic pressure throughout the city of from 45 to 60 lbs. Fire pressure is supplied by closing off the elevated tank, by means of an electrically operated gate valve actuated from the pumping station, and then pumping directly into the mains at a pressure of 110 lbs. This increased pressure is controlled by the Ross regulating valve previously mentioned. The change from domestic to fire pressure has been made in 32 seconds after the fire alarm was sounded. In case a fire alarm is turned in during the shutdown period the fire pressure can be reached in 3 minutes. The total capacity of one unit, 4,000,000 gals., is a sufficient quantity for the city's fire protection. The two units are run alternately, week about, so that one unit is always in reserve. There is a covered, filtered water reservoir in addition to the elevated tank previously mentioned. In case of an extreme demand it is possible to supply the full plant capacity at the rate of 8,000,000 gals. per day for a period of 18 hours, after which the total pumpage would drop to the capacity of the filtration plant, 4,000,000 gals. per day.

The engines are run at a speed of 164 r.p.m. for both fire and domestic service. This figure can be increased to 180 r.p.m. by means of a special device attached to the governor. At the higher speed pumpage is increased 10 per cent.

PERFORMANCE OF EQUIPMENT.

The Venturi meter record for April 23, 1915, is shown in Fig. 4. It is stated that this chart, differently calibrated, could be used fairly well to indicate the fuel consumption of the oil engines for the same 24-hour period —so closely would a diagrammatic record of their fuel consumption, which is nearly in proportion to output, approximate that of the actual productive load as shown in this chart by the gallons of water pumped. On this date No. 2 engine ran 18 hours, as did also No. 2 pump, while No. 4 pump ran 6 hours. The plant was shut down from 8 a. m. to 2 p. m. The chart shows the exact shutdown period for the engine. During the night pump No. 2 operated alone. In the morning, after it was seen that the pumpage, in excess of consumption, had not filled the elevated reservoir by 8 a. m., pump No. 4 was coupled to the engine and the elevated reservoir was soon filled. Fuel consumption for the 18 hours was 144 gals. of fuel oil. Two pints of cylinder oil and two pints of engine oil were used. The total pumpage was 2,070,000 gals., so that 69.5 gals. of fuel oil were used per 1,000,000 gals. of water pumped.

TABLE I.—MONTHLY LOG, FOR APRIL, 1915, OF WATER WORKS PUMPING STATION AT APPLETON, WIS.

Date.	Engines. No. 1—Hrs. run.	Engines. No. 1—Gals. fuel oil.	Engines. No. 2—Hrs. run.	Engines. No. 2—Gals. fuel oil.	Pumps. No. 1—Hrs. run.	Pumps. No. 2—Hrs. run.	Pumps. No. 3—Hrs. run.	Pumps. No. 4—Hrs. run.	Venturi meter. Water pumped, million gals.	Fuel oil. gals. per 1,000,000 gals of water pumped.	Lubricating oil, pints. Cylinder oil.	Lubricating oil, pints. Air compressor oil.	Lubricating oil, pints. Engine oil.	Lubricating oil, pints. Kerosene.
1..........	15	105	9	81	15	9	5	9	1.91	97.3	16	..	3	..
2..........	24	214	..	.....	24	..	18	..	2.32	92.2	2	..	..	..
3..........	17	124	..	.....	17	..	4	..	1.22	101.6	..	..	3	..
4..........	24	156	..	.....	24	..	..	..	1.83	85.2	..	..	4	..
5..........	24	178	..	.....	24	..	8	..	2.35	75.7	..	..	2	3
6..........	24	176	..	.....	24	..	4	..	2.31	76.1	108	..	..	..
7..........	18	156	..	.....	18	..	6	..	2.08	75.0	[illegible]	2	..	..
8..........	16	124	..	.....	16	..	6	..	1.72	72.0	12	..	4	..
9..........	21	156	..	.....	21	..	4	..	2.10	74.2	14	..	4	..
10..........	2	15	17	137	2	17	..	..	1.82	83.5	10	..	..	3
11..........	..	.....	18	150	..	18	..	..	2.08	72.1	..	2	4	..
12..........	..	.....	18	170	..	18	..	..	2.05	82.9	6	..	6	..
13..........	18	160	..	.....	18	..	7	..	2.26	70.7	12	..	4	..
14..........	19	148	..	.....	19	..	6	..	1.96	75.5	6	..	..	3
15..........	18	144	..	.....	18	..	5	..	2.02	71.4	..	..	..	..
16..........	18	148	..	.....	18	..	5	..	2.12	69.8	10	2	4	..
17..........	18	140	..	.....	18	..	5	..	1.95	71.7	..	..	2	3
18..........	17	140	..	.....	17	..	3	..	1.86	75.2	..	..	..	..
19..........	19	138	..	.....	19	..	3	..	1.74	79.3	16	..	..	..
20..........	2	12	17	134	2	17	1	6	2.20	66.3	..	..	5	3
21..........	..	.....	18	138	..	18	..	5	2.01	68.6	..	4	..	3
22..........	..	.....	18	144	..	18	..	7	2.05	70.2	..	..	..	..
23..........	..	.....	18	144	..	18	..	6	2.07	69.5	2	..	2	..
24..........	17	134	1	8	17	1	4	..	1.89	75.1	..	..	..	..
25..........	18	136	..	.....	18	..	2	..	1.82	74.7	10	..	..	..
26..........	19	148	..	.....	19	..	7	..	2.04	72.5	10	..	3	3
27..........	18	146	..	.....	18	..	4	..	1.99	73.3	..	2	[illegible]	..
28..........	20	158	..	.....	20	..	8	..	2.30	68.7	10	..	8	3
29..........	19	142	..	.....	19	..	8	..	2.08	68.2	..	..	3	..
30..........	18	158	..	.....	18	..	[illegible]	..	2.23	70.8	10	4	[illegible]	..
Total	..	3,456	..	1,106	..	..	..	..	60.38	*75.5	216	16	68	24

*Average 75.5 gals. fuel oil per 1,000,000 gals. water.

The monthly station log for April, 1915, is shown in Table I. On April 6th 108 gals. of cylinder oil were used to replace the oil in the crank case. This lubricating oil is changed once in three months. The water pumped on each day is recorded in 1,000,000-gal. units in the table. The fuel consumption, per 1,000,000 gals. of water pumped against a pressure of 80 lbs., was 75.5 gals. of fuel oil.

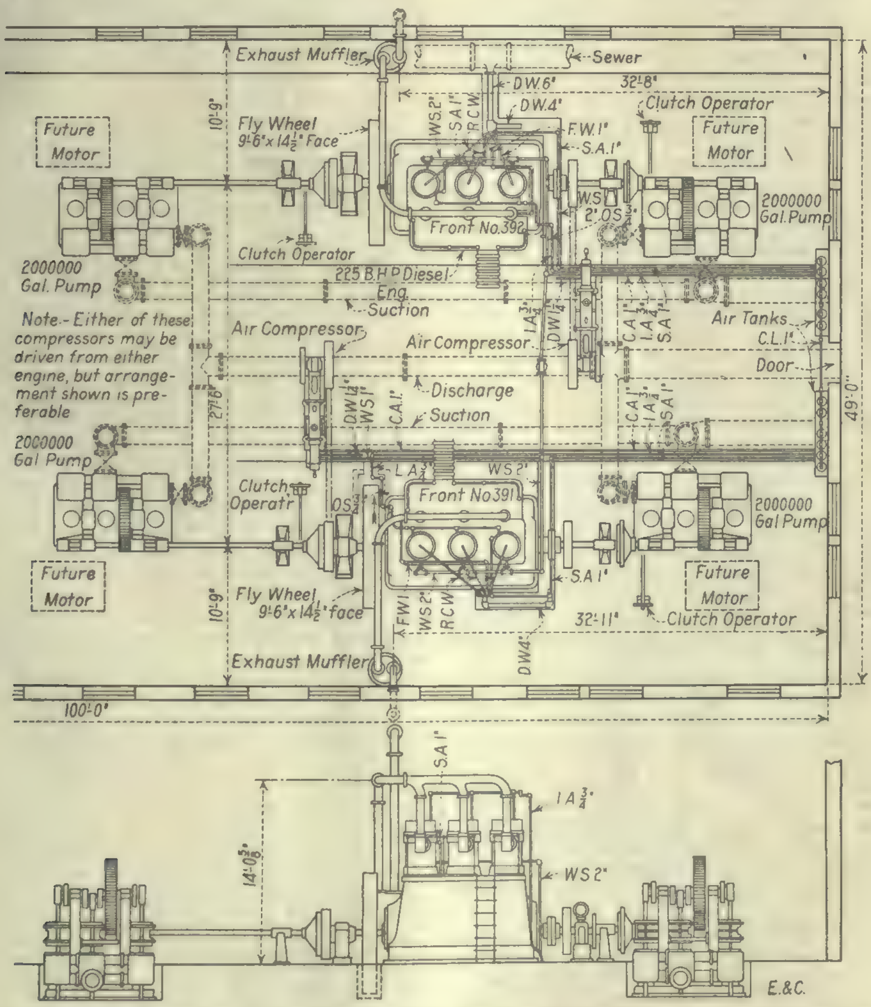


Fig. 3. Plan and Elevation of Pumping Station Equipment, Appleton, Wis., Water Works.

COST OF OPERATION.

The cost of operating the present plant for the month of April, 1915, is here compared with the cost of operating the old station during the month of April, 1914. The old pumping station was composed of one 100-HP. Corliss non-condensing steam engine connected to two double-acting duplex pumps of 2,000,000 gals. daily capacity each. Water was pumped directly into the mains, without any provision for maintaining the pressure at a fixed point, against a varying demand. The comparative costs follow:

	New station. for Apr., 1915.	Old station. Av. for 1914.
Operating labor...........	$370.50*	$230.00
Power (fuel)	132.30	783.00
Lubricants	13.54	12.87
Miscellaneous	5.00	22.37
Total	$521.34	$1,048.24
Total gallons pumped......	60,380,000	55,350,000
Fuel cost per 1,000 gals....	2.2 mills	14.1 mills
Total cost per 1,000 gals..	8.6 mills	18.9 mills

*This increase over 1914 due to increase in salaries exclusively.

IN GENERAL.

The elimination of stand-by losses is one of the chief economics to be gained by the installation of Diesel engines in city water works service. Without the expenditure of any fuel they are always ready for service. Thus the cost of maintaining banked fires and full steam pressure during shutdown periods in steam pumping plants often exceeds the

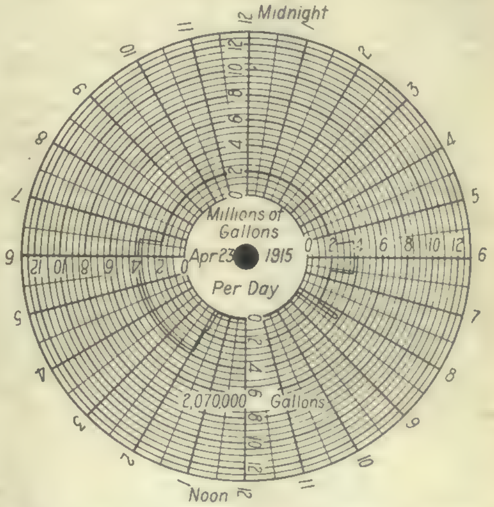


Fig. 4. Venturi Meter Record Chart of Appleton Water Works Pumping Station for April 23, 1915.

total fuel cost of Diesel engines for the same works.

ACKNOWLEDGMENT.

For the information on which this article is based we are indebted to Mr. E. A. Garrett of the Busch-Sulzer Bros.-Diesel Engine Co. of St. Louis.

Conditions Encountered and Methods Employed in Laying Water Pipes in the Congested Streets of New York City.

(Staff Abstract.)

Pipe laying conditions in New York City range from the simplest to the most complex. Since the city is still spreading out and growing there are many subdivisions in which pipe laying is no more difficult than in any small town or village. In lower Manhattan, however, any operation which involves the disturbing of the street surface and calls for underground construction, brings with it, in addition to the usual engineering problems, a multitude of incidental ones, which must also be handled and solved by the engineer. In the narrow, curving streets of lower Manhattan, crowded normally to the limit with pedestrian and vehicular traffic, any constriction of the roadway by excavations in the street creates a traffic problem of first-rate importance. Allied therewith is the problem of arranging and carrying on the work so as to reduce to a minimum interference with normal business along the street. No less important is the safeguarding of the public against accident. Even minor accidents in an area of large crowds and high values have potentialities for heavy damage suits, against both the contractor and the city. However, all of these matters are but incidental to the work. The principal problem lies not above but below the street surface.

SUBSURFACE CONDITIONS.

Crowded as the roadway may seem, the space below it, in lower Manhattan, is still more congested. Many of the roadways downtown are less than 25 feet in width, some being as narrow as 10 feet. In the space on each side of the sewer, which often occupies the major portion of the street, there are crowded, in irregular alignment, water mains, a multiplicity of gas mains, duct-banks, and distributor conduits for telephone, telegraph and electric power service, pneumatic tubes of the mail service and of the various telegraph companies, steam pipes encased in jackets increasing their diameter more than two fold, and a number of other minor pipes and conduits. To these there must be added in some important cases, the substructure and power conduits of the underground electric trolley, the Rapid Transit Subway, with its shallow covering, the column bases of the elevated railroad, and the tracks of the steam railroads and of the storage battery and horse-drawn street cars. The roadways, narrow as they are, are often further encroached upon by sidewalk vaults extending well beyond the curb line, and in some isolated cases beyond the middle of the street.

In the broader avenues, also, the available space is occupied by trunk mains and heavy lines of conduits. Fifth Avenue, with a 40-ft. roadway between sidewalk vaults, contains two 48, two 36, one 20 and one 12-in. diameter water pipes, seven gas mains, and four heavy banks of ducts. Broadway, near Twenty-fifth Street, with a 45-ft. roadway, has in addition to the trolley tracks and conduits, ten gas mains, a 12-in. water pipe and five banks of ducts, the largest of which is 4 ft. wide and 2 ft. deep. In Tenth Avenue, the roadway of which is 60 ft. wide, there are two tracks of the New York Central Railroad, a street-car track, a 30, 20, 16, 12 and 8-in. gas main, two small and one large bank of ducts, and a 36, 12 and 6-in. water main. Similar conditions obtain in others of the wider streets.

The subsurface structures usually found in the street occupy the space between planes 2 ft. and 7 ft. below the street surface, forming a network which often makes it impossible to excavate below a depth of 2 ft. without removing one of them. At street intersections, which in this section are closely spaced and often irregular, this network becomes a complex tangle. A large portion of lower Manhattan is low-lying, and the sewers are old and at shallow depth.

LAYING 128 MILES OF NEW MAINS UNDER THESE CONDITIONS.

In this crowded section of lower Manhattan, considered by many to be the most congested with subsurface structures of any district in the world, there were laid within the last nine years 128 miles of new mains comprising the Manhattan High Pressure fire system; a complete new network of water pipes, the laying of which involved the tearing up of almost every street within the entire district south of 34th St. on the west side, and south of Houston Street on the east side of Manhattan Island.

Investigations of subsurface conditions in advance of construction work were at no time complete enough to determine even a general alignment for the new pipe in the street. When the first section of the Manhattan High Pressure system was planned the Bureau of Subsurface Structures, a recording bureau, had not been established in Manhattan. The attempt was made to determine in advance the location for the proposed mains by extensive test pit digging and plotting of the structures found therein. This attempt was abandoned as too costly, and the information obtained was found to be of little value. The alignment of the new mains was almost uniformly determined from an examination of test pits dug as the work progressed, together with such information as could be obtained from the incomplete records of the various departments and public service corporations, and from surface indications of existing subsurface structures. Some special investigations were, however, made in advance of the work. These covered points known to be exceptionally difficult and complicated, such as street intersections along the route of the Rapid Transit Subway. The selection of locations for hydrants required a complete investigation and plotting of sidewalk vaults, which in the business section of Manhattan exist in front of almost every building. Detailed surveys of many of these vaults were required for the purpose of planning the construction of recesses to be built therein for the setting of hydrants.

Thus, a most important item of the work was the alteration and reconstruction of existing structures to make room for the new mains. These alterations were both extensive and costly. In connection with a contract for 14 miles of mains out of the total of 128 miles mentioned, existing water mains were rearranged at 234 locations, sewers and sewer structures were altered or reconstructed at 104 points, 55 waterproof recesses were built in existing sidewalk vaults to provide room for hydrants, and there were issued to Public Service Corporations 649 orders for alteration, removal or reconstruction of pipes, conduits or other structures owned by them. The cost of the last-named item to the companies was a considerable one. In William Street, south of Maiden Lane, the reconstruction of a heavy bank of ducts for telephone cables cost the company owning it $5,000. Alterations to gas mains ordered during the year of 1914 in connection with the laying of these new water mains amounted to approximately $20,000. The service of the Public Service corporations in many sections would not bear lengthy interruption without great inconvenience, and often monetary loss to their consumers. Compelling quick action by the companies and assuring co-operation with the city and its contractors was often difficult. Yet there were many instances, such as the intersection of Frankfort and William Streets, where, in accordance with special arrangements, five Public Service Corporations removed their structures, which were badly intertwined, and replaced them again on the same day, a holiday, after the City's contractor laid the new water mains across the intersection. Many delays were, however, unavoidable.

At many points unusual construction methods were adopted, or special provisions were made to carry on the work. At 4th St. and Broadway, after a number of unsuccessful attempts to lay a 20-in. main at normal depth, a small timbered tunnel was driven under Broadway to a depth of 17 ft., and the main was laid therein. In West Broadway, the trunk sewer is so close to the surface of the street that at practically all of the street intersections the mains had to be laid below tidewater, crossing the street underneath the sewer, which, itself, is built on treacherous ground. Similar conditions existed along Sixth Avenue and along the streets near the river front. The mains in Broadway and Sixth Avenue, and along a portion of West Broadway, have been, or are now being, rearranged in connection with subway construction. The old Rapid Transit Subway is at many points so close to the street surface that it was necessary to reconstruct sections of the subway roof to provide room for laying a main across the same. Along Seventh Avenue the shallow depth of the subway north of 23rd street made it necessary to lay the new main under the sidewalk, destroying thereby a number of sidewalk vaults along the street. In lower Fifth Avenue and lower Broadway, and at many other points, traffic conditions made it impossible to do work in normal working hours, and practically all of the work in these streets had to be done between Saturday noon and Monday morning. At many street intersections existing pipe formed such a complicated network that the entire intersection had to be tunnelled, in some cases for a distance of 100 ft., and pipe dragged in. Where this occurred, the network of piping formed an excellent roof for the tunnel. On Center Street, south of Canal Street, a 20-in. high pressure main was laid in gallery constructed in connection with the Center Street Subway. This gallery runs underneath the buildings on the west side of the street. Further south, the pipe is laid under the stairway and portals of the Tombs Prison.

In digging the trenches, many interesting objects were uncovered. Old wooden water pipe of the early part of last century was very common. Much of it was in a good state of preservation. The wrought iron bands at the bell ends were of especial interest. Wrought iron wedge gates in these pipes were more rare. A bronze driven tap with a piece of lead pipe attached was found in one of these wooden pipes. Cannon balls, and coins of the revolutionary and colonial periods were excavated in the streets near the south end of the island. At a number of points skulls and other human bones were plentiful. A broken coffin in Washington Square contained, among other things, a fine, red, wig, and close thereto a pair of old brass knuckles were found. On Elizabeth Street, under the sidewalk, at a point where hundreds of people pass each day, there existed an empty brick well 28 ft. deep, covered over by only a badly broken piece of blue-stone flagging. In Beekman Street, a 5-way casting with four 6-in. and one 10-in. branches formed a part of the old water main in the street. A number of structures, privately owned, occupying the street without franchise, were uncovered. Among them was a small tunnel across the entire width of the street, built to transmit power from one building to another opposite. In a number of downtown streets abandoned wrought iron mains of an old steam distribution system were removed to make room for the new mains. These steam mains were, for insulation purposes, enclosed in a box filled with lampblack, which attached itself to all of the workmen and to many of the passers-by. On Front street, for a distance of about two blocks, the trench pictured the history of the water main system for the last century. In this trench there were exposed: the old wooden water pipe, an abandoned 6-in. water pipe laid early in the century, a 6-in. water pipe laid in 1888, and a 12-in. water pipe laid in 1904. The removal of the first three made room for the new high pressure main.

That adverse conditions and the many difficulties encountered had little effect upon the quality of the resulting work, which was safeguarded by exacting specification provisions, is best shown by the results of the hydrostatic tests to which these 128 miles of mains were subjected after installation. The maximum rate of leakage allowed was 4 gals. per linear foot of pipe joint per 24 hours under a pressure of 450 lbs., maintained for 20 minutes. In the most difficult district covered, the average recorded leakage on 14 miles of main was only 1.7 gals. per foot of pipe joint per 24 hours. It is well, therefore, in even the most difficult situations, to remember the motto of one of the contractors' superintendents—that nothing is difficult or impossible if you have the men and the money.

ACKNOWLEDGMENT.

From paper by Max Blatt, Assistant Engineer, Department of Water Supply, Gas and Electricity, New York City, before New England Water Works Association.

Some Experiences with Leadite for Jointing Cast Iron Water Mains.

(Staff Abstract.)

The use of Leadite for pipe jointing has been attended with both complete success and an almost total lack of success, as stated in an article published in this department for Sept. 15, 1915. Many who have used it are enthusiastic advocates of the material, while others who have tried it unqualifiedly condemn it as an unworthy substitute for lead. There is, of course, a middle ground which is held by those who say the material is perfectly satisfactory when used by those who understand its peculiarities, and that the material is unreliable when placed in the hands of those who do not understand its proper manipulation. The present article gives a summary of the experiences of various individuals with Leadite. These experiences are mainly favorable to Leadite, although some failures are recorded.

Leadite was tested by the manufacturers during the ten years from 1894-1904, and the company being satisfied that it had finally perfected the process of manufacture and the composition, put it upon the market in the latter part of 1904.

FIRST USE OF LEADITE BY KENNETH ALLEN.

The first actual use of Leadite in public works construction was by Mr. Kenneth Allen, while superintendent of the Atlantic City Water Works in 1903, and its use has been continued there by Mr. Van Gilder, the present superintendent, with very favorable results up to the present time. No sign of deterioration has appeared in any instance in that city, and the joints seem to be uniformly watertight. To quote Mr. Van Gilder:

> The percentage of bad joints compares very favorably with lead under the best conditions and with close or wet joints the difference is decidedly in favor of leadite.

Use in Atlantic City is in sandy soil, much of it below ground water. Leadite works very favorably in the wet ground where molten lead could not be used. Seepage is noted in the newly poured joints, but this entirely disappears in a few days.

Mr. C. P. Cook used Leadite first in 1907, and has used it continuously since that time in the Dover, N. J., water works under pressures varying from 20 to 180 lbs. without having had a bad joint and no signs of deterioration.

The experience of Metcalf and Eddy, Consulting Engineers of Boston and Chicago, who were among the early water works engineers to become interested in leadite in New England, is well outlined in the following letter from Mr. Frank A. Marston of that firm:

EXPERIENCE OF METCALF AND EDDY WITH LEADITE.

> In reply to your inquiry regarding our experience with leadite for jointing cast iron bell and spigot water pipe, we give you the following information:
>
> Leadite was used on construction work under our supervision for the first time in 1909 at Concord, Mass., on the Nagog Pond 16-in. pipe line. In this contract it was optional with the contractor whether lead or leadite should be used, and the contractor chose the latter as offering some advantages on account of the wet character of the ground through which the pipe was laid for a considerable distance. The specifications stated in considerable detail the method to be used in handling the leadite, and special care was exercised during the construction work to assist the contractor as far as possible in obtaining good joints. The laborers were without experience in handling this material, and had some difficulty at first in heating the leadite to the proper consistency, but after a little they became fairly proficient. Some of the joints were tested during the progress of the work, and the results were for the most part satisfactory. If the writer remembers correctly, it was necessary to cut out a few joints and repour them, owing to the cooling of the leadite before the joints were sufficiently filled. As far as we have been able to ascertain, this pipe line has caused no particular trouble, and there is no indication at the present time that the leadite joints are in anything but satisfactory condition.
>
> In 1912, under a contract with the Milford Water Company, Milford, Mass., for the Purchase street pipe line, the contractor also chose to use leadite for the pipe joints. As in the previous case, the laborers experienced considerable difficulty in handling the leadite, especially in getting the material hot enough to be of the right consistency when the ladle reached the pipe joint. Several hundred feet of 8-in. pipe were laid with this material, and upon test it was found that a large percentage of the joints leaked drops of water, while some of the joints actually leaked streams of water. The leaks were observed for a week's time and it was found that the quantity of leakage gradually diminished in nearly all of the joints, so that the majority of the joints at the end of the week were apparently satisfactory. Some of the jointing material was cut out and the joints repoured where the worst leakage occurred. By this time the contractor had spent so much time and care, and there still seemed to be so much uncertainty as to the action of the material, that he gave up using leadite and went back to lead joints as being much more satisfactory. Whether or not the leadite purchased in this particular case was of inferior quality to that used at Concord, we are unable to state, but in spite of great care the results were not nearly as satisfactory, and were in fact very disappointing.
>
> In private work we know of two cases where water works superintendents are using leadite under their personal supervision, with men trained in its use, and are obtaining satisfactory results, with a material saving in cost of jointing material.
>
> In view of the above experiences and after making certain tests and observations, we have omitted the use of leadite in all specifications for municipalities, on the ground that it is an uncertain material in inexperienced hands, and where contracts are liable to be awarded to inexperienced or unreliable contractors, it seems to us unwise to allow the use of this material.
>
> Our experience has been that under such conditions the contractor charges the same price for leadite as for lead, so that there is no saving to the municipality in allowing the use of leadite, and there is hazard in the uncertainty as to whether or not the joints will be water tight. If the joints are not water tight it is a difficult matter to remedy the trouble, and an exceedingly difficult matter to persuade a contractor to cut out and repour the joints in several hundred feet of pipe line to remedy the leakage.
>
> We are confident that in experienced hands, and under favorable conditions, leadite can be used satisfactorily and with a material saving in cost, but under the conditions above mentioned we believe that it is neither advisable nor economical.

Mr. Henry L. Lyons of Buffalo writes that he used leadite in about 700 ft. of 6-in. pipe joints in 1905. This has been watched since, and has remained perfectly tight, a leak never having occurred, although leadite has not come into general use in the Buffalo system.

Mr. John Palmer, general contractor, has used leadite in one or two instances in Massachusetts towns, but is not satisfied with the results, and has abandoned its use. The difficulty he experienced was in satisfying the authorities that the joints which showed seepage at the start would become tight and be satisfactory.

EXPERIENCE OF THE HANSCOM CONSTRUCTION CO. WITH LEADITE.

In 1911 the Hanscom Construction Co. of Boston made a contract to build a complete water plant for the Barnstable Water Co. at Hyannis, Mass., on Cape Cod. The contractors requested the privilege of using leadite in the 16-in. supply line running 2½ miles from the standpipe to the village of Hyannis, agreeing to keep open the joints until it was determined what the result would be, and removing such joints as proved defective. The consent was given, and the program was carried out. The writer, as engineer for this work, gave close attention to the method of melting and pouring leadite and watched the joints closely after water had been turned on, which it was impossible to do for some weeks after the line had been laid. Water was then pumped to the top of the standpipe hill by a small pump connected into a blow-off, and the pipe was kept full intermittently for the next three months; during the period of the construction of the standpipe foundation, and the erection of the tank, the pressure varied from 0 to 40 lbs.

The first results were disappointing. We had been informed by the Leadite Co. that the joints would leak for a few days, possibly a week, but the week came to an end and there was no sign of reduction. We waited rather impatiently another week, at the end of which time the joints were still flowing rather freely; in many places small spurts were noted. We then called for the Leadite Co. to inspect the work and tell us what to do. They looked over the joints and advised us to let them set for a time longer. We had been continuing the use of leadite in laying mains in other parts of the town where it was not possible to keep joints exposed. At the expiration of the third week, as the joints still leaked, it was decided unwise to continue, and we ordered the use of all leadite stopped at once, and all further joints in the system made with lead, which was done. The leaks showed a marked reduction at about the end of the fourth week, so much so that they were eventually filled in, although far from tight, and even puddled the trenches to a slight extent. While no exact record of time was kept, it was probably about six or eight weeks before we were able to dig up joints and find tightness, but the interesting part of this was that it was real tightness; the joints were "bottle tight." We could not find so much as a drop of leakage anywhere along the pipe line.

A few months later the Hanscom Co. received a contract for laying about 12 miles of cast iron water mains from 4 to 16 ins. in size in the town of Norton, Mass., and decided to use leadite for the whole system.

In the case of the Barnstable water works the material traversed was largely dry land; that in the second plant was hard and stony ground, to a great extent in water. I need only comment on this to say that this plant has now been in operation with pressures varying from 60 to 150 lbs. for about four years, and is giving extremely satisfactory results.

Following this, three years ago, the Hanscom Co. used leadite in the complete system for Greenville, Me.; and two years ago in Mattapoisett, Mass. Last year it was used exclusively in Groveland, Mass., and Haverhill, N. H. The total of these plants is approximately 70 miles, with the usual range in sizes of mains for plants of this kind. The results in every instance have been eminently satisfactory to the contractors and to the owners of the plants.

The Reading Contracting Co. has had an experience with leadite practically identical with that of the Hanscom Construction Co., having used leadite for a period extending over ten years, and covering 30 miles of pipe lines. No signs of deterioration has appeared in any of their work, and extreme tightness has been obtained in practically all cases.

ADVANTAGES AND DISADVANTAGES OF LEADITE.

The principal advantages of leadite are in cost of joint material; reduced cost of bell holes; no caulking; quick removal; extreme tightness; to say nothing of saving in handling a lighter material.

The disadvantages that we have met with are the exactness required in melting and pouring joints, only experienced and trained men being suitable for this work.

We have found one test under which leadite is very apt to fail, where lead joints will hold. That is where pipe is laid around sharp curves so that one side of the joint is very thin. We have had a few leaks in the joints of the systems referred to, and in practically every case it has proven to be from the latter cause.

CONCLUSION.

The conclusions to be drawn from the foregoing experiences seems to the writer positive and to the effect that a very high standard of results can be obtained from leadite under practically all conditions; that the greater degree of tightness is a very important matter, and worth much effort and expense to obtain.

That the saving in cost of joint material, and in labor of joint making gives still further cause for its extensive use; and last, that the real key to obtaining these benefits is thorough knowledge of proper methods of handling and the employment of skilled men.

ACKNOWLEDGMENT.

From paper before New England Water Works Association by Mr. Henry A. Symonds, Consulting Hydraulic Engineer, 70 Kilby St., Boston, Mass.

BRIDGES

Design Features of a Single-Leaf Trunnion Bascule Bridge Over the Channel St. Waterway, San Francisco, Cal.

(Staff Article.)

The Fourth St. bridge, which is being constructed over the Channel St. Waterway, San Francisco, Cal., is a single-leaf trunnion bascule highway structure of the "Strauss" type, with reinforced concrete substructure and approaches. The span of the movable leaf, from center of trunnion to center of end bearing, is 94 ft., the trusses being spaced 46 ft. on centers. The bridge provides a 40-ft. clear roadway and two 6-ft. sidewalks. The movable span is supported on reinforced concrete cylindrical piers founded on piles. The reinforced concrete approach spans at each end are of the beam-and-slab type supported on concrete piles. The approaches terminate in sea walls, which are founded on wood piles. The bridge is protected from injury from the river traffic by a row of timber fenders on each side of the channel. A horizontal clearance of 75 ft. is provided for river traffic, the depth of water at low-water stage being 22 ft. The type of structure and the general features of the bridge are illustrated in Fig. 1.

SUBSTRUCTURE AND APPROACHES.

The design features of the substructure and approaches are shown in Fig. 2. As will be noted by referring to these drawings the movable span is supported principally on cylindrical piers, founded on piles, the footings of these piers extending 10 ft. below the bed of the waterway. In constructing the piers the excavation is to be made inside of steel caissons, and the forms are to be built of 2x4-in. yellow fir, planed. The procedure to be followed is as follows: After the steel caissons have been set in place and the excavation made to the required depth, the bearing piles are to be cut off square and the wood-stave forms set in place. The concrete in each cylinder is then to be placed in the dry, in one continuous operation. The piles are to be driven to a sufficient depth to insure a carrying capacity of 25 tons each.

The base of each cylinder is 9 ft. 6 ins. in diameter and 10 ft. high, and is supported on twelve piles. The ten cylindrical piers which support the movable span are each 4 ft. in diameter, while the two piers which support the rest end of the movable span are each 5 ft. in diameter. The piers and their footings are to be constructed of 1:2:4 concrete. Details of these piers are shown in Fig. 3.

The reinforced concrete piles which support the approach spans are 18 ins. square, and are reinforced as shown in Fig. 4. The reinforcement of these piles extends into the superstructure to within 3 ins. of the top of the floor slab. The piles are to be cast of 1:1½:3 concrete and are to be driven to a sufficient depth to support a load of 60 tons each.

The sea wall at each end of the bridge has a length of 82 ft. 6 ins., the wing-walls of which extend at right angles to the main wall a distance of 20 ft. These walls have a height

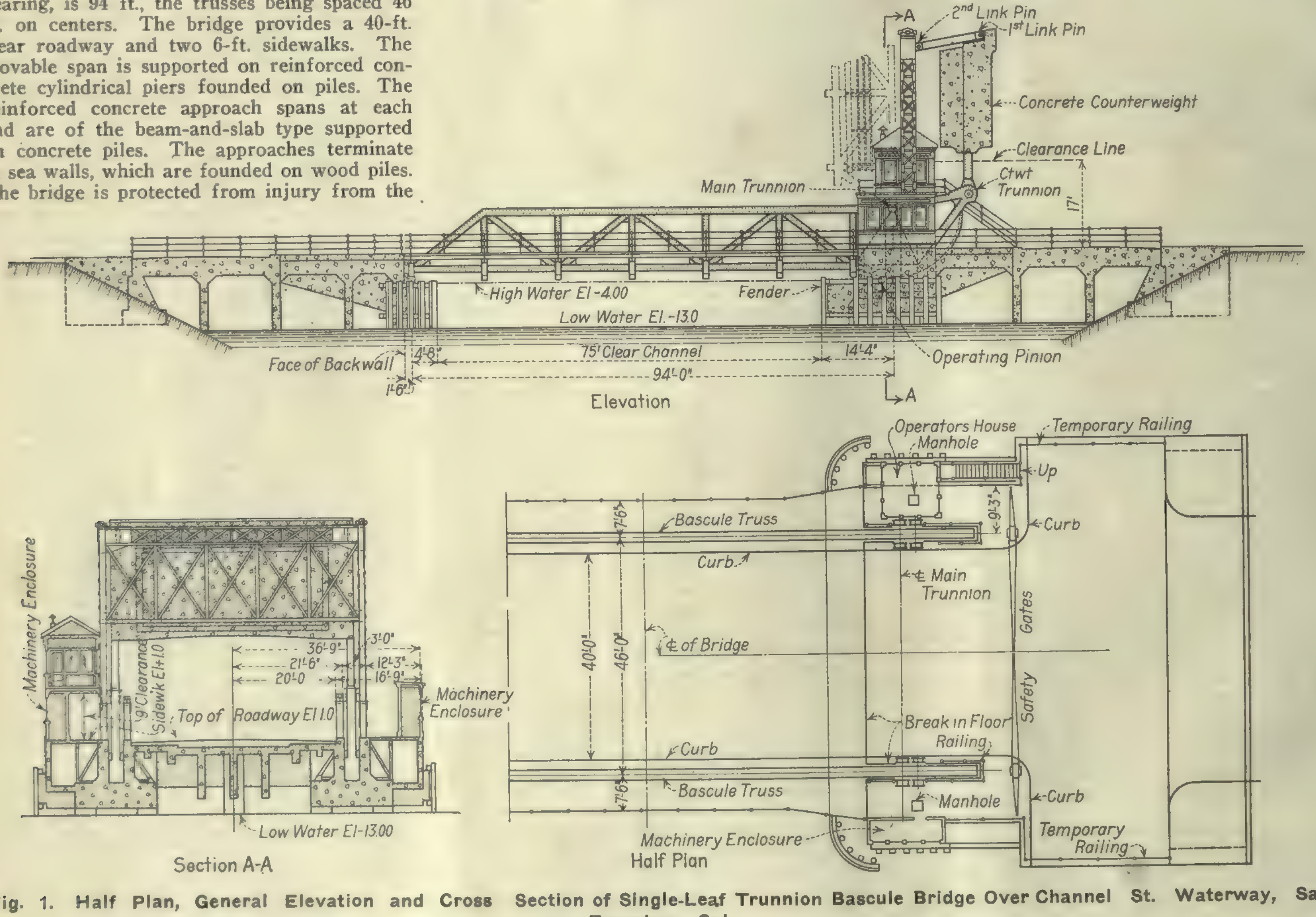


Fig. 1. Half Plan, General Elevation and Cross Section of Single-Leaf Trunnion Bascule Bridge Over Channel St. Waterway, San Francisco, Cal.

of about 13 ft. and a width of base of 8 ft. 6 ins. A cross section of these walls is shown in Fig. 5. A 1:2½:5 concrete mixture is to be used for the lower 9 ft. of the sea walls, and a 1:2:4 mixture for the upper 4 ft.

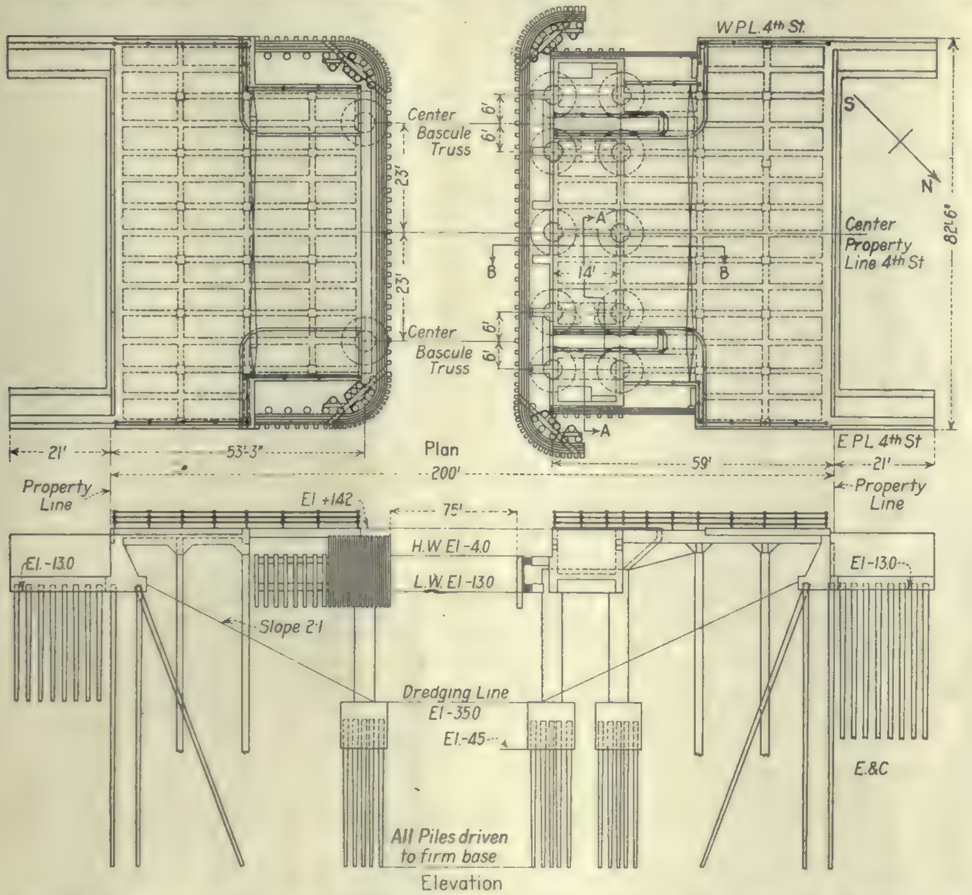


Fig. 2. Plan and Elevation of Substructure and Approaches of Bascule Bridge Over Channel St. Waterway.

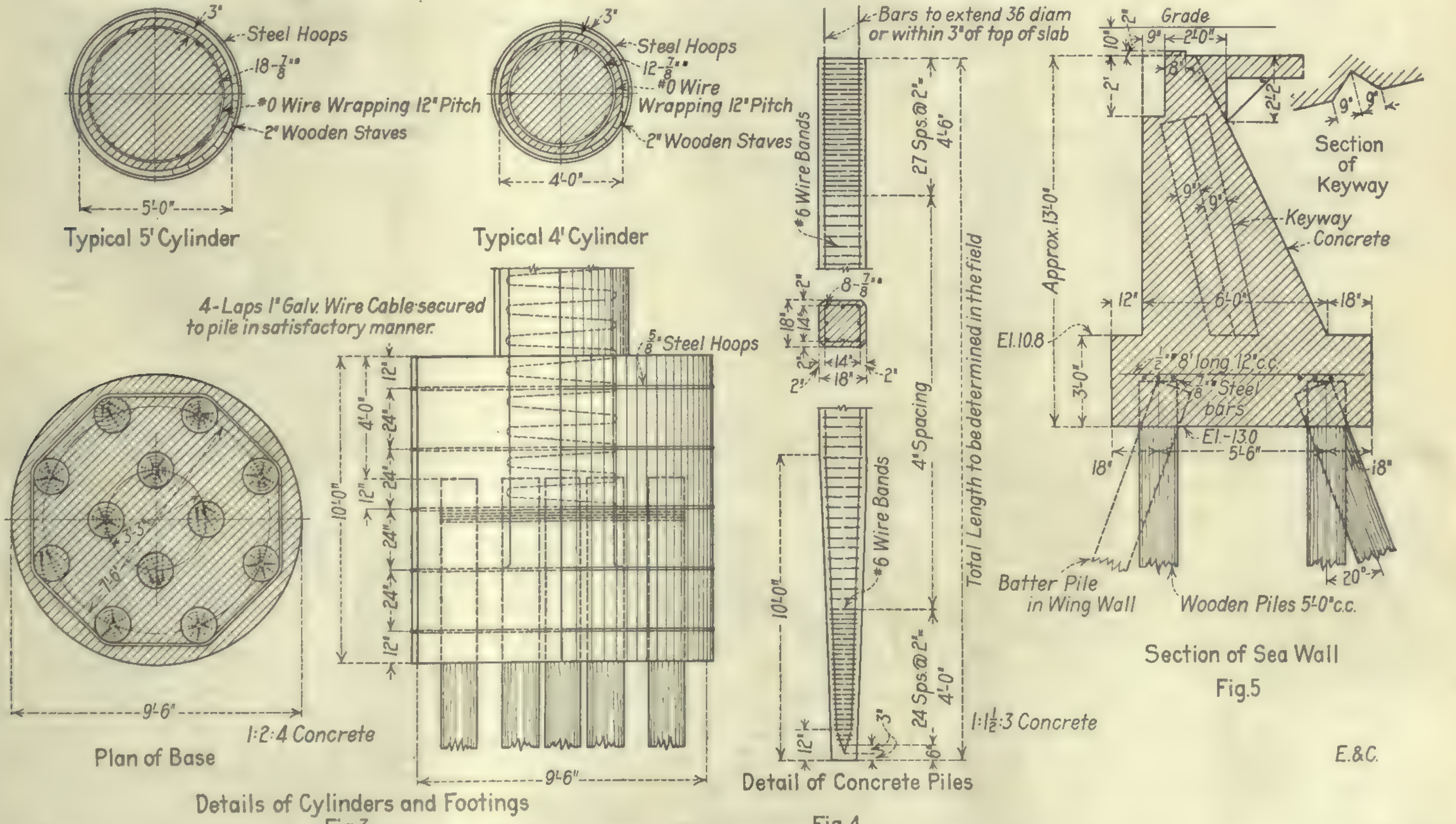


Fig. 3. Details of Cylindrical Piers and Footings of Bascule Bridge Over Channel St. Waterway—Fig. 4. Reinforced Concrete Piles Supporting Approach Spans—Fig. 5. Cross Section of Sea Wall at End of Approaches.

The type of timber protection work for the bridge is indicated in Fig. 2.

The concrete construction over the cylindrical piers supporting the movable span is shown in Fig. 6, p. 250. (For location of the sections shown in this drawing see Fig. 2.) By referring to Figs. 1 and 6 it will be noted that the four piers on each side of the center line of the roadway are capped with concrete, the dimensions of these caps being 18 x 16 ft. x 5 ft. thick. The arrangement of the beams in the floor of the approach spans is given in Fig. 2. The reinforced concrete floor slab of the approach is 9 ins. thick.

MOVABLE SPAN.

The riveted pony trusses of the movable span are spaced 46 ft. on centers, each truss has a length, from center of trunnion to center of end bearing, of 94 ft., and a depth, center to center of chords, of 11 ft. The movable span is carried on trunnions, which rest in bearings supported on structural steel posts. The span is counterbalanced by means of a concrete counterweight, which is pin-connected to the tail ends of the bascule trusses and is maintained in a vertical position during the operation of the bridge by means of structural steel links.

The operating machinery consists of two trains of gears operated by two motors, each train actuating an operating pinion which engages cast steel racks bolted to the tail ends of the trusses. The end lock is to be operated by a 3-hp. electric motor. The control of the operating motors, the end lock motors, and the gates are to be electrically interlocked with each other so that it will be impossible to move the end lock until the bridge has been completely closed, or to raise the gates until the bridge has been closed and the end lock thrown.

Figure 7, p. 251, shows the general design features of the movable span, counterweight, and counterweight frame.

The main trunnion reaction per truss is 1,096,000 lbs., of which 145,000 lbs. is live load and 951,000 lbs. dead load. The pier reaction per truss is 1,120,000 lbs., of which 145,000 lbs. is live load and 975,000 lbs. dead load. The movable span is balanced for dead load, the end reaction for live load being 173,000 lbs. The counterweight for each truss weighs 704,000 lbs.

The bridge will be paved with 4-in. creosoted wood blocks laid on 3-in. creosoted Douglas fir sub-planking.

PERSONNEL.

The plans for the substructure and approaches were prepared by M. M. O'Shaughnessy, City Engineer of San Francisco, Cal., under the direction of the Board of Public

Works. The bascule span was designed by J. B. Strauss, Consulting Engineer, of Chicago.

The Design of Substructures for Wooden and Combination Highway Bridges.

(Staff Abstract.)

Of the structural materials suitable for use in bridges the most common are: steel, concrete (plain and reinforced), masonry and wood. The larger, more expensive and, scientifically, the most noteworthy bridges, include in their principal parts only the first three and, because of this fact, the last named material has almost ceased to be considered one of the important structural materials if current engineering literature may be considered an index of engineering thought.

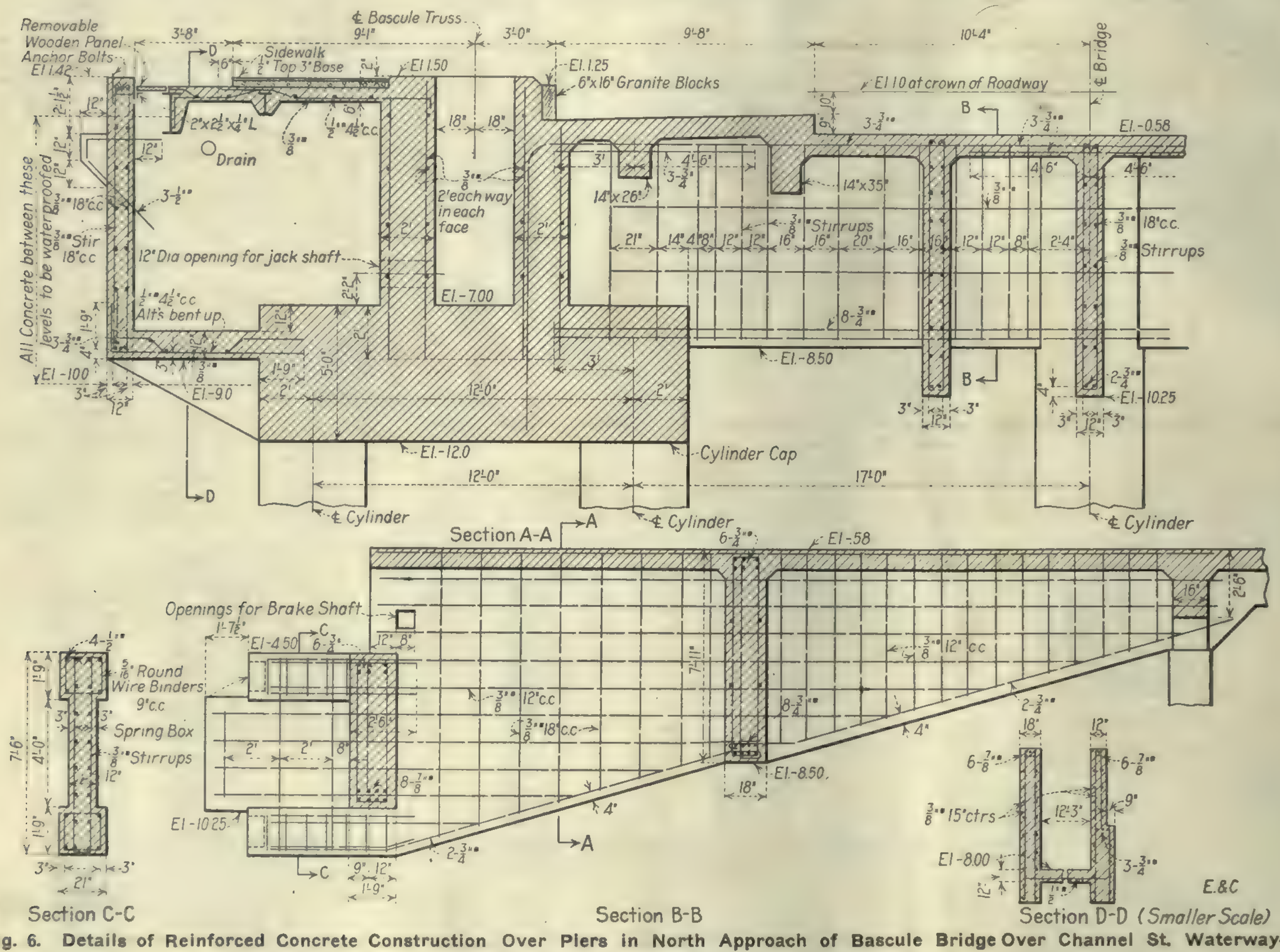


Fig. 6. Details of Reinforced Concrete Construction Over Piers in North Approach of Bascule Bridge Over Channel St. Waterway—For Locations of Sections A-A and B-B See Fig. 2, Page 249.

It should not, however, be forgotten that wood still occupies an important part in many bridge structures, and it is a question whether or not greater familiarity with other structural materials does not in some instances cause their selection when wood could more economically (using the word in its broadest sense) be employed. Cases involving the following conditions should be particularly examined to prevent the error just suggested:

(1) In many localities timber is cheap and the manufactured articles are expensive. Such conditions usually prevail in new and timbered countries where timber is close at hand and factories distant, and where transportation is expensive. Lumber may often be used and structures replaced at the ends of their periods of usefulness at less annual cost than the interest on the investment required for more permanent works.

(2) The limitations of available funds often dictate the cheapest construction regardless of economic loss in the long run. This is particularly common in the highways built by townships and counties in our western states.

(3) The probable period of use of a structure may be short. Even though its period of use will probably be longer than the life of a single wooden structure the economic advantage may be in favor of wood.

(4) Hasty construction to meet an unexpected emergency or to provide emergency repairs to damaged communications may be necessary.

The wide range of conditions covered by these four cases is evident. It will also be evident that cases (1) and (4) may prevail on either roads or railroads, but cases (2) and (3) will rarely apply to the latter. In the above cases, case (4) applies to most military bridges. The following data deal with the use of wood as an important structural material in highway bridges intended for permanent use during the life of the materials of which they are constructed. This article will treat only of the design of the substructures.

DESIGN OF SUBSTRUCTURES.

Location.—The most desirable type of substructure, and consequently the general type of a bridge, is fixed by the conditions at the bridge site. In the selection of the site all of the details of bridge construction must be considered in a general way unless the site is fixed by other conditions than that of putting the most suitable bridge across a given stream. Usually the site is fixed within comparatively narrow limits, and the bridge engineer is concerned only with the comparisons of the various sites that are available within the limits beyond which the crossing may not be sought. A stream *can* be crossed anywhere, but the problem is to select the site that will allow the construction of a bridge to answer the desired purpose at the least ultimate cost.

Often the selection of the best site is easy, being evident to the most inexperienced eye; frequently it involves only a rough mental approximation of cost; but in many instances the most satisfactory site can be selected only by careful studies of the types required by the several available locations. In such cases the knowledge of what can be done, how it is accomplished, and how much it costs *in the particular locality is essential.* No rules can be given, but the following are desirable features of the site, named in what is frequently their order of importance: Solid bottom; permanent banks; straight upstream reach; small width; low velocity current; single current or parallel currents; good approaches; and shallow water. Few bridge sites afford all of these advantages; some offer few; and others none.

As noted in the preceding paragraph the best type of bridge is fixed by the purpose to be served and the site selected, and where there is a choice of suitable sites the bridge required at each is more or less definitely determined in the processes of their comparison. In general, three conditions govern the design of the substructure: First, the supporting power of the foundation; second, the probable effect of the current; and third, the height of the grade crossing. Wood not being adapted to extreme spans, in the construction of wooden highway bridges, troublesome foundation pressures are rarely encountered. The current effects include scour, drift, and ice, in addition to the dynamic force of the flowing water itself, which is usually insignificant. The height of grade crossing determines the proper spans by economic considerations when the most suitable spans are not determined by the preceding factors. Since the cost of piers of a given type and height increase with their number, and since the cost of superstructures increases with the length of the spans (for a given height and type of pier) there is a single span length of maximum economy. Generally, however, except in elaborate work, the advantages of standard construction avoid the necessity of hair-splitting studies. The type of wooden substructures suitable for various conditions will be outlined in the following paragraphs:

Trestle Bents.—Because of the short span and consequent wide distribution of pressure almost any soil is capable of supporting either framed or pile trestles, and they are at present more widely used than any other type of wooden substructure. They offer, however, slight resistance to current effects, and because of their obstruction to the channel are particularly susceptible to damage by ice and drift, being liable to destruction either by the simple force of impact, or in unstable bottoms by the increase of scour resulting from the lodgment of ice and drift against the bents.

Framed bents on mud sills can not be considered safe except in stable bottoms. Pile bents or bents on pile foundations are ordinarily safe against scour if the piles penetrate a solid clay stratum to a depth of 5 ft. or more, and in softer bottoms if the penetration of the pile is at least equal to the maximum observed depth of water. Safety in the last case is contingent upon the prompt removal of drift from lodgment against the bridge. The dynamic effect of the current is not dangerous in current velocities ordinarily encountered, but drift in rapidly flowing streams may be dangerous and in streams having a distinct "break-up" or ice run, trestles can not be considered safe.

Simple trestles are not ordinarily applicable to sites having a high grade crossing. Heights up to 12 ft. can usually be accepted with little suspicion, but in the interests of economy greater heights should be compared with longer span structures. The spacing of the bents may vary between the limits of 12 ft. and 20 ft., 15 ft. being a common spacing.

Framed Trestles are used where the soil near the surface is sufficiently compact to support the bents and where scouring effects are small. They are ordinarily constructed only where the water is very shallow. The posts should rest on a mud sill, usually a square or round timber with a width not less than that of the posts measured perpendicularly to the bent. The sill should be notched to receive the feet of the posts, and the posts should be toe-nailed to it by one or more spikes in each side of the post. Framed bents may also rest upon pile foundations. Such use is limited to sites in which the bearing power of the soil is poor or difficulties in properly seating the mud sill exist, and where piles of sufficient length to form the entire bent are not available. The foundation is constructed as a pile bent, the cap of the bent taking the place of the mud sill. The bents ordinarily contain four posts. The posts should be equally spaced, the tops of the outside posts falling under the guard rails of the bridge floor. In unusually wide bridges additional posts can be used to decrease the size of the cap. Posts are designed as columns after any standard tables of strength (such as Kidder's "Architects' and Builders' Pocketbook." In the use of local timber due allowance must be made for the quality of the sticks secured. In Alaska, where the native spruce is injured by irregular growth due to the climatic conditions, the writer has usually employed a factor of 60 per cent in reducing the strengths given for spruce in Kidder's tables to obtain the strength of sound Alaska spruce). A minimum diameter of 6 ins. should usually be required. In bents under 6 ft. high the posts are vertical; in higher bents the outside posts should usually be given a batter of 2 or 3 ins. per foot. In bents higher than 6 ft. sway bracing of 3x10-in. planks, one on each side diagonally across the bent, bolted to the mud sill at one end, to the cap at the other, and spiked to the posts, should be employed. In lower bents sway bracing should be used where current forces against the bent are to be expected.

The cap should be designed as a beam with its width that of the post measured perpendicularly to the bent. It may be given shallow notches to receive the tops of the posts, to which it should be drift bolted to each post with one or more ½-in. or ⅝-in. drift bolts.

Pile Trestles are used where foundation difficulties are met. These difficulties may be in the form of insufficient bearing strength of the surface soil, in the depth of the water, or in probable current effects. The number of piles may depend upon the bearing power developed; usually, however, not less than three piles to the bent are allowed, and that number is sufficient in most cases. In the determination of the safe load on a pile the common formula given below is recommended:

$$\text{Total safe load} = \frac{2wh}{s+1},$$

where w = weight of hammer, in pounds.

h = height of fall, in feet.

s = penetration under last blow, in inches.

It is of value only when the penetration under the last blows is approximately uniform. In extremely high bents the strength of the piles as columns should be examined. Ordinarily, piles should not be under 12 ins. in diameter at the butt and 6 ins. at the tops. For convenience in driving they should not exceed 18 ins. in diameter at the butt. They may be driven with the bark on, if the superstructure is to be made of logs or hewn timber unseasoned, or if driven in salt water; otherwise they should be peeled, and if the superstructure is expensive and is to receive careful maintenance, painting, etc., they may be creosoted, depending upon the circumstances under which they are to serve and the cost of the process. Pile bents are capped and sway-braced like frame bents. The bottom of the sway bracing is usually at a horizontal sash brace, at the surface of the ground or at the low water line. The sash braces should be two 3x10-in. planks bolted to the piles, one on each side of the bent. High bents requiring storied construction or longitudinal bracing are not common. When found economical, however, they are used, the longitudinal bracing and the sway bracing being computed from the estimated maximum

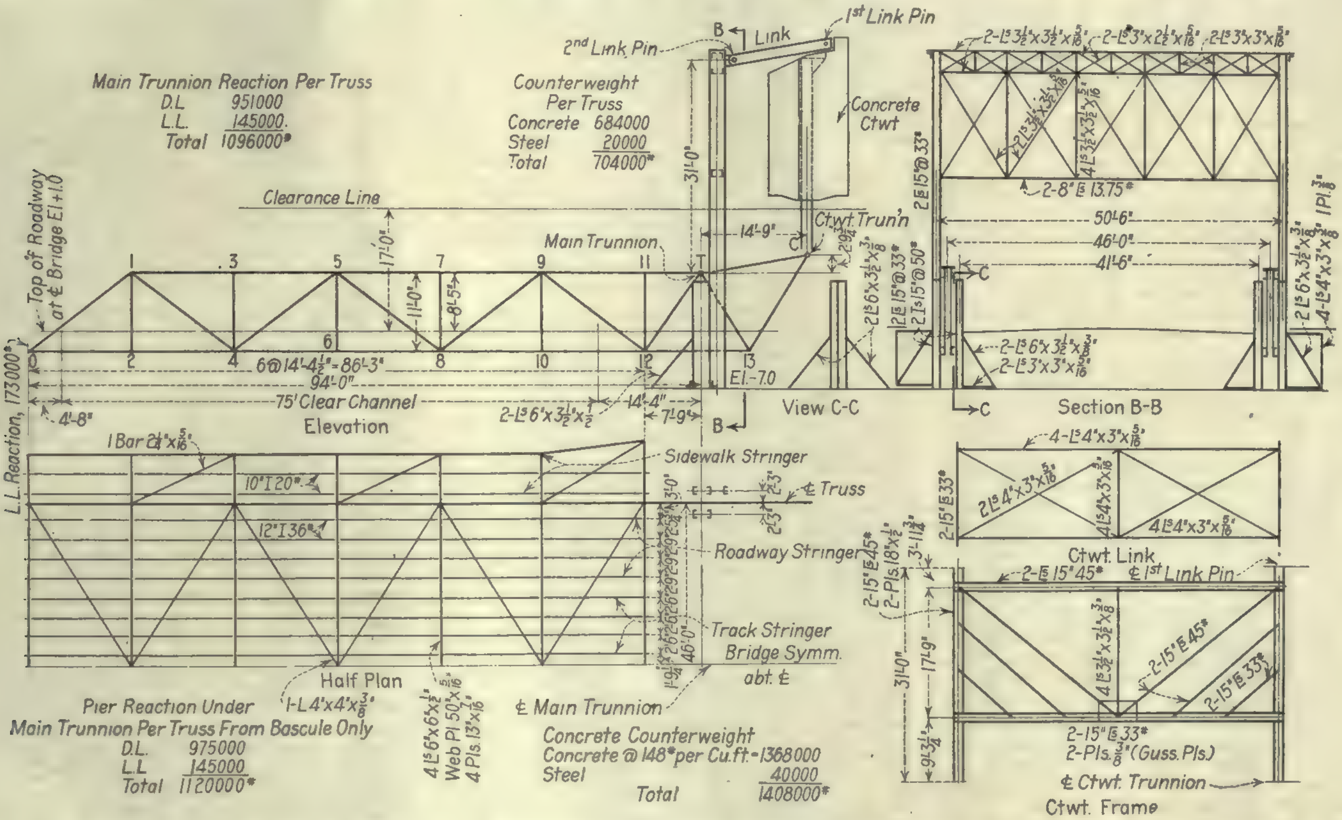


Fig. 7. Stress Sheet for Bascule Span and Counterweight Frame of Bridge Over Channel St. Waterway, San Francisco, Cal.
(For description see page 249.)

wind loads, etc., instead of by the arbitrary adoption of the sizes given above.

Piers.—When spans longer than 20 ft. are desirable the substructure of the bridge consists of abutments and piers. The supporting power of the foundation may require the adoption of long spans, when the bottom of the stream presents variable soil conditions, so that suitable foundations can be secured only at certain points on the crossing. This condition is rare and the long spans are usually made desirable to avoid obstructing the channel, or because of the necessity of protecting each pier from scour, drift or ice, or because of the height of the grade crossing. The first and last conditions being questions of foundation pressures only, their solution depends merely upon special adaptations of the principle of trestle bents. Ordinarily, each pier is made up of the two simple bents under the abutting ends of two consecutive spans. They are designed as ordinary framed or pile bents, taking into consideration the increased loads of the longer spans. They are braced to each other by a system of cross bracing if necessary—practically always if framed bents, and usually if pile bents over 8 ft. in height. The usual type of timber piers designed to withstand the effects of currents will be considered under the heads of *"Pile Piers," "Crib Piers,"* and *"Pile and Crib Piers."*

Pile Piers may be used when the spans have been increased to allow the passage of drift and may be considered useful in withstanding very weak ice flows. The length of span should be safely greater than the possible length of single pieces or booms of driftwood, in which case, properly designed and constructed piers can usually be depended upon. Pile piers under 10 ft. in height can be expected to stand a run of ice; pieces not exceeding 10 cu. ft. in size in currents up to about 4 miles an hour, or proportionately smaller pieces in more rapid currents. (In this and similar proportions mentioned later the mass of the piece is inversely proportioned to the square of the velocity of the current.) For greater impact forces their safety should be considered doubtful. The bearing power of piles carrying vertical loads can be determined as previously noted. If piles are expected to withstand forces having large longitudinal components they can be examined as cantilevers where the stresses are calculable. Piles to withstand the impact forces of ice and drift should penetrate a firm stratum—clay or gravel—not less than 6 ft. nor less than the distance from the highest point of impact to the surface of the ground. Pile piers can not be depended upon where thick ice can freeze to the piles and be lifted by rising water. The general remarks previously made in regard to peeling, creosoting, etc., apply to pile piers.

A pile pier of the type under consideration consists of two parts: the supporting pier, or main pier; and the nose, or guard pier. The main pier is composed of two pile bents separated 4 ft. to 8 ft. The number of piles, the sway bracing, and the longitudinal cross bracing are dependent upon the penetration, the bearing power of the piles, the length of the spans, and the height of the piers, according to the principles previously indicated. Cross bracing is important if the piles of the guard pier are braced to the piles of the supporting pier. The nose or guard pier may consist of a single dolphin or group of three or more piles driven as closely together as possible and with their tops bound together by a cable or metal strap. This should resist ice and drift under conditions that make the stability of pile piers of some little doubt, but cannot be expected to resist ice or drift in swift currents. A better form of nose consists of several piles driven in a row upstream from, and opposite, the center line of the supporting pier. The upstream pile should be cut off 2 to 3 ft. below the probable height of the water line at the time of drift or ice flow. The other piles should be cut off at increasing heights toward the pier and all should be cut at such an angle that a nose log can be drift-bolted to them. The angle of the nose log with the horizontal may vary from 30° to 40°, decreasing as the probable impact forces increase. The nose log should be about 12 ins. in diameter, it should be supported at not greater than 4-ft. intervals, and should be drift-bolted to each pile with two ½-in. or ⅝-in. drift-bolts, one on each side of the center line of the nose log. A light metal strap or a light railroad rail should be spiked to a round nose log if ice is to be resisted. If the nose log is square, the rail, or two small angles, one at each upper edge, may be used. This form of nose is capable of standing heavy impact forces if the current is parallel to the center line of the pier. It can not, however, be expected to resist an ice jam.

Crib Piers.—Many of the functions of *crib piers* overlap those of pile piers to a considerable extent, most of the functions of pile piers being equally well performed by cribs. In such cases the particular type to be employed depends upon the facilities for erection. Crib piers, however, have certain special adaptabilities and limitations. They are more suitable than pile piers in locations subject to variations in the direction of currents at varying water stages, to locations where hard strata are at insufficient depths to give lateral support to piles, and to locations subject to ice jams. They are not so suitable for unstable bottoms (though they may be used with mattress protection), for sites in which confinement of the channel is objectionable, and for sites requiring piers of great height. Well constructed crib piers over 8 ft. in height should stand a considerable amount of impact from drift and ice. They are safe under almost all ordinary conditions of drift, and should stand an ice run with pieces about 3 cu. yds. in a current of 4 miles an hour and proportionately smaller pieces in swifter currents.

Cribs may be built of logs or squared timbers. The sticks used should have a minimum diameter of 8 ins. If logs are used, they may be peeled, but in most cases the advantage of peeling does not warrant the expense. The main body of a crib will usually be rectangular, 16 to 24 ft. in length and 8 to 12 ft. in width, inside dimensions. The exact size of the pier depends upon the weights to be supported, the impact forces to be resisted, and the height required. It is ordinarily divided into compartments by cross ties, separated about 4 ft. horizontally and that distance or less vertically. If the crib is to be sunk into a soft foundation the first row of ties should be far enough above the bottom of the crib to permit the required sinking, and a floor should be put in on these ties. Otherwise, flooring is not required unless the crib is to be sunk in water deep enough to float the crib. In this case a portion of the crib may be floored.

The logs or timbers may be halved together at the corners, making a tight crib, or simply laid alternately (a long log and then a cross log) making a crib with openings the size of the timbers. Usually, with round logs, both logs should be flattened to a bearing surface about 4 ins. wide on each side, and with squared timbers they should be laid without notching. Each log or timber is bolted to the log below with one ⅝-in. drift bolt long enough to reach through the first log below and to extend about 2 ins. into the second log. These drift bolts may be shorter above and below the points at which impact forces are to be expected, except that in piers over 10 ft. high the lower bolts should not be shortened. In addition to the rectangular body, piers subject to the attack of drift and ice should be given a wedge-shaped nose upstream, and in unstable bottoms with rapid currents, a short wedge-shaped tail. The body of the pier should be built like a rectangular pier, but with the long logs extending beyond the cross logs a sufficient distance is required to allow them to be framed and drift bolted to the wedge logs. The upstream nose should generally have a vertex angle of about 60° at the line of greatest impact. The wedge logs should be framed at the vertex, as described for the corner of a rectangular pier, the ends extending sufficiently to allow a bearing of not less than 6 ins. for the nose log. The vertex angle of the wedge increases from bottom to top to give the nose log a slope. The remarks regarding the size, slope, metal protection and bolting of the nose of a pile pier apply to the nose of a crib pier. The tail wedge is usually not necessary. When required to prevent the formation of a suction eddy it is usually made with a vertex angle of 90°. It is framed like the nose, but without a nose log and with a constant angle at the vortex, making the tail line vertical. The tail wedge should be carried to the high water line.

Cribs are filled with stone, at least to the highest line of probable impact. The size of the stone is unimportant, except that it must be larger than the openings between crib logs; it is usually large enough to be handled one stone at a time and not larger than one or two-man stone. The stone should be placed well against the walls, smaller pieces being wedged into spaces between larger stones and the crib logs. The spans of the superstructure rest on caps, one for each span. The caps usually rest on stringers which are supported by the crib walls, from which the caps are set back 2 ft. or more, frequently being placed one-quarter of the distance from one wall to the other.

Pile and Crib Piers are used where strength greater than that obtainable with simple cribs is desired. They are particularly useful in soft bottoms where cribs can not be expected to stand without settlement from time to time, unless sunk to impracticable depths. When the length of the crib is small, the addition of the piles greatly increases its resistance to impact; as the height increases the value of the piles becomes less. In cribs that may reasonably be suspected of liability to even small settlement the supporting piles should be added if the superstructures are expensive. A well constructed pier of this type will resist a heavy ice run, and by increasing the dimensions it can probably be expected to withstand any but the most severe ice jams.

The simplest form of pile and crib pier is composed of a crib constructed according to the principles already given, but with the trusses supported on pile bents extending through the cribs and driven into the underlying bottom. The caps of the piers take the place of and occupy the positions recommended for the crib caps, the crib stringers being omitted. A complete pile and crib pier is constructed like the crib pier described above, but with an additional pile at each corner of the rectangular portion of the pier and with piles along and against the walls of the rectangle and the nose. All of the piles are inside of the cribs and should be about 4 ft. apart. The logs are then drift bolted to the piles with ⅝-in. drift bolts. This construction adds greatly to the strength of the pier, being particularly a protective measure against damage to the pier and the supporting bents caused by excessive settlement of the pier itself. Piers of this type should not be floored, and when the filling settles the crib should be filled as soon as possible.

Abutments.—The approaches to bridges of wood will usually be pile or framed bents, if of considerable length, and in any case will usually terminate in a single mud sill for the support of the floor stringers. When built-up abutments are necessary the best form of wooden construction is usually a vertical river wall parallel to the bank of the river and with vertical wing-walls. The river wall and wing-walls are constructed like a side wall and the corresponding wedge walls of a crib pier. The wing-walls, where oblique, usually make an angle of 45° or less with the river wall. The ties of the crib construction are replaced by headers extending into the bank or fill behind the abutments, according to the rules for spacing given for the ties. Frequently the wing-walls will be perpendicular to the river wall, and when so placed the ties can be omitted. Another type of abutment is constructed of piles and sheathing.

If scour beneath the abutment is expected the abutment may be supported by piles driven behind and against the wall. The logs of the wall should be drift bolted to the piles. In this case the filling next to the wall should be of stone, and if it sinks it should be replaced as soon as practicable. Abutments built as indicated can be considered safe under any conditions of ice and drift that make pile and crib piers permissible. Their greatest danger is from the effects of bank erosion, which must be cared for when necessary by mattress or other form of bank protection.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Capt. Glen Edgar Edgerton, Corps of Engineers, U. S. A., in *Professional Memoirs* for July-August, 1915.

Details of the Stocking Trestle Used by the Colby Iron Mining Co. at Bessemer, Mich.

(Staff Abstract.)

In our issue of Sept., 1915, we published an article on the design, construction and cost of a permanent type of ore stocking trestle consisting of a steel superstructure supported on a single line of reinforced concrete columns. The principal advantage of this type of stocking trestle is that it is not necessary to dismantle the trestle at the time the ore is removed from the stock pile. A somewhat similar design, constructed of wood, has been built at Bessemer, Mich., for the Colby Iron Mining Co., the following data referring to this trestle:

Each bent consists of a single leg of 12x12-in. fir, 38 ft. long, on which is mounted a 12x12-in. fir cap, 7 ft. long. This cap is braced to the leg by means of two 6x8-in. x 6-ft. fir pieces, mortised and bolted both to the cap and to the leg. To each cap there is bolted two 12x12-in. x 4-ft. fir corbels or bolsters, to which are bolted the 8x16-in. x 32-ft. stringers.

The stringers are trussed with 16-lb. rails, to each end of which there is riveted a ⅝-in. plate, the latter being bolted to the stringer. The truss rods are blocked in the center with a 6x12-in. piece. To the stringer are spiked 3-in. planks, 5 ft. long, the 30-lb., 30-in. gage rails being laid on these planks. A 16-lb. guard rail is spiked outside of the 30-lb. rail. To each end of the cap there is bolted a plate, with an eye in the end, for attaching the guys. These guys consist of ⅜-in. galvanized wire strands, and they extend out to side bents, erected at a distance of 100 ft. from the trestle, the guys from three center bents being attached to each side bent. The guys pass over a cap and down to eye-bolts, passing through a 12x12-in. x 16-ft. timber near the ground.

The side bents are 32 ft. high, and are built of round timbers, well braced. They are in turn guyed, by two ⅝-in. wire ropes, to a "dead-man" concreted in the ground.

The ore is dumped into the stock pile from three-ton tram cars, equipped with electric motors. As the legs are 38 ft. high, and are spaced 32 ft. on centers, the steam shovel is able to work efficiently between the bents. This shovel operates over tracks laid along each side of the stock pile. After finishing one cut the shovel is moved back on the loading track and work is started on the other side of the pile. This procedure enables the first track to be moved in while the cut on the opposite side of the ore pile is being made.

The design originated with Oscar Gustafson, surface foreman at the Colby and Ironton mines. The above data were abstracted from a paper by G. S. Barber before the recent meeting of the Lake Superior Mining Institute.

Regulation of Water Powers in Europe.—Water-Supply Paper, 238, issued by the U. S. Geological Survey, and prepared by René Tavernier, chief engineer of the Department of Public Works of France, treats of the manner in which France, Switzerland and Italy have dealt with the problem of utilizing the water powers afforded by the streams of those countries.

SEWERAGE AND SANITATION

Method and Cost of Constructing 42 and 48-in Concrete Sewers at San Antonio, Tex.

The Stieren St. storm water sewer system, here described, is a part of San Antonio's new storm water sewerage system. It is one of the trunk lines of the system. It serves one of the residence districts and discharges into the San Antonio River. The main line consists of 42-in. and 48-in. monolithic concrete pipe, with two short laterals of 18-in. vitrified clay pipe. One of the latter is really part of another sewer, as it empties into an existing line. Part of the concrete pipe was reinforced with Clinton electrically welded wire mesh and part was plain concrete. In most cases there were from two to six inlets, without catch basis, at each street intersection along the main line. All single inlets had 12-in. vitrified clay pipe leading to the concrete pipe, and the double inlets had 15-in. and 18-in. clay pipe, depending upon the amount of water to handle. All angles in the concrete sewer were turned on curves with a radius from 20 ft. to 35 ft. on the center line. Generally there was a manhole at the tangent point of each curve and at the center of each intersecting street where the sewer was on a tangent. The streets were 50, 55 and 60 ft. wide, and with the exception of two blocks, where the line was near the center of the street, it was generally about 20 ft. from one property line.

Most of the manholes were 4 ft. in diameter and were made of concrete. There were a few places where obstructions or other circumstances were responsible for their being larger than 4 ft.; in these cases they were built of brick. Telescoping steel forms were used for all concrete sewer lines and manholes, the same set used on the 48-in. line being reworked and used for the 42-in. line. All but three inlets were built of hard shale brick laid up in cement mortar, the three being constructed of concrete. The intention at first was to build all of concrete, but owing to the fact that the inlet work had to be kept two or three blocks behind the main concrete gang on account of not wanting to shut off traffic on all streets at once at each intersection, it was found cheaper to construct them of brick than to move the mixer or mix the concrete by hand.

ORGANIZATION OF FORCES.

After getting started the organization was divided into two gangs under two foremen. The gang ahead did the excavating, laid the main sewer, poured the concrete manholes and did part of the backfilling. The second flushed the trench, finished backfilling, pointed up the concrete sewer inside where necessary, constructed the inlets and connections and cleaned up in general. Several of the brick inlets were built by contract, the rest being built by the foreman of the second gang. It was at first thought that one foreman could run both gangs, but on account of the fact that they were necessarily scattered it was soon found that one man could not do the work properly. The second foreman undoubtedly saved his wages in increased efficiency of the men, besides doing what bricklaying was necessary. With the exception of a few white men, all common laborers were Mexicans and Negroes, and on account of paying higher wages than was the custom in the city at this time, the best workers in town were secured. All except a few were experienced in this kind of work and the increased rate of pay certainly lowered the unit costs from what they would have been with cheaper labor.

All sewer pipe were paid for at a certain bid price per linear foot in place, according to depth. Inlets were paid for at a price each, as also were manholes for a depth of 7 ft. or under. For additional depth of manholes over 7 ft. there was a bid price per vertical foot. Loose rock excavation and all work in connection with concrete bulkhead at outlet were paid for under unit prices bid for each particular item. All unforeseen work for which there was no bid price, such as taking care of sanitary sewers which were in the way, was paid for at cost plus 15 per cent. This item amounted to approximately $250 for the job.

EXCAVATION.

The job was started by doing the excavation by hand, but after the first month's work a Parsons steam trench excavator did practically all the excavation. Owing to the short radius of most of the curves the machine could not cut the curves to advantage, and there were several short pieces of tangent dug by hand where there were large pipes in the way or when the machine was out of commission for repairs. The first stretch of 48-in. sewer, about 800 ft. in length, which was dug by hand, was on an average 12 ft. deep and the trench was cut 5 ft. wide. The upper 6 or 7 ft. was gravel and black loam, and the rest a white clay or adobe. Owing to the close proximity of another and deeper sewer and to the fact that it rained most of the time while the work was in progress heavy bracing and constant care were necessary to prevent caving. Two rows of rangers were put in and vertical sheeting driven about 1 ft. apart down to where the top of the concrete came. Each row of rangers was held with a trench jack every 5 or 6 ft. Even then the clay when wet showed a tendency to slip from behind the sheathing, especially when the trench had become narrowed and undercutting was necessary to get clearance for the concrete shell. However, no ditch was lost on account of caving or slipping, but the cost of bracing on this stretch equaled or exceeded that for the rest of the sewer.

The remainder of the excavation was in hard gravel with a few boulders in places, so hard in fact that the teeth of the excavator had to be sharpened every day or two to make any progress, and minor breakdowns were frequent. The following were the widths of trench for hand excavation: For 12-in. pipe, 18-ins.; for 15-in. pipe, 22 ins.; for 18-in. pipe, 30 ins.; for 42-in. pipe, 39 ins., and for 48-in. pipe, 48 ins. and 60 ins. The widths of trench for machine excavation were as follows: For 18-in. pipe, 28 ins.; for 42-in. pipe, 36 ins., and for 48-in. pipe, 48 ins. On the class of material that was encountered in the machine excavation of most of the 48-in. line the trench could have been much narrower than 48 ins. and would have stood up well with the undercutting necessary, especially as there was very little rain while it was being cut. However, as this line was reinforced, a 48-in. trench was about the minimum that would allow the rolls of wire mesh to be handed down to the form setters.

The machine excavation was contracted at 30 cts. per cubic yard for depths under 7 ft., and 40 cts. per cubic yard for depths over 7 ft. This price was for straight excavation and did not include cost of undercutting where necessary and shaping the bottom of the trench to the proper cross-section of the concrete shell. Owing to this fact and because the curves and other short stretches were cut by hand it was difficult to separate the unit costs on excavation between different depths and between that done wholly by hand and that done in the main by machine and finished by hand. With all labor receiving 25 cts. per hour except two leaders, who received 30 cts. and 35 cts. per hour, the hand excavation in the first 800 lin. ft. mentioned above cost 60 cts. per cubic yard, solid measurement. The following is a summary of the excavation for the whole job, based on solid measurement:

EXCAVATION COSTS.

Cut. ft.	Cu. yds., mach.	Cu. yds., hand.	Total.	Aver. cost.
0- 7.......	538.5	637.7	1,175.2	$0.613
7-10.......	3,235.3	469.7	3,705.0	.625
10-12.......	779.3	1,996.6	2,775.9	.595

It will be noted there is no excavation listed above as 12 to 14-ft. cut, though there was such a classification allowed in the final estimate. This is due to the fact that the 12 to 14-ft. cut was only a few tenths over 12 ft. deep and therefore no effort was made to separate the costs between that and 10 to 12 ft.

The above costs apparently show that it was cheaper to excavate wholly by hand on this job than by machine at the contract prices paid. However, such was not the case, for the machine cut down the payroll 50 per cent or more, considering the work being done in the same length of time, and liability insurance on sewer work was being paid at $6 and $8 on the $100 payroll. Or if a small gang had been used, the job would have taken twice as long without a machine and the overhead would have been correspondingly increased.

The contract prices for machine excavation did not include cost of taking care of any pipes encountered in the line of the trench. There were 19 water services cut and replaced at an average cost of 57 cts. each for material and $1.93 each for labor, making a total average cost each of $2.50. Fourteen of these were ⅜-in. galvanized pipe, three of ½-in. lead pipe laid in 3-in. clay tile, and one each of ¾-in. and 1-in. black pipe. In most cases the iron pipe was not dug up to the main, but simply cut on each side of the sewer trench and a cock inserted without turning the water off and an ordinary union used to replace the same piece of pipe taken out. There were 14 gas services cut and replaced at an average cost of 51 cts. for material and $2.49 each for labor, or a total average cost each of $3. Eleven of these were 1¼-in., two were 1½-in. and one 2-in. black pipe. The gas services were handled in the same manner as the water lines except that the flow of gas was stopped with a plug instead of a cock and a long-screw was used for reconnecting instead of a union. The above prices include all digging and fitting with common laborers at 25 cts. and a fitter at 45 cts. per hour. The cost of individual services varied considerably from the average, as there were so many different conditions and circumstances that governed each case. Where the location of a service pipe was overlooked and the machine cut it the cost of replacing was increased on account of having to insert all new pipe. Occasionally in a case of this kind a water service would be torn loose at the lead connection and this added more to the cost. Where the water services were wholly of lead they were dug up and disconnected at the corporation cock, and therefore the cost for cutting and replacing was wholly labor for digging and relaying.

Practically all surplus material from the excavation was loaded directly into wagons by the excavator and hauled away at once to vacant lots and low streets within a few blocks. The remainder of the surplus dirt was hauled away after the backfilling had been done and it was made sure that no more would be needed in the trench. The city and other parties had teams at the machine part of the time and altogether 541 cu. yds. were hauled off, free of cost in this manner. The remaining 2,361 cu. yds. were hauled and disposed of at a cost of 48.7 cts. per cubic yard solid measurement. Teams and drivers were paid 50 cts. per hour and laborers 25 cts. per hour, and the above cost includes all lost time while teams were waiting at machine or at dump. It was practically impossible always to have just the exact number of teams hauling so as to keep neither machine nor teams waiting on account of varying lengths of haul, different kinds of material encountered in trench and minor breakdowns of the machine.

The actual cost of backfilling and cleaning up the streets amounted to 15.7 cts. per cubic yard of material backfilled, solid measurement. All except the final dressing up, which was done by hand, was done by two men and team with a "go-devil." This is nothing more than a light steel scraper with flat bottom and no sides. A piece of cable about 30 ft. long enabled the team to work on the unobstructed side of the trench. On a short piece of sewer a portable gasoline engine equipped with winding drum was used to handle the scraper instead of a team.

The total labor cost of bracing trench against caving amounted to $164 for the whole job. This does not include cost of bracing for holding forms in place alone.

All ditches were thoroughly flushed with water through 1¼-in. hose connected to fire hydrants. This work was usually done by men backfilling or cleaning up street, and the cost was insignificant. As near as could be determined the labor cost of flushing was 0.5 ct. per lineal foot of concrete sewer. The shallow pipe lines were tamped instead of flushed. Thirty days after finishing the job the trenches had not shown the slightest settlement, notwithstanding three excessively hard rains.

FORMS AND REINFORCING.

Three men in the trench and one or two on top handled the forms and reinforcing for a day's run, which varied from 50 lin. ft. to 120 lin. ft. The first section of steel form pulled forward was expanded inside the last section set previously. Concrete block which had been placed on grade and line in the trench bottom supported the forms the proper distance from same. Where wire mesh reinforcing was used the top of the block was so shaped as to allow the mesh to rest the proper distance below the forms. The reinforcing was bent and tied on the bank and handed down into the trench as needed. The forms were held to line by means of knee braces thrust down between them and the trench sides, which were withdrawn as the concrete reached the springing line. A 2-in. x 12-in. ranger was placed along each side of the trench about 1 ft. above the top of the concrete and held in place by sewer jacks over each joint of the steel forms, which were approximately 4 ft. apart. Short pieces of 2x4-in. stuff were cut to proper lengths and used as struts between the jacks and the tops of the forms to hold the latter to grade until the concrete covered the top, when they were removed. This method was very effectual and in only a few cases did the forms rise from the buoyancy of the wet concrete. The cost of the bracing was included in the cost of placing forms.

An effort was made to separate cost of placing reinforcing from that of placing forms, but as the same men generally did both, and as the former was small compared with the latter, they were run together. One form man received 30 cts. per hour and the rest 25 cts., except occasionally there was a second man in the gang at 30 cts. The average cost of placing forms for the whole job amounted to 16.8 cts. per lineal foot of sewer, the 42-in. costing practically the same as the 48-in. There were 208 lin. ft. of forms on the job and these were sold as junk at the end of the job at 1 ct. per pound. The net cost of the forms for the whole job was $585, or 12.3 cts. per lineal foot of sewer.

Wire mesh reinforcing was bent and tied at a cost of 3 cts. per lineal foot of sewer, or $5.54 per ton. The men doing this usually received 25 cts. per hour. The bending was done by hammers, the resultant curve being really a polygon with 8-in. sides, instead of a circle.

CONCRETE.

Concrete was mixed in a ¼-cu. yd. batch mixer, gasoline-driven, and in most cases chuted into place by means of two steel troughs 12 ft. long. The aggregates were so placed that the mixer was moved about 25 ft. each time. Where the cut was shallow it became necessary to have one extra man or more raking the concrete down the troughs when placing anywhere other than directly opposite the mixer. Concrete up to the springing line was made "sloppy" so as to flow well around the reinforcing and not form pockets in the shell. No outside forms were used and it was necessary to make the concrete rather stiff for the top third of the sewer so it could be shaped properly and not waste too much. The proportions of the mix were 1 Portland cement, 4 washed river gravel, and 2 crushed limestone. The river gravel contained an excess of excellent sand and the resultant mix was a dense concrete similar to a well graded 1:2:4 as usually specified.

All concrete laborers received 25 cts. per hour except the mixer man, who received 45 cts., and one other who worked part of the time dressing up the surface, who received 35 cts. per hour. The actual cost of mixing and placing concrete for the whole job was $1.10 per cubic yard, which includes the cost of pointing up the inside of the sewer where necessary. Some reduction could have been made in this cost had a self-propelling mixer been used, as no small amount of time is wasted in moving the mixer by hand. From observation on similar jobs where they were used the writer is of the opinion that a self-propelling mixer of the paver type is best adapted to this kind of work. Also the higher the discharge from the ground the better, because the concrete can be chuted farther each way from the mixer and the number of moves reduced.

MANHOLES.

Both inside and outside forms for concrete manholes were of steel, except the inside form for the conical part at the top. This was made of wood in eight parts, so that the pieces would come out of the reduced opening at the top after the concrete had set. The inside form for the straight part was one regular section or more of the 48-in. sewer forms, and these were taken out before the top part was poured. No attempt was made to cut the inside forms to allow the steps to be placed in the walls as the concrete was poured, and they were grouted into place in holes drilled before the concrete was hard, but after the forms had been removed. The same method was pursued where clay pipes from the inlets entered the manholes or the walls of the sewer barrel.

There was practically no additional excavation for the manholes and the actual average labor cost per manhole for the whole job, 7 ft. and less in depth, was $6.55. The cost per vertical foot for depths greater than 7 ft. was 96 cts. These costs included setting forms, pouring concrete, removing forms, pointing up where necessary, setting casting, cutting holes for steps and pipes and grouting the latter in place. This cost is an average of 27 manholes, seven of which were of brick on the clay pipe line or where obstructions would not allow the use of concrete. In three cases a sanitary sewer intersected between invert and crown, and in these places a 5-ft. manhole was built so as to give additional waterway to offset the obstruction of the sanitary line. The clay pipe of the latter was replaced by a piece of iron pipe where it passed through the manhole. In one instance, when the sanitary line came so near the invert of the concrete pipe as to cause liability of sticks, etc., lodging and forming too great an obstruction, the sanitary line was carried under the storm sewer by means of a siphon.

INLETS.

The average total labor cost of all inlets, which includes three of concrete and 64 of brick, amounted to $5.18 each. This cost includes labor on excavation and backfilling, concrete bottoms and curb above openings, laying brick, plastering inside with cement plaster and setting casting. All labor received 25 cts. per hour except the bricklayer, who received 50 cts. per hour. On several the brick laying, plastering and setting casting was contracted at $2.50 each, and on a few others at $3.50 each. The insides of the basins were

2 ft. 4 ins. x 2 ft. 1 in. and on an average of about 3 ft. 6 ins. deep. The front and the side walls were 8 ins. thick, and the back wall 4 ins. thick. The short section of curb placed over the opening was reinforced with two ½-in. twisted square steel bars.

BULKHEAD AT OUTLET.

Where the main line emptied into the river a reinforced concrete bulkhead was constructed to retain the earth fill and protect the end of the pipe. There were 131 cu. yds. of excavation in this work, which, with laborers at 25 cts. per hour, cost 47 cts. per cubic yard. There were 1,000 sq. ft. of form surface touched by the concrete which cost 4.2 cts. per square foot for labor alone to erect. Carpenters were paid 45 cts. and helpers 25 cts. per hour on this work. The cost of mixing and placing 57.1 cu. yds. of concrete was $1.08 per cubic yard. Concrete was mixed about 75 ft. from the wall and wheeled in wheelbarrows on runways to the forms. The walls were reinforced with the same size of wire mesh as was used in the sewer, and in addition had ½-in. and ¾-in. twisted square bars for dowels to tie the wall into the base and the footing.

All the above costs include supervision, night-watch, time-keeper, and in fact all field labor connected with the work. This item called "general" labor amounted to 17 per cent of the total payroll and was apportioned to each item for which a separate record was kept.

The above work was done by the McKenzie Construction Co. and under the supervision of M. C. Irwin, assistant city engineer in charge of sewer construction of the city of San Antonio. Samuel M. Gray, Providence, R. I., is consulting engineer for the city on all sewer work under construction.

ACKNOWLEDGMENT.

The foregoing matter is practically a full reprint of the text of an article by E. W. Robinson, Engineer with the McKenzie Construction Co. of San Antonio, Tex., in the September number of *Concrete-Cement Age*.

Beautifying Sewage Disposal Works at Harrison, N. Y., by Artistic Design and Planting of Flowers.

(Staff Article.)

The two accompanying views of the sewage disposal plant at Harrison, New York, are of unusual interest because they show an attempt to beautify the plant and its surroundings. Particular attention is called to the plantings at the intersections of the sprays on the sprinkling filter beds, as shown in Fig. 1. Even when the sprays are not in action the plant is sightly and when the sprays are in operation a very attractive effect is produced. The expense of providing the attractive features in this plant was trifling and certainly was worth while.

As will be seen in Fig. 1, 2-ft. lengths of 6-in. vitrified pipe, filled with earth, are embedded in the broken stone of the filter, and the moisture from the sprays and the moisture in the stone produce thriving plants. Canna lilies were used in planting and the view shows clearly how well they have grown. The total cost incurred in this planting was $60 for a bed of one-quarter of an acre in area. Figure 2 shows the entire plant and gives a good idea of how the grounds have been beautified.

In designing the pumping station a slightly greater expense over that absolutely required by the stern necessities of the case was incurred by adding a little cut-stone trimming to the structure. The pleasing effect so secured is shown in Fig. 2.

The Harrison plant was designed by Mr. Alexander Potter, Consulting Engineer, New York City. At our request Mr. Potter supplied the photographs here shown.

The beautification of sewage treatment plants is a subject to which engineers should give attention. Editorial comment on this subject appears elsewhere in this issue.

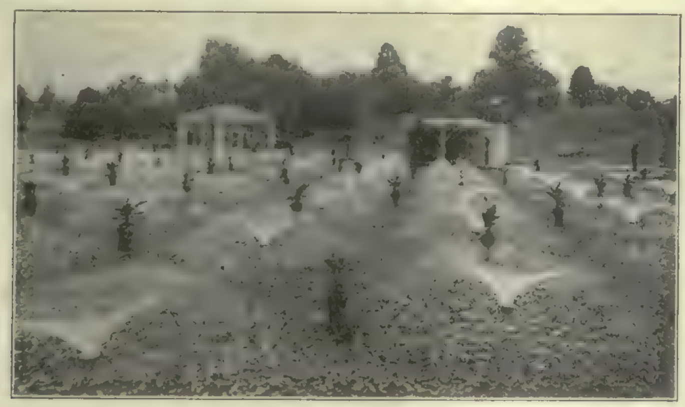


Fig. 1. View of Harrison, N. Y., Sprinkling Filters in Operation, Showing Use of Canna Lillies as a Means of Beautifying the Plant.

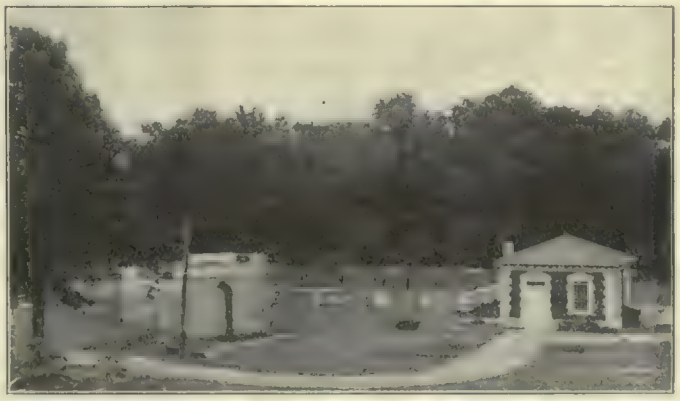


Fig. 2. General View of Harrison, N. Y., Sewage Treatment Plant, Showing Attractiveness of Design. Note Cut Stone Trimming on Pumping Station.

Method and Cost of Refuse Collection and Disposal in Los Angeles, Cal.

(Staff Abstract.)

LOS ANGELES CLASSIFICATION OF MUNICIPAL REFUSE.

Los Angeles separates municipal refuse into garbage, non-combustible rubbish, combustible rubbish and market refuse.

Garbage is defined by ordinance to be all animal and vegetable refuse from kitchens and all household waste that shall have been prepared for or intended to be used as food, or shall have resulted from the preparation of food.

Non-Combustible Rubbish is defined by ordinance to be ashes, bottles, broken crockery, glass and tin cans and other metallic substances, and like or similar substances that will not cinerate through contact with flames of ordinary temperature.

Combustible Rubbish is defined by ordinance to be paper, pasteboard, carpets, rags, clothing, books, boots, shoes, straw, packing barrels, boxes, furniture and similar articles that will cinerate through contact with flames of ordinary temperature.

Market Refuse is defined by ordinance to be and to include decayed and unsound meat, fish, fruit and vegetables from meat, fish, fruit and vegetable markets and animal and vegetable refuse from such markets.

The collection and disposal of refuse is under the jurisdiction of the engineering department of the Board of Public Works. One superintendent is placed in direct charge, with a foreman in charge of the night work and a foreman in charge of the collection of noncombustible rubbish. In discussing the collection only that portion of the city south of Cahuenga Pass and north of Manchester Ave. will be considered because no collection is yet being given in any portion of the San Fernando Valley. In the Harbor District the work is let in three small contracts at a cost of approximately $400 per month. In the Shoestring District the work is done by one team working two days per week.

COLLECTION OF GARBAGE.

The department sees that garbage is kept as free as possible from rubbish, both combustible and non-combustible, and is quite successful in this respect.

For the collection of garbage the main portion of the city is divided into nine districts. The central business portion is given collection every night in the week. The apartment and semi-business section is given collection three times per week. Hotels and large apartment houses throughout the city are given collection as often as required.

The remainder of the city is given collection twice a week, maps giving the regulations and the outlines of districts are prepared. It is the policy of the department to have these maps printed on manilla paper, and distributed whenever the outlines of a district are changed, and copies are kept on hand to be distributed to new residents in a district. The portion of the city where collection is given every night and three times a week is all collected at night. The remainder of the city is collected in the day time.

For the night work the department has one foreman and 16 collectors with 16 two-horse teams with wagons having tanks that have a capacity of 115 cu. ft., or approximately 6,000 lbs. For the day collection the department has 48 collectors with 48 two-horse teams, the same weapons being used day and night.

A telephone operator is kept at the phone day and night to answer calls concerning collections and to direct the teams so they may work to the best advantage.

The department owns its own equipment and live stock, and has built buildings on grounds leased for a term of years. All shoeing and repair work is done by the department with its own forces. The barns and corral are located across the street from the works of the Pacific Reduction Co. to whom the garbage is delivered. The reduction plant is located immediately west of the Los Angeles River on Leonard St., and is well isolated in the industrial section.

The street leading to the plant has been paved and the distance from the center of the city is 3¼ miles. The distance to the plant from 102 collection routes is less than 4 miles. Of a total of 165 routes, 36 are over five miles, the maximum being 10½ miles.

The quantities of garbage collected in the last 3 years are as follows:

	Tons.
1912-1913	44,656
1913-1914	46,723
1914-1915	49,193

The average cost per ton to haul for the year 1914-15 was $1.93. There has been a notable increase in garbage this summer. In July, 1914, 4,443 tons were collected and in July of 1915 this figure increased to 5,636 tons.

GARBAGE REGULATIONS.

The garbage regulations of the department are that garbage must be placed in metal watertight cans with tight covers, and fitted with outside handles, in cans of a capacity between 3 and 16 gals. The receptacles are to be placed during times of collection as follows:

"A"—Where there is an open alley in rear, within 5 ft. of property line.

"B"—Where there is a side entrance, but no open alley in rear, at an accessible point on premises between 50 and 75 ft. from front property line.

"C"—Where there is no open alley or side entrance, place on front curb. Each receptacle shall be accessible to the garbage collector when called for.

NON-COMBUSTIBLE RUBBISH REGULATIONS.

Non-combustible rubbish is collected from private residences and flats. Recently small apartment houses and public institutions are also being given collection. Collection is given once a week, the city being divided into six districts.

The non-combustible rubbish regulations are:

Cans for ashes must be watertight, have tight covers, outside handles and a capacity of 3 to 16 gals. Receptacles for holding non-combustible rubbish must be tight and have a capacity of 5 to 30 gals.

Receptacles to be placed on days of collection as follows:

"A"—Where there is an open alley in rear, within 5 ft. of property line.

"B"—Where there is a side entrance, but no open alley in rear, at an accessible point on premises between 50 and 75 ft. from front property line.

"C"—Where there is no open alley or side entrance, place on front curb.

Cans must be placed before 8 a. m. on days of collection.

Collection is by means of 2½-ton motor trucks on which beds are constructed which have a capacity of 10 cu. yds., the sides and ends being let down for unloading. Seven trucks are in use and each truck has two collectors with it, the driver doing nothing else. The trucks are rented fully equipped and operated at a cost of from $9.69 to $9.75 per day each.

The material collected is used for filling low ground; the dumps are kept as presentable as possible, by being covered with dirt.

A contract has been let for the salvaging material from these dumps, from which the city obtains $100 per month. Ground for dumping non-combustible rubbish is obtained at little or no expense to the city.

The collection of non-combustible rubbish since the beginning of March, 1915, is as follows:

	Cu. yds.
March	4,335
April	3,485
May	4,013
June	3,381
July	3,201

The average cost per cubic yard is 70 cts.

Small dead animals are collected by the city, one man with a runabout being employed for this work at a salary of $110 per month, the employe furnishing his own machine. For the collection of small dead animals the city endeavors to collect $1.25 from the owner. Dead animals, such as calves, sheep, hogs and goats are collected by the Pacific Reduction Co. For each such animal the city is paid 80 cts., and the reduction company is allowed to charge the owner $1.25 for collection. All large dead animals, such as oxen, cows, steers, horses and mules are collected by the Pacific Reduction Co. The city is paid $3 for each animal, and the Pacific Reduction Co. is allowed to charge the owner $3.50.

COLLECTION OF COMBUSTIBLE RUBBISH AND MARKET REFUSE.

Collection of all combustible rubbish and market refuse and non-combustible rubbish from stores and hotels is made at the owner's expense. For this there are at present 113 licensed collectors who are required to sign an agreement to deliver all combustible rubbish and market refuse to the Pacific Reduction Co. for disposal. They are required to pay to the Pacific Reduction Co. 3 cts. per hundred for disposal of combustible rubbish, and 6 cts. per hundred for disposal of market refuse, with a minimum charge of 15 cts. for each load.

Non-combustible rubbish is hauled by private collectors and dumped on low ground. It requires considerable oversight to prevent private collectors from disposing of their material at other places than the plant of the reduction company.

REFUSE DISPOSAL.

The city has entered into a 10-year contract with the Pacific Reduction Co. for the disposal of all garbage, dead animals, market refuse and combustible rubbish. The city is to receive for garbage delivered 51 cts. per ton, $3 each for large dead animals and 80 cts. each for small dead animals, not including cats or dogs.

The Pacific Reduction Co. have constructed a modern reduction plant on Lenard St., and have been operating it since March, 1915, gradually taking over the garbage until at the present time (August, 1915), they are taking somewhat more than half of the garbage. The garbage is delivered by belt conveyor from the bins to the cookers. The grease is extracted by the naphtha process. The fibrous material is dried and ground into fertilizer or hog and chicken feed. Their contract required that all the garbage be taken by Sept. 1, 1915. It may not be possible to do this, because at present the company has only 20 cookers. Ten additional have been ordered and are about to be installed. Twenty cookers have an approximate capacity of 150 tons per day. The balance of the garbage is being sent to the hog ranch near Vineland Junction.

The contract also provides that the combustible rubbish must be hauled to the company by the private collectors. This is being done and the company is salvaging the paper and such other materials as are of value and burning the rest, using the steam in their reduction plant. The contract provides that market refuse must be destroyed at the plant of the reduction company. This is not being done yet, with the exception of such small quantities of market refuse as are found among the combustible rubbish. The plant is operating in a satisfactory manner and there has been no cause for complaint.

It will be seen that the city derives an income from its garbage of approximately 26 per cent of the cost of collection.

The method of unloading is to lift the tank of garbage from the running gear and carry it by "traveler" to the bin, dump it, and return the tank to the wagon. The contract provides that the company must wash the tanks and have extra tanks to prevent delay.

ACKNOWLEDGMENT.

Major portion of paper by Mr. A. C. Hansen, chief deputy to the City Engineer of Los Angeles, before the League of California Municipalities.

The Plumber's Day in Court.

The editors have received the following letter, written on the stationery of the Young Men's Christian Association of Dayton, Ohio. Our correspondent requests that his name be withheld:

To the Editors:

In your number for Sept. 15 you published an article entitled: The Plumber's Day in Court. I have read it and in one place it states that the Plumbers' Association is to blame for the conditions referred to therein. But if you will take time or if the federal government will investigate, it will be found that the master plumber is forced to do things that he would not do if it were not for the local unions, such as the United Association of Plumbers and Steam Fitters of America. I am not a master plumber, but am a journeyman plumber, and if you want to send a federal inspector to investigate a trust proper, send them to me—I can tell them a thing or two. It will be a wise act to dissolve the local plumbers' union as well as the Master Plumbers' Association. Hoping that the federal government will regulate both associations, I am

Very truly yours,
A JOURNEYMAN PLUMBER.

Dayton, Ohio, Sept. 22, 1915.

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Yale Engineering Association.—There has been recently formed an organization among graduates of Yale University, known as the "Yale Engineering Association." The objects of the Association are stated as follows: To help the educational work at Yale, by service in an advisory capacity to engineering departments, visits and conferences, publishing the work of "Sheff." as widely as possible, and furnishing speakers for undergraduates in engineering classes; to establish cordial and mutually helpful relations between Yale engineers, by occasional joint meetings, helping graduates to get located, and to provide summer work for students; to encourage Yale men to join national technical societies, etc. Edwin M. Kerr, '84 S., President Westinghouse Electric & Mfg. Co., is the President of the new Association, and Richard T. Dana, '96 S., consulting engineer and author of the Handbook of Construction Plant, is Secretary. The first meeting will be held in New Haven early in November. A committee from the Executive Board is actively engaged in preparing an attractive program. The present membership of nearly 500 is rapidly growing.

Jy 19-'23.

The Lighter Side of Engineering and Contracting

A Good All Around Man Wants a Job.

THE following application for a job is stated to have been received by a railroad contractor:

Dear Sur: I understand from a friend of mine you are warded contract in this place which I rite to you. If you wish to have a place for me dear sur I would like work for you very much. i am fist class workman and soons i hear bout your job I know thats the job for me to git, and i think perhaps shure nuff that contractor he needs me on that work, and I promise me you that jest soons you hire me I not make you no trouble. If you hire me dear Sur do so immediately and if you want any recommend I can recommend myself bettern any one elce. And i'm jest the man you want. My speshulty is rock work earth work in wheelbarrows quicksands and any other kinds of work yu may have on hand. I handel lots dinumite an powder, can lode ¾ in. holes with 1½ in. sticks of dinumite without drivin' it in with a hammar or tampin' it with crow bar. I am pritty good man of repairin' hoistin' ingine. I repair a steam boilers one day without stoppin' engin by taking out three bust tubes and puttin' in 3 new ones with 120 lbs. steam on and not lost 1 lb. steam. I can reference you for list of my other speshultyes two numerus to menshun.

Yours tru.

P. Dolan Gets a New Car.

PATRICK DOLAN, a down-east section foreman, never wastes words nor company material. One foggy morning while taking a spin over his section he collided with an extra freight and his car was reduced to scrap iron and splinters. His report to his superior officer was as follows: Peter Moriarity, Roadmaster, Esquire: August the one, foggy mornin', wildcat frate, green man at brek, handcar smashed to hel, where will I ship wreck? P. Dolan, Sec. Foreman.

He Had to Spit on His Hands.

JOHN OLSEN, the marine contractor, at one time had in his employ a day laborer who was ambitious to become a diver. One day the opportunity came and the man put on the diving suit and went down. He hardly had been down two minutes before he signaled to be drawn up again. The helper hauled him up quickly and he indicated that he wanted the helmet unscrewed. When this was done he began to take off his loaded shoes and rubber combination suit. "I'm done with divin'," he explained. "No more of this business for me. To the devil with a job where ye can't spit on your hands."

Sub-Contractor Philosophy.

Said the sub: I'll stick the contractor, by
Gee!
For I know durn well he'll try to stick me.

License.

The yellow dog is licensed
He wears a metal tag;
The bar-keep buys a license
To sell a man a jag.
The peddler needs a license
To peddle out his wares,
And the hackman has a license
To haul around his fares.
The motor car is licensed
By State and City, too;
The barber gets a license
And hangs it up to view.
The architect is licensed
And stamps it on his plans,
And my poetic license
Is as good as any man's.
Most everybody's licensed,
And the time is drawing near
When a fifty dollar license
Will make an engineer.

A Plug of Tobacco for a Horse.

A Sub-contractor, in his eagerness to find work for his outfit, bit off more than he could chew. He puttered around on the job for awhile, getting deeper in the hole every day. Then on a dark night he pulled out, taking with him a pair of horses which was about all the stock he had left. Tired and discouraged he drove into a little town and stopped in front of the store. The storekeeper came out. "Want a horse?" said the sub; "I'll trade him to you for goods." The storekeeper looked over the animals critically, and then said: "Wall, I'll trade ye in tobacco, plug fer plug."

Bats.

THE municipal bat roost of San Antonio, Texas, has proved a success, it is announced. It was started a year or so ago as a means for exterminating malarial mosquitoes. A roost with a capacity of 250,000 hangers-on was built and the bats were colonized. As a result the number of mosquitoes in the city has been appreciably reduced. The council has shown its appreciation of the protection by passing an ordinance prohibiting the killing of bats, and also has taken steps to secure the passage of a bill for state-wide bat protection. Thus is shown an appreciation of the fact that bats in the belfry are preferable to mosquitoes in the bed room.

Why Fords Go Up Stream.

PETER Peterson, the Puget Sound contractor, writes us that he was coming down the Skagit River a few days ago when he counted one hundred and fifty automobiles going up the river on the opposite bank. He asked a farmer what it meant. "Is there a fair or something?" "No," replied the farmer, adjusting his steel-rimmed specs., "them's Fords going up the river to spawn."

Simplicity of Expression.

OCCASIONALLY during dull seasons engineers proficient in railroad construction drift into temporary positions as track foremen in maintenance of way work. In these positions they are always dependable in rendering accurate time roll distributions for their monthly labor gangs. On one of the large trans-continental railroads, Harry Price, a former engineer, during one month inserted in column of the time roll distribution form an item of one half day laborer, indicating in column, "Nature of Work Performed," the following description, "Empounding Live Stock." Billy McCann, a finished veteran of twenty years, acting in similar capacity on an adjoining section, had a like item to distribute. McCann in his own true style impressively wrote, "One half day laborer, getting killed nag off of Rite of Weigh."

C. A. E., Los Angeles, Cal.

A New Figure?

POSSIBLY the planting of Canna lilies on the sprinkling filter bed of the sewage disposal plant at Harrison, N. Y., will furnish the rhetorician with a serviceable new figure of speech. To illustrate how good sometimes comes out of evil it has long been the custom to say "From out the swamp the lily grows." Perhaps the rhetorician will now ring the obvious changes in the old figure. A modern touch, with a generous admixture of classical allusions, is much appreciated by the progressive orator. Perhaps the engineer is now to get some advertising in commencement orations and Chautauqua lectures, not to mention sermons. If so the lilies of the bed will be doubly useful, even though they neither toil nor spin.

Where in Hell Is It?

A CERTAIN contractor who had been out of work for several months was approached by a friend who asked him if he believed in God. "No," replied the contractor. "Do you believe in heaven?" Again an emphatic no. Then you believe in hell, don't you?" "Well," responded the contractor, "I don't know, but business has gone somewheres."

H. C. M., Bishop, Cal.

Skinner Mulvey says: The proof of the pudding is the amount left on the plate. Big profits don't always come from big contracts.

CURRENT NEWS

The Doings of the Week.

Business activities, in general, were well sustained during the past week. In many lines fall activities opened auspiciously. Bank payments reflected a larger use of money, the totals for the week being a trifle larger than two years ago. International, political and financial matters appear to have assumed more favorable aspects. Higher prices for cotton and foreign orders for munitions were important features of the week. It is now expected that definite developments regarding the Anglo-French loan will result in the next few days. It is probable the loan will be for $500,000,000 instead of a billion as originally proposed. In the construction field there has been a slowing up of activities as indicated by the amount of new work reaching the call for bids stage. A good part of this, particularly as regards road and street improvements, is due to the approach of the cold weather season. Road and street construction, however, continue to furnish a considerable part of the advertised work. Municipal water works and sewer developments, especially for smaller cities, are still furnishing many bidding opportunities. Federal government work, however, is slack and no large jobs appear to have come up in the past week. The U. S. Reclamation Service has a considerable amount of excavation work that will be advertised from time to time this fall. A feature of the week in the Steel Trade was activity of the railroads in placing orders for future delivery. The New York Central Line is reported to have ordered 150,000 tons of rails for 1916 rolling. The Chicago, Burlington & Quincy R. R. placed orders for 20,000 tons, the Wheeling & Lake Erie for 22,000 tons and the Erie R. R. for 20,000 tons. Domestic orders for steel for manufacturing plant expansion included 1,500 tons for factory at Akron, O., for B. F. Goodrich Rubber Co.; 2,000 tons for Union Steel Co. at Canton, O.; 1,500 tons for the Shelby Steel Tube Co. at Ellwood, Pa., and 1,500 tons for an Armour factory at Chicago. The export orders included about 100,000 tons forgings and rolled steel for projectiles. New inquiries also were received for about 12,000,000 6 in. to 16 in. high explosive shells for delivery in 1916. The export business has caused an advance of $2 a ton on wire products. Domestic consumers of steel bars, in particular, are having trouble in getting deliveries. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Sept. 22 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Sept. 22. Cts.	Sept. 15. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia........	1.509	1.459
Iron bars, Pittsburgh..........	1.35	1.35
Iron bars, Chicago.............	1.35	1.25
Steel bars, Pittsburgh.........	1.35	1.35
Steel bars, New York...........	1.519	1.519
Tank plates, Pittsburgh.......	1.35	1.35
Tank plates, New York.......	1.519	1.519
Beams, etc., Pittsburgh......	1.35	1.35
Beams, etc., New York.......	1.519	1.519
Skelp, grooved steel, P'gh....	1.35	1.30
Skelp, sheared steel, P'gh....	1.40	1.35
Steel hoops, Pittsburgh.......	1.35	1.35
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.90	1.90
Galv. sheets, No. 28, P'gh....	3.50	3.60
Wire nails, Pittsburgh........	1.75	1.65
Cut nails, Pittsburgh.........	1.60	1.60
Fence wire, base, P'gh........	1.60	1.50
Barb wire, galv., P'gh.........	2.60	2.50

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.35c.

Railways.—Two encouraging developments of the past week in the railway situation were the decision of the Interstate Commerce Commission to re-open the Western rate case, and the activity of the carriers in placing orders for rails and equipment. From a construction standpoint, however, the past week was as quiet as the previous ones.

Roads and Streets.—None of the states, with the exception of Ohio, appear to have called for bids during the past week on any considerable amount of state highway work. Ohio opens bids Oct. 8 on several jobs. The Terrell Road District of Terrell, Tex., is calling for proposals on gravel macadam road construction to cost about $200,000. Bids will be opened Oct. 13 at Columbus, Miss., on about 51 miles of macadam roads for three road districts of Lowndes county. The county commissioners at Columbus, O., and at Canton, O., also are advertising several fair sized contracts. Four counties in Arizona decided to vote on bond issues aggregating $860,000 for highway construction. The University Park Realty Co., St. Louis, Mo., awarded a contract for 600,000 cu. yds. of grading. Marengo county, Alabama, let a $60,000 job; Los Angeles, Cal., let a $92,000 paving contract; Idaho State Highway Department awarded 26½ miles of highway construction in Bannock County; a $34,848 contract for two gravel roads in Henry Township was let by County Commissioners of Rochester, Ind.; Taylor, Tex., awarded a 120,000 sq. yd. paving contract to Uvalde Rock Asphalt Co., San Antonio, and the Kaw Paving Co., Topeka, Kan.; Philadelphia, Pa., opened bids on grading and paving work estimated to cost $350,000.

Bridges.—No particularly large bridge undertakings reached the call for bids stage during the past week. Proposals, however, are being asked on many small structures, mostly for counties.

Drainage and Irrigation.—Several fair-sized drainage and irrigation jobs came up for advertising during the past week. Osceola County, Ia., opens bids Oct. 4 on a river channel improvement requiring 217,000 cu. yds. of excavation; Victoria County Drainage District No. 3 of Texas, is asking bids on work calling for about 1,100,000 cu. yds. of excavation; Arcadia Drainage District of Arcadia, Fla., is calling for proposals on a job to cost about $24,000. The U. S. Reclamation Service opens bids Oct. 20 on 11 miles of the Ironstone Canal of the Uncompahgre Project, the work involving 209,000 cu. yds. excavation in open cut. The Twin Falls Canal Co., Twin Falls, Idaho, is asking bids on about 250,000 cu. yds. of excavation for its high line canal. The Sanitary District of Chicago opens bids Oct. 21 on Contract Sections 13 and 14 of the Calumet Sag channel, the work including 1,280,000 cu. yds. of excavation and 175,000 cu. yds. of concrete. Winston Bros. Co., Minneapolis, Minn., J. H. Flick Construction Co., Chicago, Ill., Kilpatrick Bros. & Collins, Beatrice, Nebr., and Fred M. Crane Co., Omaha, Neb., were low bidders on the four schedules of the Fort Laramie Canal work for the U. S. Reclamation canal.

Waterworks and Sewerage.—Bids are being asked on several contracts for furnishing pumps, pipe and other equipment. A number of smaller municipalities also are calling for proposals for new waterworks or for improvements to existing systems. Contracts let include a $23,400 system for Manchester, N. Y., and a $23,000 contract for a supply main at Covington, Ky. New sewerage construction advertised also is mostly for smaller cities. The contracts let include a $24,000 job for Centerville, Ia., and a $149,827 job for Kenosha, Wis. New sewer jobs coming up for bids include the following: Sewer system and disposal work for Mesa, Ariz., to cost about $70,000; sewer system for Edgewater, Colo., to cost $30,000; 4 miles of sewer and disposal works for South Bound Brook, N. J.; 3 miles of sewer for Minot, N. D.; 14,000 ft. of sewer for Algona, Ia., and sewer extensions for The Pas, Man.

Buildings.—Educational buildings are furnishing numerous bidding opportunities. The Ferro Concrete Construction Co. at $452,519 was low bidder on the East High School for Cincinnati, O. John T. Brady Co., 103 Park avenue, New York City, was awarded contract at $494,000 for New Westchester County (N. Y.) Court House. Boyajohn, Arnold Co., Portland, Ore., at $227,000, were low bidders for Oregon State buildings. Hodgins Construction Co., St. Paul, Minn., was awarded contract at about $400,000 for assembling plant at Oklahoma City for Ford Motor Co. Stone & Webster Engineering Corp., Boston, Mass., is reported to have secured contract for $1,000,000 terminal plant at Mobile, Ala., for Mobile Transfer & Storage Co. New work advertised includes: U. S. Postoffices at Merrill, Wis.; New Braumfels, Tex., and Seymour, Ind., a $100,000 city hall for Little Falls, N. Y.; a dormitory for the State College at Brookings, S. D.; a $100,000 building for the University of Oklahoma; a court house at Rock Rapids, Ia., and a $300,000 private building at Albany, N. Y.

The Floating Bidder.

Building contractors in certain sections of the country. especially those specializing in smaller educational and other public structures, have had more than their share of troubles this season. In the first place lettings have not been as abundant as could be wished. In the second place an unusually large number of the contracts have been awarded to irresponsible bidders. This is particularly true in the case of school houses. As these undertakings are publicly advertised any contractor or self-called contractor, if he can furnish the required certified check or bond, can submit a bid. As a result many of these jobs have been let at prices that predicated trouble for the contractor and the owner. The capable and responsible bidder has little chance in competing with the floating bidder who has his office under his hat and everything to gain and nothing to lose. The former usually has a definite idea of what he can do the work for and he figures his estimate accordingly. The latter, also, may know what the work should cost (more often he doesn't), but having nothing to lose, he is willing to take a chance, trusting to luck or to scamping to pull him through. Many public officials in their eagerness to get an improvement done cheaply, consider only the bidding price. To them the lowest bid is of more importance than the lowest responsible bidder.

Preliminary Bids on Paving.

An interesting method of securing price cutting in pavement construction was tried recently by the officials of a western city. The work was publicly advertised. In the official notice it was stated that the bids were to be preliminary ones and were asked for the purpose of obtaining information as to the costs of various types of pavement, so that the council could determine the amount to be expended and the yardages to be laid. As a further inducement it was stated that each bidder must give a bond with his bid as a guaranty that when the work was re-advertised he would submit the same price. The bids were to be opened and read in public. In view of these conditions it naturally would be thought that competition from contractors would be light. Nevertheless 12 bids were received, each accompanied by the required surety binding the bidder to submit the same bid at the new letting. The proposals were made public and after a due period the improvement was readvertised. New contractors entered the contest and knowing what their competitors' must bid were able to shade their prices, and thus secure the contracts.

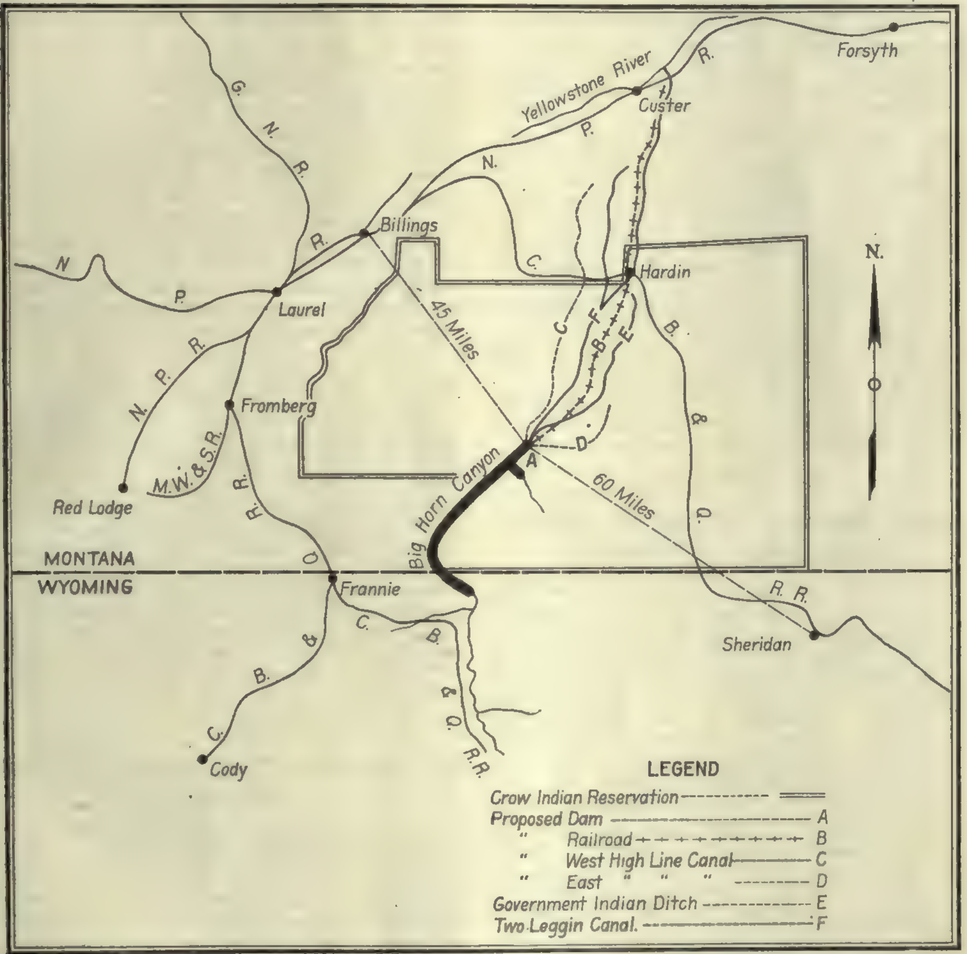
A $13,000,000 MONTANA DEVELOPMENT.

Power Plant, Irrigation System, 68-Mile Railroad.

Proposed by Big Horn Canyon Irrigation & Power Co.

A hydro-electric, irrigation and railway development, estimated roughly to cost $13,000,000, is proposed by the Big Horn Canyon Irrigation & Power Co. of Hardin, Mont. The project involves the construction of 68 miles of standard gage railroad from a point 3 miles east of Custer, Mont., to the mouth of Big Horn Canyon, the building of a dam and power plant in the canyon for the development of perhaps 150,000 HP. and the installation of an irrigation system for watering 100,000 acres of land.

Surveys for the railroad were started in March, 1913, and were completed in September of that year. The route passes within ½ mile of the Hardin, which is approximately half way between the two terminals. From Hardin north the line follows the heart of the valley passing through 32 miles of cultivated farm land. The southern half of the road, 36 miles in length, will run to a point 120 ft. above low water at the mouth of the canyon, and from here spurs will extend to the site of the projected dam. One bridge will be required over the Big Horn at a point about 8 miles south of Hardin. An 800-ft. tunnel also will be required. The total cost of the railroad is estimated at $800,000. Its construction is proposed for the purposes of serving the valley and to expedite the hauling of construction material for the power dam. About 35 per cent of the right of way already has been obtained.



Location of Proposed Works of Big Horn Canyon Irrigation and Power Co.

The site for the projected dam is located about ½ mile above the outlet of the canyon. At the point selected the canyon is narrow, the river flows between cliffs of limestone rising to a height of about 1,000 ft. It is proposed to construct a concrete dam of the circular arched type, 415 ft. high, with a base thickness of 400 ft. and a top thickness of 30 ft. This dam also would be used for raising water to irrigate 100,000 acres. The storage reservoir would be 49.7 miles in length. Diamond drill borings have been made at the site of the proposed dam. These showed solid limestone bedrock at depths ranging from 5 ft. to 15 ft. below the channel.

The irrigation feature of the development is not to be undertaken until the power plant is in operation. It is planned to obtain the water supply by means of tunnels a few hundred feet in length connecting into the reservoir at a level approximately 200 ft. above the river level at the mouth of the canyon. It thus will be possible to carry the water by gravity to about 90,000 acres of bench land on the west side of the river and to 10,000 acres of land on the east side. The first mentioned tract extends from the mouth of the canyon north to a point about 10 miles north of Hardin, and makes a strip about 43 miles long and from 3 miles to 4 miles wide. The tract on the east side is known as the Fort Smith bench. The irrigable land begins within ½ mile of the dam site. Surveys for the irrigation feature are not yet entirely completed.

Preliminary work on the Big Horn project has been under way for about 3 years, and the development is now ready for financing. The Big Horn Canyon, Irrigation & Power Co. was incorporated in 1912. John J. Harris, Hardin, Mont., is President, and A. W. F. Koch, Hardin, is Chief Engineer.

A monument to Lindon Wallace Bates Jr., the noted young engineer who lost his life on the Lusitania, will be built by his parents on the highest point of the Berkshires, near Pittsfield, Mass. This peak, 2,300 ft. above sea level, is on the Bates estate, and was the favorite retreat of the young man. The proposed monument is to be a shaft 115 ft. high, and will resemble the historic Pompey's pillar.

SECTIONS 13 AND 14, CALUMET SAG CHANNEL.

Bids for Construction Asked by Sanitary District of Chicago.

1,286,000 Cu. Yds. Excavation—175,000 Cu. Yds. Concrete.

Bids will be received by the Sanitary District of Chicago until Oct. 21, 1915, for the construction of Sections 13 and 14 of the Calumet-Sag Channel. These sections are the most easterly portion of the channel and involve the construction of many important auxiliary works such as controlling works, retaining walls and bridges. The quantities involved are very large and are here stated.

Section 14 is 1¼ miles long and extends from the controlling works, to be constructed under this contract at the Little Calumet River, to the eastern end of Section 13. The material to be excavated in Section 14 consists of 550,000 cu. yds. of glacial drift and 85,000 cu. yds. of rock. Both sides of the section for its full length are to be lined with gravity section concrete retaining walls. The amount of concrete in Section 14 is 87,000 cu. yds.

Section 13 is 1 mile long. It extends through the town of Blue Island. Both sides of this section are also lined for their full length with concrete retaining walls. The concrete to be placed on this section amounts to 85,000 cu. yds. The material to be excavated consists of 585,000 cu. yds. of glacial drift and 66,000 cu. yds. of rock. There is rock in the bottom of the section at practically all points. Thus the rock depth on both sections for long distances is about 4 ft. and this increases in places to 14 or 15 ft.

The normal width of the completed channel between faces of retaining walls is 63 ft. The top of the wall is at elevation +5. The channel grade is at about —21. The elevation of the natural ground surface along the line ranges from datum to about +10.

As stated, the controlling works are to be constructed at the east end of Section 14. These works consist of two pairs of sector gates opening into suitably shaped recesses in the retaining walls which line the channel. Normally these gates will stand open. They can be held in any intermediate position desired and can be used as locks when desired. The channel width at the locks is 50 ft. and the water depth is 24 ft. All the city sewers of the Calumet district, that is, south of 87th St., will discharge into this new channel just below the controlling works. A lie-by section 100 ft. wide and one-quarter mile long, will be constructed to permit the passing of large boats.

The channel will cross a number of railway tracks and the contract will include the construction of bridges to carry these steam railways across. At a point near the west end of Section 13 the channel will be crossed by the Grand Trunk and the Baltimore & Ohio Chicago Transfer tracks. These lines will require the construction of bridges for six tracks. Near the center of Section 13 the channel will be crossed by the Chicago, Rock Island & Pacific Railroad lines and bridges will be constructed for three tracks. The channel will also be crossed by six highway bridges and one foot bridge. The contractor is to erect four of the bridges required and is to both fabricate and erect the others. The amount of structural steel to be erected is 1,100 tons and the amount to be fabricated is 750 tons. Some of the concrete mentioned above is to be reinforced and a total of 350 tons of reinforcing steel will be required on the whole job.

The work is to be done under the protection of a levee at the east end to hold out the flood waters of the Little Calumet River. Stony Creek crosses Section 13 and will be flumed across the section during construction. This stream will eventually discharge into the channel.

The longest haul from one of the intersecting steam railroad lines to any point on the work will be about 1¾ miles. All spoil must be leveled. On Section 13 all the spoil will be spread on one side of the channel and will range from 250 to 300 ft. in width as leveled. Spoil will be leveled to a width of about 100 ft. on each side of Section 14 except at controlling works, where a great width will be leveled up to suit future requirements of the district at this point.

Contractors can bid on each section separately or on the two sections combined. The time limit is short—the work must be done by Jan. 1, 1918.

For these notes we are indebted to Mr. R. H. Burke, Division Engineer of the Sanitary District of Chicago, who is in immediate charge of this work.

Flood Abatement Project, Olean, N. Y.

A flood prevention development calling for an expenditure of nearly a quarter of a million dollars will be placed under construction soon at Olean, N. Y. The work will consist in deepening, straightening and generally cleaning out Olean Creek from its junction with the Alleghany River to a point about 2½ miles upstream, together with the construction of the necessary dikes and retaining walls on both banks of the creek. This protection work is designed to take care of flood conditions to an elevation of 3 ft. above the highest known water stage in the creek.

The north bank of the Alleghany River also will have to be diked east and west of its junction with Olean Creek for a total distance of about 4 miles. The elevation of the dikes along the river will provide for the control of flood waters to an elevation of 4 ft. above the highest known stage in the Alleghany River, which occurred during the same year as the Johnstown flood.

In connection with this dike protection it will be necessary to lay about 4,000 ft. of intercepting sewer parallel with and inside the dikes. This will carry approximately the entire sewage of the city and as the dike protection cuts off two creeks, one east and one west of the city, it will be necessary to install three small pumping stations to pump the creek water and sewage over the dikes during the high-water stage that occurs each year. It is also proposed to remove the Oliver Dam across Olean Creek and to lengthen the bridges on South Union St. and on State St. about 100 ft. each. The entire cost of the construction work is estimated at about $225,000. The city of Olean, N. Y., already has sold $150,000 of bonds to pay for its share of the work.

The engineering and inspection will be under the supervision of O'Connor & Chapman, Engineers, 100 State St., Albany, N. Y.

Status of Hetch-Hetchy Water Supply.

Good progress is being made with the preliminaries of the Hetch-Hetchy water supply development of the city of San Francisco, Cal. The next big contract to be let in connection with this improvement will be the building of a railroad from Rosasco to the dam site. This section will be about 67 miles in length and is estimated to cost $1,800,000. It will be used primarily for hauling construction material for the dam and other work. It is reported the contract for the railroad will be let in about 30 days.

Preliminary work on the Hetch-Hetchy project is now stated to be complete. The site of the reservoir is being cleared and the diversion tunnel for passing the waters of the Tuolumne River around the main dam site is being constructed. Designs have been made for the cyclopean masonry dam and plans have been prepared for the Moccasin Creek power house. In all about $2,000,000 has been expended for rights of way, surveys, roads, telephone lines and hydrographic work.

The Hetch-Hetchy development will be carried out under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

A 10,000,000-Bu. Grain Elevator at Chicago.

Plans will be submitted to contractors at an early date for a new grain elevator plant at South Chicago, Ill., for the Chicago & Northwestern Ry. The plant will be operated by the Armour Grain Co. and is to be one of the largest and most complete grain-handling and storage houses in the country.

The plant will comprise a working house of 1,000,000-bu. capacity, with facilities for receiving grain at the rate of 360 cars in 10 hours and for shipping to cars at the same rate. At the same time it will be arranged to dry 90,000 bus. of grain and bleach 240,000 bus. of oats in 10 hours. It also will have large clipping and cleaning capacities.

There will be a marine tower for receiving from vessels at the rate of 20,000 bus. per hour, and a river house equipped to ship to boats at a rate of 120,000 bus. of grain per hour, into a shipping gallery to carry grain out along the wharf for trimming the vessels after they have received the bulk of their load at the river house. Between the working house and the river house there will be a storage house, which will bring the ultimate storage capacity of the plant to approximately 10,000,000 bus.

All machinery will be electrically driven, power being supplied from a complete independent power plant of 4,700 HP. Water tube boilers and turbo-generators will be used. Complete facilities will be provided for collecting the dust caused by the handling and cleaning of the grain and for sacking the dust in loading in bulk. The other structures in the development include an independent office building for convenience of the operators, a welfare building for employes, a shop building and 1,200 ft. of wharf.

John S. Metcalf Co., 108 South La Salle St., Chicago, Ill., is the designing and consulting engineer for the elevator.

Nickel Plate R. R. Grade Crossing Elimination at Cleveland.

The west side grade crossing elimination work of the Nickel Plate R. R. at Cleveland, O., mentioned in our last issue was started on Sept. 1. The project calls for the elimination of 25 grade crossings from Fulton Road to Detroit Ave., a distance of about 2½ miles. It involves depression of tracks, construction of 4-track roadbed, 13 highway bridges and approaches and other miscellaneous work. The bridges will be of reinforced concrete construction and there also will be numerous retaining walls. The approximate quantities of material include 1,600 tons of steel and 43,000 cu. yds. of concrete. There also will be 750,000 cu. yds. of excavation and 25,000 cu. yds. of fill in street approaches. The approximate cost is $2,900,000. The work is being done by company forces under the direction of A. J. Himes, Cleveland, Engineer of Grade Crossing Elimination for New York, Chicago & St. Louis (Nickel Plate) R. R.

Progress on $65,000,000 Union Terminal, Chicago.

The Union Station Co. of Chicago, Ill., has applied to the Illinois Public Utilities Commission for an order authorizing the issuance of $50,000,000 of first mortgage 4½ per cent gold bonds. This is the company building the new union terminal at Chicago for the Pennsylvania and other railroads now using the present union station. Construction work was started some months ago on several features of the development.

Perhaps the most important work now under way is the freight house to be erected at Polk St. The contract for the foundations for this structure was let some time ago to the Blome-Sinek Co., Chicago, and the work is now well advanced. The contract for the structural steel was awarded to Thompson-Starrett Co., Chicago.

The building will be a steel frame structure, fireproofed with concrete and brick curtain walls, and will rest on a pile and concrete foundation. The plans and specifications for the freight house are not yet complete and it will be some little time before the general contract is let.

Construction work is now being carried out for sewers and for other minor work for the new union terminal. The latest work advertised by the company called for the improvement of Canal St., from Madison St. to alley south of Monroe St., and Monroe St., from Canal to Clinton, by raising grade and laying granite blocks. Bids for this work were opened Sept. 22.

Reinforced Concrete Bridge in Carmi Township, Illinois.

A fair-sized bridge job in Carmi Township, White County, Illinois, is now ready for bids. The work calls for the construction of a reinforced concrete structure over the Little Wabash River at Main St. It will consist of five reinforced concrete spans of 55 ft. each, with an 18-ft. roadway and a 6-ft. walk. The height over all will be 42 ft. Piles will be of plain concrete and abutments of reinforced concrete. The estimated quantities are as follows: Reinforced concrete, Class A, 1185.4 cu. yds.; plain concrete, Class B, 705 cu. yds.; reinforcing steel, 192,375 lbs.; cast iron rockers and steel plates, 6,918 lbs.

The nearest railroad station is Carmi, ½ mile from the site. Sand and stone are reported available at Carmi at $1.10½ per cubic yard. Haul to bridge site is ¼ mile on hard road. Green timber for false work can be cut 1½ miles from bridge site. The present structure consists of two steel spans each 130 ft. long. Low water flow is 18 ins. deep; high water flow 36 ft. Excavation will be in clay, shale and loose rock to extend 2 ft. below stream bed to sandstone foundations in all cases except the south abutment, which is founded above stream bed. The engineer's estimate is $22,600. Plans and specifications were prepared by the Illinois State Highway Commission, Springfield, Ill. Bids will be received at the office of the County Clerk, Carmi, Ill., until 1:30 p. m., Oct. 5. George H. Brown, Carmi, Ill., is County Superintendent of Highways.

A $1,500,000 Coal Pier at Baltimore, Maryland.

The directors of the Baltimore & Ohio R. R. on Sept. 16 authorized the erection of a new coal pier at the Curtis Bay terminal at Baltimore, Md. The pier will cost approximately $1,500,000 and will have a capacity of 10,000,000 tons a year. It will be one of the largest yet built and will provide enlarged facilities for the port of Baltimore.

It is estimated that it will require 18 months to build the pier. Work on the improvement will be commenced as soon as contracts can be let.

The pier was designed by Francis Lee Stuart, chief engineer of the Baltimore & Ohio R. R. The plans embody a number of features for rapid loading of vessels and reducing breakage of coal to a minimum in handling shipments from cars into vessels. The pier will be of steel construction and will be fireproof thrughout. There will be two car dumpers inshore, built in units and equipped with rapid moving belts leading to movable towers on the pier which load into vessels on either side, or the entire loading capacity can be directed to one vessel.

The pier will be 700 ft. long by 115 ft. wide. The car dumper will be capable of handling cars 53 ft. long and of unloading 40 100-ton cars an hour. The belts for conveying the coal will be run at speeds of from 250 ft. to 500 ft. a minute.

Hangars for U. S. Navy.

The Federal Government is calling for bids for the construction of three hangars at the U. S. Navy Aeronautic Station, Pensacola, Fla. They will be steel-framed sheds with flat roofs, and will have a frontage of 72 ft. center to center of columns and a depth of 100 ft. center to center of end columns. From the longitudinal center line of the floor to the underside of the roof trusses is 20½ ft. The sides of the sheds and gables are to be covered with asbestos corrugated sheathing fastened to the steel frame. The roofing will be built of asbestos roofing laid upon wood sheathing. The ends of the hangars are to have openings 20 ft. high and not less than 60 ft. wide, fitted with accordion or auditorium doors, hung on ball-bearing, swiveled trolleys traveling on the lower chords of the end roof trusses. There will be concrete floors, which will be laid under another contract. Bids for the hangars will be received until 11 a. m., Oct. 16, by Bureau Yards and Docks, Navy Department, Washington, D. C.

PERSONALS

Mr. A. Kempkey, consulting engineer, announces the removal of his offices to the sixteenth floor of the Hobart building, San Francisco, Cal.

Mr. James N. Gladding has been appointed city engineer of El Paso, Texas. Mr. Gladding has been city engineer of Albuquerque, N. M., since October, 1906. He is a graduate of the Massachusetts Institute of Technology, mechanical and civil engineering courses, class of 1906.

Mr. Charles J. McDonough, who for two years past has been division engineer of the New York State Highway Department, in charge of Division No. 6, with headquarters at Syracuse, has been transferred to Division No. 9, with headquarters in Buffalo. Division Engineer William M. Acheson, who has been in the Buffalo office, will succeed Mr. McDonough at Syracuse.

Mr. E. Lippe has opened an office as consulting engineer at Room 618 Crilly building, 35 S. Dearborn street, Chicago. Mechanical and electrical equipment of buildings are his specialties. His past experience includes engineering work on the Singer Tower, New York; La Salle Hotel, Chicago; the Robert Simpson Co., Ltd., building, Regina, Sask., and the Ely Walker Co. building, St. Louis, Mo. Mr. Lippe has been instructor to steam and electrical engineers, heating and plumbing fitters in several of the technical night schools of Chicago. He has written several books and articles on heating and ventilating subjects.

Announcement is made of the formation of the firm of Beardsley, Dougan & Beardsley, engineers and contractors, with offices in the Macbain building, Roanoke, Va. The firm will specialize in hydroelectric development work, land and topographic survey and maps, preliminary surveys and estimates for proposed railways, superintendence and engineering construction work in general. The members of the firm are Mr. W. D. Beardsley, Mr. F. A. Beardsley and Mr. J. A. Dongan. Mr. Dongan has had considerable experience as superintendent of concrete work on railway construction and hydroelectric development. He was formerly connected with D. W. Flickner of Roanoke, also with Gibbs & Hill, the Appalachian Power Co., Bluefield, W. Va., and the Parker Brooks Construction Co. of Macon, Ga., for whom he has handled construction work. The Beardsleys both acquired their technical training at Rensselaer Polytechnic Institute, Troy, N. Y. Mr. W. D. Beardsley had had a good deal of practical experience prior to and during his college course. Upon leaving the Institute in 1911, both went to work for the firm of Viele, Blackwell & Buck of New York, and were employed on field work on hydroelectric construction in Virginia and Canada. The new firm is at present engaged in building a concrete-lined two-compartment reservoir for the city of Covington, Va.

CONTRACTORS.

The Moore-Sieg Construction Co. of Waterloo, Iowa, who was awarded the contract for installing the new sewer system at Decorah, Iowa, as announced in our Contract News of last week, is a newly organized firm, though its members have been in the contracting field for some years. Mr. S. D. Moore, the president of the company, organized and for five years was president of the Black Hawk Construction Co., doing a general contracting business in Iowa, Minnesota, Dakota and Nebraska, and specializing in concrete buildings, but incidentally doing a considerable amount of sewer and water work. The business expanded so rapidly as to become unwieldy and in February, 1915, Mr. Moore sold his interest to Mr. G. F. Scales, who had been secretary and manager of the building department. Mr. Moore then, with Mr. W. R. Sieg, who had been chief engineer and manager of the sewer and water department of the Black Hawk Company, organized the Moore-Sieg Company to engage in sewer and water works construction and paving. The new firm bought from the Black Hawk Construction Co., all of the equipment, good will, etc., pertaining to the sewer and water works department of the business. Mr. Sieg is secretary and treasurer of the firm. Mr. L. A. Moore is vice-president and is also president and manager of Moore & Moore, Inc., who operate a line of retail lumber yards in Iowa. Mr. F. C. Young, formerly of the Western Construction Co. of Iowa City, is manager of the paving department.

The sewer department of the Black Hawk Construction Co., from 1910 to 1914, put in jobs at Chamberlain, S. D.; Waseca and New Ulm, Minn.; Waterloo, Independence, Waverly, Cedar Falls, Sumner, Dewitt, Fort Dodge, Cherokee, Alden, Ames and other towns in Iowa. Since the organization of the Moore-Sieg Construction Co. in February, it has done water and sewer work in Iowa Falls, McGregor, Mason City, Fort Dodge, Cherokee, Ames, Storm Lake and Rockwell City, Iowa, and paving and curb work in Storm Lake, Cherokee and Guthrie Center, Iowa.

The present contract at Decorah calls for the construction of two miles of main sewer, $14,557; 11 miles of lateral sewer, $69,135; septic tanks, filter and outlet, $18,001; total, $101,693. Extra rock excavation amounts to about $10,000.

OBITUARIES

Samuel Todd Davis, Jr., president of the Locomobile Company of America, whose death was announced in our issue of September 15, was a civil engineer, graduate of Rensselaer Polytechnic Institute of Troy, N. Y., class of 1895. He was president of that class, and received other class honors. After leaving college he became associated with Amzi Barber, later his father-in-law, and formed the Trinidad Lake Asphalt Co. at Port au Spain, Trinidad. For several years Mr. Davis resided on that island as assistant general manager of the company. He was manager of the Locomobile Company from its founding in 1899 by Mr. Barber, and has been president since 1907. He was actively interested in the development of the motor car, and was founder and first president of the National Association of Automobile Manufacturers, which later became the Automobile Chamber of Commerce.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces an examination for the position of Ship Draftsman in the Bureau of Construction and Repair, Navy Department. Salary $3.28 to $5.04 per diem; Oct. 13-14.

Examinations will be held in St. Paul, for residents of St. Paul only, for the following positions:

Water Works Designing and Construction Engineer, $250 per month; minimum age 25; five years' experience in water works engineering required. Oct. 1.

Engineering assistant, testing laboratories. Oct. 5.

Civil Engineering Draftsman, $50 to $100 per month. Oct. 22.

Junior Civil Engineer. Oct. 22.

On November 10, an examination will be given to residents of the State of New Jersey to fill several vacancies in the engineering corps of the State Department of Health. The title of the examination is "Examination for Assistant Sanitary Engineer." Persons interested should communicate with Gardner Colby, New Jersey State Civil Service Commission, State House, Trenton, N. J.

INDUSTRIAL NOTES

The Gardner Governor Co., Quincy, Ill., has an interesting exhibit at the 10th annual foundry and machine exhibition which is being held at Atlantic City, N. J., from Sept. 25th to Oct. 1.

Mr. W. E. Hardy, for the past 11 years connected with the Diamond Rubber Co. and the B. F. Goodrich Co., and lately in charge of the sales of their mechanical rubber goods division, has lately been appointed Sales Manager of the Boston Belting Co., Boston, Mass., manufacturers of mechanical rubber goods.

The Terry & Tench Co., Inc., New York City, has lately secured an order from the Harlan-Hollingsworth Corp., for two more ship yard cranes, such as were built for them in Wilmington a couple of years ago.

Mr. W. H. P. Fisher has been appointed Sales Manager of the L. M. Booth Co., New York City, manufacturers of the Booth Water Softener and engineers and contractors for water purification plants.

The Marsh-Capron Manufacturing Co. of Chicago has transferred its general offices from the quarters which it has occupied for several years in the Old Colony Bldg. to a suite on the 14th floor of the recently completed Lumber Exchange Bldg. at 11 South LaSalle St., Chicago. The move was made partly with the object of securing more commodious and thoroughly modern quarters in order to better take care of the rapidly increasing business of the company; and partly for the sake of the improved location which is directly in the center of Chicago's contracting activities and consequently much more easily accessible to those desiring to call.

NEW CATALOGUES

Locomotives and Engines.—Paper, folder. W. A. Zelnicker Supply Co., St. Louis.

Zelnicker's Bulletin No. 178, listing the second-hand equipment now on the market. Includes locomotives and engines for various industrial uses, rails and tank cars.

Truck Tires.—Paper, 3¼x6 ins.; 16 pp. The B. F. Goodrich Company, Akron, Ohio.

"Upsetting Mileage Tradition" is the title of this booklet, which gives information and actual service statistics relative to the new De Luxe type of tire for motor trucks. Illustrated. (This new tire was described in our issue of July 21.)

CATALOGUE REVIEWS

Deep Wells for Irrigation Pumping.—Paper, 7½x10½ ins.; 40 pp. The American Well Works, Aurora, Ill.

Bulletin 141, "Methods of Constructing Large Capacity Deep Wells for Irrigation Pumping in the Great Plains," contains much information and interesting reading matter. The introduction briefly relates the history of early experiments along this line, and the success of the deep wells put down for irrigation purposes in the Texas Panhandle.

The methods of sinking and developing these wells and the equipment required are described in detail and photographs of the work and the tools are included.

RAILWAYS

BIDS ASKED.

New York:

New York, N. Y.—Until Oct. 26, by Public Service Commission, for First District, for station finish construction on new Utrecht Ave. elevated railroad in Brooklyn.

New York, N. Y.—Until Oct. 15, by Public Service Commission, for First District, for portion "C" of ballast contract for new Rapid Transit Lines. This portion covers about 80,000 cu. yds. of trap rock or hard limestone.

PROSPECTIVE WORK.

Arkansas:

Melbourne, Ark.—Surveys are to be started this month for proposed electric railway from Guion to Melbourne. A. C. Veach of Gravette, Ark., is promoter.

California:

San Francisco, Cal.—It is reported that contract will be let within a month for constructing 67 miles of railroad to site of Hetch-Hetchy Reservoir. Work will cost about $1,800,000, and will be done for city. M. M. O'Shaughnessy is City Engineer.

Colorado:

Durango, Colo.—Denver & Rio Grande Ry., according to report, is to at once broad gage its line into Durango from a point south of Alamosa.

Illinois:

Chicago, Ill.—Chicago Union Station Co. has asked the Public Utilities Commission for order authorizing issuance of $50,000,000 of first mortgage gold bonds for construction of new union terminal in Chicago.

Indiana:

Fort Wayne, Ind.—Board of Works has granted Pennsylvania R. R. extension of time for filing of plans for grade separations east of Calhoun St.

Tifton, Ind.—Lake Erie & Western R. R. will expend about $50,000 for extending its west yards.

Kentucky:

Somerset, Ky.—The Queen & Crescent Ry. is making surveys for double track from Somerset to Flat Rock. Survey has also been made for similar work from Tateville to Greenwood.

Missouri:

Nevada, Mo.—Financial representatives and construction engineers have been over surveyed route of proposed Nevada & Lebanon R. R. W. A. Thompson is promoter.

New Jersey:

Morristown, N. J.—New Jersey & Pennsylvania Railroad, a 24-mile line, has been purchased at a court sale by J. Irving Demarest of Sewaren, N. J., for $23,500. New owner operates a quarry 2 miles from the railroad.

New York:

New York, N. Y.—Public Service Commission for First District will call for bids in a few weeks for the construction of the tunnel section of the 14th St.-Eastern line. This tunnel is to extend under East River from 14th St., Manhattan, to N. 7th St., Brooklyn.

North Carolina:

Sanford, N. C.—Seaboard Air Line Ry. is reported to plan expenditure of about $200,000 for revision of line and grades between Sanford and Apex, N. C.

North Dakota:

Jamestown, N. D.—Midland Continental, according to reports, may extend its line from Wimbledon to Grand Forks this year.

Ohio:

Cleveland, O.—River Terminal Ry. Co. has applied to State Utilities Commission for permission to sell $1,000,000 worth of stock. Part of this sum is to be used to pay for the right of way and tracking already constructed, remainder to be used for additional track, etc.

Cleveland, O.—New York, Chicago & St. Louis R. R. (Nickel Plate) started work Sept. 1 with company forces on elimination of 25 grade crossings in this city. Approximate cost of work will be $2,900,000. A. J. Himes, Cleveland, is engineer grade crossing elimination for railroad.

Oklahoma:

Miami, Okla.—Final surveys are reported under way for Oklahoma Interstate Ry., proposing a line connecting Columbus and Galena, Kan., with Baxter Springs and Miami and other Oklahoma towns. Practically all right of way is reported to have been secured. John R. Rose, Oklahoma City, is President.

Clinton, Okla.—Stockholders of Clinton, Oklahoma & Western R. R. are reported to have authorized construction of southeast extension of the line.

Pennsylvania:

Phoenixville, Pa.—The Philadelphia & Reading Ry. is reported to have started work on enlarging the Phoenixville tunnel. The tunnel is 1,900 ft. in length.

Washington:

Klickitat, Wash.—Construction is to be resumed on Klickitat Northern Ry. The line will extend from Klickitat 12 miles into the interior, and will be a branch of the Spokane, Portland & Seattle Ry., of which A. N. Lupfer of Portland, Ore., is Chief Engineer.

Wyoming:

Laramie, Wyo.—Engineering work is under way for extension of Colorado, Wyoming & Eastern Ry. from Northgate to Elk River and thence to Yampa River. J. M. Herbert, Laramie, is President.

BIDS OPENED; CONTRACTS LET

Connecticut:

Hartford, Conn.—Lathrop & Shea, New Haven, reported to have been awarded contract by the Connecticut Co., for grading for new North and Trolley line, in Hartford.

Iowa:

Waterloo, Ia.—T. F. Leake & Co., Chicago, Ill., have been awarded contract for improvements and additions to shop of Illinois Central Ry. at this place. About $181,000 is to be expended.

Missouri:

Kansas City, Mo.—Metropolitan Street Railway Co. is reported to have awarded contract to Columbia Construction Co., Milwaukee, Wis., for about 38,935 ft. of extension to cost about $500,000. Work includes single and double track line on various streets in the city.

New York:

New York, N. Y.—Public Service Commission for First District, has authorized New York Municipal Railway Corporation to award contract for furnishing structural steel for third tracking of Myrtle Ave. elevated railroad between Broadway and Wyckoff Ave., Brooklyn, to Phoenix Bridge Co., at $40.50 per net ton.

Oklahoma:

Beaver, Okla.—Beaver Construction Co. has contract for completion of Beaver, Mead & Englewood R. R. Co., proposing line from Forgan south to Beaver. The grade already has been completed. There will be two small frame 14-ft. bridges on mud sills and one 350-ft. bridge on piling. J. H. Morgan is President of construction company. L. A. Walten is Engineer in charge.

Pennsylvania:

Indiana, Pa.—Andrews Co. has work under way grading for new railroad spur between Yellow Creek and Heilwood.

ROADS STREETS

BIDS ASKED.

Arizona:

Phoenix, Ariz.—Until 5 p. m., Oct. 5, by C. A. Thompson, Superintendent of Streets, for paving Madison St. with bitulithic.

California:

Bakersfield, Cal.—Until 11 a. m., Oct. 7, by I. L. Miller, Clerk, County Supervisors, for 6 miles of concrete pavement on Bakersfield-McKittrick Road.

Los Angeles, Cal.—Until 2 p. m., Oct. 11, by H. J. Lelande, Clerk, County Supervisors, for work in Road District No. 3, involving 17,500 sq. yds. of bituminous surfaced concrete paving.

Los Angeles, Cal.—Until 2 p. m., Oct. 11, by H. J. Lelande, Clerk, County Supervisors, for improvement of portion of Harbor Truck Blvd., work including 8,600 cu. yds. of excavation, 24,797 tons of granite in paving and shoulders; 16,000 tons of granite already furnished in place to be spread, rolled and watered.

Bakersfield, Cal.—Until 10:30 a. m., Oct. 7, by I. L. Miller, Clerk, County Supervisors, for 5 miles concrete pavement on Weed Patch Loop Road.

Colorado:

Lamar, Colo.—Until noon, Oct. 11, by L. M. Markham, County Clerk, for grading and surfacing with gravel or shale certain portions of the Santa Fe Trail.

District of Columbia:

Washington, D. C.—Until 11 a. m., Sept. 30, by Depot Quartermaster, U. S. Army, for paving, grading and construction of coal vaults at the Walter Reed General Hospital.

Florida:

Pensacola, Fla.—Until Oct. 17, by City Commissioners, for three blocks of paving around new hospital. Estimated cost, $10,000. L. Earle Thornton, City Engineer.

Indiana:

Winamac, Ind.—Until Oct. 5, by County Commissioners, for Reinholdt Gravel Road in Tippecanoe Twp., to be 3 miles in length and to cost about $9,231. C. E. Paul, County Surveyor.

Jasper, Ind.—Until 2 p. m., Oct. 5, J. H. Seng, County Auditor, for furnishing two 8-ft. cut road graders with engine and tongue hitch.

Logansport, Ind.—Until Oct. 19, by Board of Works, for paving on Erie Ave., W. Broadway, Wheatland Ave., Linden Ave. and Race St. H. H. Thompson, City Engineer.

Columbia City, Ind.—Until 1 p. m., Nov. 5, by T. A. McLaughlin, county auditor, for road on Whitley-Noble County line

Columbia City, Ind.—Until 2:30 p. m., Nov. 5, by T. A. McLaughlin, County Auditor, for three highways in Smith Twp.

New Albany, Ind.—Until 10 a. m., Oct. 14, by J. C. Miller, County Auditor, for 2 miles of road in New Albany Twp.

Shoals, Ind.—Until 10 a. m., Oct. 11, by L. D. Haga, County Auditor, for road in Halbert Twp.

Bloomfield, Ind.—Until 2 p. m., Oct. 5, by G. E. Kidd, County Auditor, for macadam road in Central and Highland Twps.

Vincennes, Ind.—Until 2 p. m., Oct. 5, by J. I. Muentzer, County Auditor, for gravel roads in Washington, Palmyra and Steen Twps.

Iowa:

Des Moines, Ia.—Until 9 a. m., Oct. 6, by Horace Susong, City Clerk, for about 6,200 sq. yds. of paving; sheet asphalt, brick, vertical fiber, bithulithic and other materials will be considered.

Cedar Rapids, Ia.—Until 10 a. m., Oct. 1, by L. J. Storey, City Clerk, for paving "B" Ave. Bridge with creosoted block, vitrified brick, sheet asphalt, or vertical fibre brick.

Kansas:

Kansas City, Kan.—Until Oct. 5, by Commissioners, according to reports, for 6 in. concrete pavement on Argentine Drive.

Maryland:

Easton, Md.—Until noon, Oct. 5, by Frank W. Seth, County Roads Engineer, for 1,800 ft. of concrete, macadam or shell highway construction.

Michigan:

Brighton, Mich.—Until 2 p. m., Oct. 11, by Burt Beurmann, Highway Commissioner, Genoa Twp., for 6¾ miles of trunk line road on Grand River Road in Genoa Twp.

Minnesota:

Buffalo, Minn.—Until Oct. 4, by Village Clerk, for grading Lake Shore Road.

Duluth, Minn.—Until 11 a. m., Oct. 5, by Commissioner of Public Works, for grading and paving on Third Ave. east.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

H. P. Gillette　C. S. Hill　C. T. Murray　S. C. Hadden　C. W. Malcolm　C. R. Thomas

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The Contractor's Timekeeper.

In general we are content to judge the value of a particular kind of work by the rate of pay which it commands. After this rate has become somewhat standardized it often is difficult for us to realize that changing conditions may have so affected the duties and requirements of a position that a radical revision of rates is justifiable.

We believe that contractors have not generally recognized the value to an organization of an efficient timekeeper. In the past, when contracting firms were less complex, and when all the work was done under the personal direction and supervision of a member of the organization, the duties of the timekeepr were simple and merely clerical in nature. This condition no longer exists, and a large percentage of construction work is now done by organizations maintaining offices and working forces in widely separated parts of the country. The heads of such organizations no longer give personal attention to all the details of the work—often they are known only by sight by their superintendents and foremen, and generally they are entirely unknown to the workmen. Under existing conditions the position of timekeeper is one of great importance. The holder of such a position exercises greater influence, either for good or evil, than is generally recognized. As guardian of the pay roll his duties frequently bring him into personal contact with every man employed on a particular job. He can do more to promote good will and encourage fair dealing on the part of the workmen than any representative of the organization. In fact the general reputation of a firm for fairness or unfairness is often built up largely by the timekeepers in its employ.

Although the truth of these statements can hardly be denied, the salaries paid to timekeepers by many firms is far too low to attract really competent men. Too often the position is held by young men who merely use it as a stepping stone to something considered better—better simply because it commands a higher salary. If contractors were alert to their best interests they would no longer consider the timekeeper as an apprentice, who is learning at their expense only to leave them when he becomes of real value, but as a permanent member of the organization, retained because of his personality, his experience and his knowledge of men and of values. The most successful contractors—those who have proper regard for the human element as a factor in success—are making the position of timekeeper an attractive one, but there are still many who, judging from the rate of pay, underestimate its value.

The Interstate Commerce Commission —Its Organization and Work.

A full knowledge of the facts, and the ability to reason correctly from these facts, are absolutely necessary if one is to offer just criticism of any project or of any public body. If the facts are withheld for reasons unknown to the public then a public body is largely to blame if its actions are misunderstood, or are viewed with suspicion. Within the past year the Interstate Commerce Commission has been criticised very generally, both by those connected with the railroads and by those who have most to gain by a reduction of railroad rates. Much of this criticism has not been pertinent and might have been forestalled had the facts been more readily apparent. Some of it has undoubtedly been presented from selfish motives. In some cases the commission has been held responsible for most of the ills with which *some* of the railroads are now afflicted. In general it has been difficult for engineers to form definite and correct opinions, largely because the witnesses on one side only have been heard. We are glad to present, elsewhere in this issue, the commission's views on this important question, as expressed by Mr. E. E. Clark, a member of the commission, before the National Industrial Traffic League. Some of the statements of Mr. Clark will here be considered briefly.

In a discussion of what constitutes a reasonable rate—an exceedingly important question, and a debatable one—Mr. Clark said:

> It cannot be determined solely by the cost of the service, because the cost, plus a reasonable profit, might, as to some commodities, be prohibitive. It cannot be measured alone by the value of the service, because that would open the way for the railway to absorb, as to some traffic, the profits that legitimately belong to the shipper. It cannot be ascertained from a consideration of distance only, because so to do would destroy competition between producing fields and in common markets. In the last analysis it is a question of judgment, and, very properly, the judgment that finally controls is that of a disinterested, impartial tribunal, whose decisions must be made only in the light of full hearings and proper investigations, and are, as to matters of law, reviewable in the courts.

The courts have laid down the principle that the carrier is entitled to a reasonable return upon the property devoted to the public use, and the law guarantees the owners of railways against confiscation of their properties, and Mr. Clark argued that the value of the property should be determined, not by figuring a return upon the outstanding bonds and stocks, but by an official and dependable valuation of railway properties. He readily conceded that the law which was adopted for this purpose is exhaustive and requires the performance of a vast amount of detail work and the determination of many vexed and vastly important questions in a field where no one has blazed the path.

In taking exception to the view of those who think that if the railroads in a particular section of the country can, as a whole, show their net return from operation is unduly low they all should be permitted to increase their charges, Mr. Clark said:

> If all of these roads had been constructed, financed and operated on business principles and as business concerns, and the net results of their operation showed an improperly low return, I would find no difficulty in accepting the view that they were justly entitled to such increases in their charges as would render their operations profitable. But in such a case the tribunal that authorized such an increase should also have the power to fix the minimum rate, so that the burden might not be inequitably distributed. * * * The carrier is entitled to earn a profit from legitimate enterprise and effort, but when it comes to increasing rates in general, or upon an important part of the traffic, I find difficulty in accepting the theory that because certain roads are in financial straits all roads in that section may properly increase their rates, when the greater number of those roads have for a series of years been able, under existing rates, to maintain their properties in splendid condition, pay all fixed charges and taxes, declare each year handsome dividends upon their stocks and carry rather liberal sums to their surplus accounts.

Mr. Clark suggested some changes in the law and in its administration, and in speaking of the alleged need for a reorganization of the commission said:

> The commission has given much thought to this subject and to the various plans that have been suggested for simplifying and expediting the work of the commission, and has reached the conclusion that the largest measure of relief and the best results would be secured by enlarging the membership of the commission and authorizing it to divide itself into groups or divisions, each division to have and exercise all the powers of the commission in the matters or cases referred to it. * * * Personally, I feel that the valuation work is of such magnitude and importance and of such a technical nature that a commission or a division of the commission should give its undivided attention to the new and intricate problems which will arise in numbers as the work progresses, and especially as the time for fixing upon a valuation approaches.

We believe that increased attention to the valuation work is essential if the commission's valuation is to stand as a just and equitable one. With the present organization there is danger of hurried and incomplete work. Director Prouty originally set Jan. 1, 1920, as the date for the completion of the field work, and, based on recent progress, it is believed the work can be completed by that time. In June of this year 3,870 miles of line were covered by the federal roadway and track valuation parties, and in July the mileage covered was 4,060. On Sept. 1, 1915, the roadway and track parties had completed the inventory of about 30,000 miles of road and 40,000 miles of track. Field work has been completed and tentative reports have been prepared on a number of roads, including the Texas Midland, the New Orleans, Texas & Mexico, the San Pedro, Los Angeles & Salt Lake, and the Atlanta, Birmingham & Atlantic. Among the larger roads on which roadway and track parties are now engaged are the Boston & Maine, 6 parties; the New York, New Haven & Hartford, 3 parties; the Big Four, 5 parties; the Pere Marquette, 4 parties; the Illinois Central, 4 parties; the Chicago, Rock Island & Pacific, 8 parties; the Great Northern, 8 parties, and the Chicago, Milwaukee & St. Paul, 4 parties. With the experience already gained as a guide the valuation work is being systematized, but it is of such magnitude and importance that the organization of a separate division of the commission to take entire charge of it seems clearly advisable.

The Miracle of World Wide Telephony

Five weeks ago we wrote of "The Miracle of Nation Wide Telephony." Since then another epochal achievement makes it possible to substitute "world" for "nation." Again the engineers of the Bell telephone system have astonished mankind. Six months ago they enabled us to talk from the Pacific to the Atlantic coast by wire. A week ago they performed the same feat by wire plus wireless, and the day following they announced that they had talked by wireless across the continent and beyond to Hawaii—a distance of 4,600 miles.

Mr. John J. Carty, chief engineer of the American Telephone & Telegraph Co., and his staff of engineers have invented apparatus by which the human voice leaps, as it were, from the lips along a telephone wire and then springs into space, until it reaches a wireless telephone receiver thousands of miles away. The new device will not supplant the existing telephone plant, but will supplement and extend its field to such an extent that world wide telephony is now attainable, if, indeed, it may not be said to have been attained.

While others are commenting editorially upon this astonishing achievement, viewed purely as a step in electrical progress, let us consider it from the point of view of the sociologist or political scientist. To us it seems worthy of special note that this last great stride in telephonic service is attributable not to the engineers of the government owned telephoned systems of Europe, but to the engineers of a privately owned telephone system of America. In the recent past there has been some talk of the purchase of the great Bell system by the federal government, and, in support of such a plan, English, French and German experience has been cited. Let us examine the foreign "exhibit," as the lawyers say.

In all these European telephone organizations that are owned by governments we find not a single instance of progress in the art of telephony. This is not merely fortuitous. It points directly at an underlying cause. Americans have no monopoly in brains. Remember that it was an Italian who perfected wireless telegraphy. But Americans engaged in the development of railways and public utilities have had almost a monopoly of freedom—and that is the underlying difference between such enterprises here and in Europe. Government ownership is, in its effect upon initiative, akin to slavery. It may be in some cases no worse than the slavery of "red tape," but usually it is the slavery that men in the mass inevitably impose upon individual daring and genius. It was not Vail, the postoffice employe, who accomplished great things. It was Vail, the president of the Bell companies, who, as general, stood back of his great corps of engineers and made it possible for them to prove their greatness. History, we think, is practically barren of records of any notable advance in any art or science attributable to the employes of any government. Certainly this is true of telegraphy, telephony, railroading and other public utility enterprises.

It is conceivable that Uncle Sam might profitably invest a billion dollars in the purchase of the Bell system, but it would be a profit dearly bought in the end, for the real price would be cessation of economic progress.

We have at hand an exhibit filed in a recent rate hearing before the Public Service Commission of Pennsylvania, in which it was shown that the yearly payment for Bell telephone service by the average telephone subscriber station was $93.28 in 1894 and $37.66 in 1913. The price for telephone service has steadily and rapidly declined in Pennsylvania, as it has in every other state, because advances in the science and business of telephony have made possible new economies. The public has shared in these economies to such an extent that the public may be truthfully said to have secured for itself nearly all the saving effected by the telephone companies. This is one of the astonishing things that the general public knows nothing about. But it is one of those facts that will go a long way toward checking the drift toward government ownership when its significance is grasped.

Genius rebuffs the yoke of government,
Moves not, by goad and less by common
greed,
Rebels at 'straints, yet pulls a galley stroke
Be but the barge its own and its last dock
A narrow slip in Fame's harbor of renown.

WATER WORKS

The Valuation of Water Works Properties.

VI. Appraisal of Development Cost or Going Value and Franchise Value.

By Halbert P. Gillette.

For convenience in appraising property it is customary to divide it into two broad classes: (1) Physical or tangible property; and (2) non-physical or intangible property. The terms physical and tangible, when used in this connection, are presumed to denote the plant itself—the things that can be seen, felt or otherwise sensed. Whereas the terms non-physical and intangible are presumed to denote the items of property that cannot be physically sensed, but whose cost or value is either a matter of record or calculation.

It is important to realize, however, that many of the items of physical or tangible cost are quite as non-physical or intangible as those commonly classed as non-physical. Thus after a plant has been built there is no physical thing in the plant that can be designated as "interest during construction," or as "cost of construction accounting," or as "cost of engineering," which are all regarded as parts of the total physical cost. These are quite as non-physical or intangible in fact as the "cost of attaching the business," which is classed as intangible. Hence the terms physical and non-physical, tangible and intangible, at bottom denote no fundamental difference in the costs or values to which they relate, but are merely convenient expressions for classifying costs or values, which classification each appraiser adopts rather arbitrarily for his purposes, but in which few appraisers are consistent with their own theories. Men are so commonly deceived by words that it is not unusual to find engineers, public utility commissioners and judges floundering in a morass of quibble as to whether a given item of cost or value should be classed as "tangible" or "intangible." In truth no cost is either physical or tangible except in relation to the money with which it was paid for. Mental services relate to things that affect the senses, but once such services have been performed and paid for no tangible substance may remain to indicate the fact. It is pure sophistry, therefore, to argue that the service rendered by a timekeeper on construction work is a whit more entitled to be called tangible than is the service of a man who attaches customers to a plant by soliciting or advertising.

What is true of costs in this regard is equally true of values. The *value* of a plant that produces goods or services is the present worth, or capitalized value, of its prospective net earnings. Now this value may be arbitrarily split into several parts or classes, but no segregation can be justified save on the ground of convenience or for purposes of comparison. Thus the value of a farm is the present worth of its prospective net earnings. Having established that value, we may then estimate the cost of the buildings and other improvements, and deduct estimated depreciation therefrom to get "depreciated value" of the improvements. Then we may deduct this "depreciated value" of improvements from the total value of the farm and call the remainder the value of the land. Yet without any improvements land is frequently almost valueless. This is strikingly evident in the case of irrigated land. Clearly in such cases the total value exists by virtue of a combination of several elements, and any segregation of the total value into parts is, after all, defensible only on the ground of convenience and for comparison. It is also significant that banks refuse to lend money on unimproved property.

Similarly in the case of a water works plant its *value* is the present worth of its prospective net earnings. We may, if we choose, deduct the estimated "depreciated value" of the plant from the total value and call the remainder "franchise value," or "going concern value," or what not; but let us not fancy for a moment that either the "depreciated value" of the physical plant or the "franchise value" are really separate values capable of existing in the absence of one another.

A few utility commissions have used "depreciated value" of physical property as a base for rates, and in explaining their action have said that such a value itself implies recognition of a going concern. So it does, but it fails to imply *full* recognition. To allow even $1 of appraised value in excess of the salvage or scrap value of the plant would be some recognition—a dollar's worth of recognition—of the existence of a going concern value. To allow the difference between scrap value and "depreciated value" involves a still further recognition of a going concern, but it is the rankest sophistry to infer that in so doing a full and fair recognition has been given either to going cost or going value.

The decisions of the courts are far from being concordant on the question of the so-called non-physical or intangible costs or values. There are several reasons for this, but a careful study of the decisions of all the leading cases has convinced me that no court, not even the United States Supreme Court, has ever yet had placed before it, in evidence or in argument, a clear statement of two exceedingly important distinctions, namely: (1) the distinction between cost and value; and (2) the distinction between a condition of "agency" and a condition of "competition" in public utility affairs. If a public utility company were a public agent in the fullest degree, and had it always been an agent, the so-called "value" of the utility property would be its actual cost, including therein all deficits in fair return on its investment. But if a public utility company has not been a public agent in the fullest degree, if it has been subject to actual or potential competition in the past, and if it faces such competition in the future, then the "value" of its property is true value—the present worth or capitalized value of its prospective net earnings. This competitive condition has existed, at least in part, in the past for nearly all public utilities, and only recently has the new agency theory evolved.

In the attempt to span the gap between the old condition and the new theory, courts, commissions and engineers have again and again attempted to mix the unmixable—costs and values. Nowhere have they made worse muss than in discussions of the so-called "non-physical values." The terms used have added to the confusion. Thus the Wisconsin Railroad Commission's term "going value" relates to a cost and not to a value at all. It should therefore be called "going cost" if the word "going" is to be used. The Washington Public Service Commission still acts under a law that enjoins them to find the fair "market value" of utility properties, but they actually find no such thing. They usually have determined the cost of reproduction new and have added something thereto—no one has ever said just what it is that was added, nor how estimated —and the total is called "market value."

In the third article of this series (July 7) I defined "cost" as being money outlays, debits incurred, proprietary losses of normal income, and proprietary compensation for risks involved in production.

In the fifth article (Sept. 1) I defined the value of any *part* of complex plant thus: Assuming gross income to be unchanged by substituting an alternative part in a plant, the value of any part is the first cost of its most economic alternative plus the capitalized difference in their respective annual operating expenses.

It will be well now to define the value of a property that is expected to produce goods or services.

The value of a property that will produce marketable goods or services is the present worth or capitalized value of its prospective net earnings.

By "net earnings" is here meant the balance left after deducting operating expenses, depreciation annuities and taxes from gross operating revenue. Interest charges, whether on notes or on bonds, should not be regarded as an operating expense or a charge to be deducted in order to arrive at net earnings.

In the second article of this series (June 2) and in another article on depreciation (July 14, 1915) I have discussed briefly the process of "capitalizing prospective net earnings" by dividing them by a rate of interest. I may add to the precautions there named a further precaution: If there is to be a limit to the duration of the prospective income because of the expiration of a franchise, or for other reasons, a franchise sinking fund annuity must be calculated and deducted from the average or "equated" net earnings. The remainder is then to be capitalized at the fair return rate. Ordinary bond sinking funds should not enter the problem at all.

Intangible cost is the cost involved in attaching business to a plant.

Intangible value is that part of the total value (deduced by capitalizing prospective net earnings) remaining after deducting the tangible or physical value from the total.

Intangible cost is given various names, such as "development cost," "development expense," "going cost," "going value," "going concern value," "cost of establishing the business," etc.

Intangible value is also given various names, such as "franchise value," "going concern value" (occasionally abbreviated to "going value"), "good will," etc.

Since some terms like "going concern value" are used by some people to mean intangible *cost,* whereas other people use the same terms to mean intangible *value,* no end of confusion and illogical reasoning results.

"The franchise value" of a public utility corresponds to the "good will" of a business that is not operated under a franchise, for both are dependent on prospective net earnings. There is, however, such a thing as "franchise cost," which is the cost of securing a franchise. This has no necessary relation to the value of the franchise.

With the exception of a recent decision of the Supreme Court of New Jersey the courts for many years past have been in accord in rejecting "franchise value" as a part of the appraised total used as a base for rate-making. On the other hand "franchise value" has been uniformly sustained in appraisals for tax cases and in most condemnation cases. I need not enter into the details of calculating the "franchise value" or "good will value," for the methods are relatively simple and quite generally understood. I have pointed out the main precautions to be taken to avoid error. But as there are several methods of estimating intangible costs it will be well to discuss these at some length.

There are two commonly used methods of estimating going or development cost: (1) The deficit method as applied to the actual plant investment, income and expenses; (2) the deficit method as applied to a hypothetical projected new plant, the construction of which is supposed to start at the time of the appraisal and its customers subsequently attached until its net revenue equals that of the existing plant, but without competing with the existing plant. The first of these methods is often called the historical or Wisconsin method. The second is often called the Alvord method.

I now propose a third deficit method, which resembles the Alvord method except in that it is assumed that the new hypothetical plant must compete with the existing plant.

Each of these three deficit methods makes the going or development cost a sequel to "interest during construction," for the deficit is the deficiency in a fair interest return on the investment. Each method compounds the interest on the deficit. The interest rate used is a "fair return rate," which is a subject reserved for the tenth article of this series.

It will be seen that the historical or Wisconsin method of deriving the development or going cost logically associates this cost with the actual cost of the physical plant and not with the estimated cost of reproducing it under present conditions. The Alvord method, however, was devised to secure a development cost that could logically be associated with the cost of reproduction of plant under recent past and immediately prospective conditions. However, I think it falls short of accomplishing this end, and for that reason I have proposed the third method.

The advocates of appraising the cost of reproducing the physical plant under recent past or prospective conditions, and of assigning a functional as well as a natural depreciation, have apparently not realized that in essence they were proposing to set up an *alternative* plant as a criterion by which to judge the value of the existing plant. But even if they have clearly seen this implication they have not seen its corollary, to wit: If a new *alternative plant* is set up as a criterion of the worth of the existing old plant, then a new *alternative business* must also be estimated to attach to the new alternative plant. But a new alternative business can be secured only by *competing* with the old existing plant.

I grant that to establish business under such a competitive condition will cost far more than under the Alvord theory, and that the Alvord method therefore gives an irreducible minimum, if present and prospective conditions are assumed. But I object to the claim that the Alvord method is wholly consistent with the "cost of reproduction method." An alternative plant spells competition, and therefore a business built up under competition and not under the ideal condition assumed in the Alvord method.

TABLE I.—DEVELOPMENT COST BY THE ALVORD METHOD.

	Old plant			New plant					
Year.	Gross revenue.	Operating expense.	Net earnings.	Gross revenue.	Operating expense.	Net earnings.	Total difference.	Present worth factor (6%).	Net difference.
1914...............	$24,000	$14,000	$ 7,800	.....	$ 6,000	—$ 6,000	$13,800		
		2,200*					2,700†		
		$16.200					$11,100	$0.9434	$10,470
1915...............	26,800	14,400	12,400	$12,000	10,000	2,000	10,400	0.8900	9,260
1916...............	28,100	14,600	13,500	20,600	12,400	8,200	5,300	0.8396	4,450
1917...............	29,500	14,800	14,700	26,500	13,900	12,600	2,100	0.7921	1,660
1918...............	30,900	14,900	16,000	30,000	14,700	15,300	700	0,7473	520
1919...............	32,200	15,000	16,200	32,200	15,000	16,200	......	0.7050	......
Development cost............									$26,360

*Depreciation differential. †Interest during construction previously allowed under reproduction of physical plant.

Street railways, electric interurbans, steam railways, telephone lines and even water works have been built to compete with existing plants. They have in every case encountered very great development cost, often so great as to make the new properties dismal failures. This is strikingly seen in the so-called "independent telephone companies," whose development cost has usually been ruinous to them. Such alternative plants may have been built because their promoters assumed that lower plant costs could be had than were actually incurred by the old Bell plants. But the promoters failed to estimate their probable development or going cost under competitive conditions. Could an assumption of the Alvord method conditions have been realized in practice the consequent low development cost might have justified the building of "independent telephone" systems. But practice and theory failed to meet there, as they fail to meet anywhere when it is assumed that a new alternative plant can be built to serve a community habituated to use the existing old plant, yet without engaging in a competitive fight for business with the existing plant. In other words, while I can conceive the ideal conditions of the Alvord method, and while I grant that those conditions yield a low development or going cost, my mind refuses to admit that the Alvord method is fully concordant with any reproduction method of estimating the cost of physical properties.

Reverting for the moment to the competition of new utility plants with existing old plants I may add that while promoters of the new plants—whether they be public officials or individuals in private life—often plan a *small* new plant designed to skim only the cream of the utility business in a given locality. When this is done certainly the old company should be left free to meet such unfair competition by any legal means that it may adopt. In brief, its hands should not be tied by a commission. Of course the rational way under public regulation is to prohibit this sort of competition.

The Alvord Method.—For a complete discussion of this method of estimating development cost the reader is referred to a paper read before the American Society of Civil Engineers by Metcalf and Alvord entitled "The Going Value of Water Works." The paper was reprinted in ENGINEERING AND CONTRACTING March 29, 1911.

In Table I, I give a recent application of this method to a water works that served about 8,000 people in the year 1914. The investment in the plant alone was about $100,000 exclusive of overhead costs. Its gross revenue and operating expense for 1914 are given in the table as $24,000 and $14,000 respectively, and after deducting an estimated depreciation correction for that year the net earnings were $7,800. Construction of the hypothetical new plant was assumed to begin and end in 1914, and result in a $6,000 operating expense (organization of staff, soliciting business, etc.), with no income from operation.

The business of the old plant was assumed to continue its previous rate of growth for five years, and that of the hypothetical plant was assumed to overtake that of the old plant in 1919. The eighth column, "Total Difference," is found by subtracting the net earnings of the new plant from those of the old plant. The items in the eighth column are multiplied by the "present worth factor" in the ninth column to get the "net difference" in the tenth column—that is, the present amount (in 1914) of the difference in net earnings between the old and the new plants. The "present worth factor" is taken from a compound interest table, such as that on page 12 of my "Handbook of Cost Data." The development cost by the Alvord method is thus calculated to be $26,360 in this case. This $26,360 was added to *depreciated* value of the old plant.

The Wisconsin Method.—The Wisconsin method was applied to this same water works, as far back as the accounting records were available, and the result is shown in Table III. The original nucleus of the plant was built in 1885, but it had passed through a receivership and no accounting records back of 1900 were available. In such a case it might at first appear impracticable to apply the Wisconsin method, but it is possible to approximate quite closely to the development cost incurred during the period for which the annual earnings and operating expenses are available. Thus the reproduction new cost of the plant, less overhead charges and land values, was about $100,000 as of Jan. 1, 1914. Overhead charges were eliminated, for those that had been charged did not appear in the ledger plant account, but in operating expense. The second column in Table II was arrived at by deducting successively the yearly additions to plant, recorded in the ledgers, starting with $100,000 as the base in 1914. Thus it was established that the plant investment was $76,200 as that of Jan. 1, 1900. The gross earnings and operating expenses (in round numbers) were set up in columns 3 and 4, from which the "apparent net earnings" in column 5 were deduced. The "apparent expense" includes taxes and current maintenance but includes no depreciation fund annuity.

Table III starts with the $76,200 property investment derived from Table II, and column 4 of Table III is the same as column 5 of Table II. An 8 per cent "fair return rate" was assumed, and $76,200 multiplied by 8 per cent gave $6,100 (in round numbers), which was entered in column 3, Table III. Since the net earnings were only $3,500, there was a deficit of $2,600 below the fair return of $6,100, so this deficit was entered in column 5. During 1914 plant additions of $1,000 were made, as shown in the sixth column. Hence if we add this $1,000 and the deficit of $2,600 to the $76,200 we have a total property cost of $79,800 as of Dec. 31, 1900, or as of Jan. 1, 1901. Accordingly this $79,800 is entered in the second column opposite 1901, and the same sort of calculations is made for 1901 as for 1900. Thus the table is built up, resulting in a development cost of $50,370 for this plant during the 15-year period. How much more it was prior thereto no one knew, but it was scarcely worth inquiring into in this case, for here already was a development cost equal to nearly half the physical cost. It is true that this $50,370 includes those overhead costs (on the $23,000 of plant additions) which were improperly charged to operating expense from 1900 to 1914. But this may be readily estimated and deducted. The most important thing to note is that the development cost thus deduced should be added to the cost *new* of the physical plant and not to its *depreciated* value. The reason for this is that the operating expenses include no depreciation annuity, hence no provision for the accrued depreciation existing in the old plant. Were an adequate depreciation annuity included in operating expenses each year from the time the plant was built down to date, it should be at least sufficient to build up a depreciation fund equal to the accrued depreciation. And were this done the development cost would be increased by exactly the amount of the depreciation fund. Had that been done, then the resulting development cost would be properly added to the depreciated value of the plant to get the total investment in "tangible" and "intangible" property.

TABLE II.—PLANT INVESTMENT AND EARNINGS.

Year.	Plant, Jan. 1.	Gross earnings.	Apparent expense.	Apparent net earnings.
1900.....	$ 76,200	$13,000	$ 9,500	$ 3,500
1901.....	77,200	13,800	10,700	3,100
1902.....	77,900	13,500	10,000	3,500
1903.....	79,100	14,200	9,800	4,400
1904.....	81,500	15,200	10,400	4,800
1905.....	82,800	15,700	10,000	5,700
1906.....	85,300	17,600	12,100	5,500
1907.....	87,200	18,300	15,100	3,200
1908.....	88,300	18,400	14,400	4,000
1909.....	91,300	19,900	15,000	4,900
1910.....	93,500	20,700	13,900	6,800
1911.....	96,800	21,800	14,900	6,900
1912.....	98,300	22,400	16,100	6,300
1913.....	99,000	23,900	14,500	9,400
1914.....	100,000	24,000	14,000	10,000
Total.	$1,314,400	....	....	$82,000

An article on "Development Cost" in ENGINEERING AND CONTRACTING, June 26, 1912, gives a long reprint of one of my appraisal reports in which are outlined many of the details to be considered in applying the Wisconsin method. I had worked out these details prior to the decision of the Wisconsin Railroad Commission (Hill vs. Antigo Water Co., 3 W. R. C. R. 623), in which they first adopted what is now styled the Wisconsin method of determining "going value." But prior to that other engineers had suggested and applied the same method. In fact this deficit method is prescribed in a contract between the city of New York and the Empire City Subway Company dated May 15, 1891, from which I quote:

> The said party of the second part shall, at any time after Jan. 1, 1897, upon demand of the commissioners of the Sinking Fund in the City of New York * * * sell, assign, transfer, convey and set over to the Mayor, Aldermen and commonality of said city the subways, conduits and ducts constructed by it, as aforesaid, * * * and other property * * * upon payment of the actual cost thereof; and if the said company shall not have earned ten per cent per annum on actual cost during the terms of this contract a further payment shall be made in addition to the cost not exceeding ten per cent on such cost to the extent of such deficiency in annual earnings, or such less sum as may be agreed upon.

Doubtless older contracts of this nature exist.

Below I quote from a decision of the Federal Court rendered in 1904, in which the Wisconsin method was repudiated by the court five years before it was adopted in Wisconsin. It is interesting to note the false reasoning used by the court in repudiating the deficit method. The court says:

> The company may have purchased a plant larger and more expensive than necessary; the current rates of interest may have been abnormally high; many causes which have absolutely no relation to the value [typographical emphasis mine] of the company's business now as a going concern may have increased or diminished the deficiency in revenue. [165 Fed., 657 (C. C. W. D., Cal., 1904).]

Note how the court slips from a discussion of cost into a discussion of value. A deficit in fair return is a *cost*, and it not only may not but actually does not have any necessary relation to the *value*, for the latter depends entirely on capitalized prospective net earnings. The court falsely sets up a criterion of value as a way of discrediting an actual cost, yet the court does not thereupon conclude to adopt value (capitalized net earnings) as the appraisal base. This sort of sophistry is met on every hand. I rarely go on the witness stand that I am not cross-questioned by attorneys who attempt to discredit a given *cost* by showing that it has no commensurate *value*. Yet they repudiate entirely the use of value (capitalized net earnings) as a rate-making base. In such cases if the appraiser has a clear conception of the distinction between cost and value, no great difficulty is found in making the distinction clear to the commission or court.

I believe that both "going cost" and "franchise value" should be presented for consideration, but that they should be kept entirely distinct.

COURT AND COMMISSION DECISIONS.

There are a great number of decisions on intangible costs and values. It is important to differentiate between those rendered in tax cases, those in condemnation cases, and those in rate cases. The following decisions relate mainly to the Wisconsin method of determining development or going cost. For the most part these quotations are arranged chronologically:

> Two of the experts estimated the value of the going business to be equal to the total amount by which the current rates of interest exceeded the net profits of the business prior to 1880. In other words, the value of the going business is equal to the cost of establishing the Spring Valley Water Company's business originally, and that cost is equal to the deficiency of revenue prior to 1880. This estimate is open to the objection that the deficiency of revenue may have been due to extravagant or wasteful management. The Company may have purchased a plant larger and more expensive than necessary; the current rates of interest may have been abnormally high; many causes which have absolutely no relation to the value of the Company's business now as a going concern may have increased or diminished the deficiency in revenue. Furthermore, if it be conceded that early deficiency of revenue is the proper measure of value, for the going business, then it follows that, the greater the deficiency and the more unprofitable the business, the greater the present value of the going concern; and, if the business had yielded large profits from its very inception, the going business today would be worthless. [Spring Valley Water Co. vs. City and County of San Francisco et al., 165 Fed., 657 (C. C. W. D., Cal., 1904).]

> The net earnings of a producing plant are a more significant test of its value than the gross earnings. It was also proper for the Commission to pay regard to the fact that the plaintiff had an established business, built up after experiments and changes during the long period. [Norwich Gas & Elec. Co. vs. City of Norwich, 76 Conn., 565; 57 Atl., 746 (1904).]

> It would seem that the value of an established business for rate fixing purposes is not as equitably represented by either its capitalized net earnings or by the present worth in the excess in the earnings of an old plant having an established business, over those of a new plant starting without business, during such period as may be required by the new plant to obtain the same amount of business as that of the old plant, as by the actual net cost of building up this business. In fact, it appears that the value of the business alone, for rate making purposes, is best measured by its net cost to the investor. * * * This cost, when it exists, may be said to constitute the going value of a plant, and would seem to include all the elements that can be equitably considered in that connection. [Hill vs. Antigo Water Co., 3 W. R. C. R., 623 (Wisconsin, 1909).]

TABLE III.—DEVELOPMENT COST BY THE WISCONSIN METHOD.

Year.	Property, Jan. 1.	8% fair return.	Apparent net earnings.	Deficit.	Plant additions.
1900...	$ 76,200	$ 6,100	$ 3,500	$ 2,600	$1,000
1901...	79,800	6,400	3,100	3,300	700
1902...	83,800	6,700	3,500	3,200	1,200
1903...	88,200	7,060	4,400	2,660	2,300
1904...	93,160	7,450	4,800	2,650	1,300
1905...	97,110	7,770	5,700	2,070	2,500
1906...	101,680	8,130	5,500	2,630	1,900
1907...	106,210	8,500	3,200	5,300	1,100
1908...	112,610	9,010	4,000	5,010	3,000
1909...	120,620	9,650	4,900	4,750	2,200
1910...	127,570	10,200	6,800	3,400	3,300
1911...	134,270	10,750	6,900	3,850	1,500
1912...	139,620	11,170	6,300	4,870	700
1913...	145,190	11,610	9,400	2,210	1,000
1914...	148,400	11,870	10,000	1,870	.....
Development cost, including overhead charges on the $23,000 additions to plant from year 1900 to 1914..............				$50,370	

The above cited case is the first decision of the Wisconsin Railroad Commission specifically stating their belief in the deficit method of calculating going value. Their next important decision on this point was the case of the City of Appleton vs. Appleton Water Works Co., 5 W. R. C. R. 215 (1910). They have subsequently confirmed these decisions by many others.

> An established railroad system may be worth more than its original cost and more than the mere cost of its physical reproduction. * * * It has attained a position after many experiments common to railroad enterprises which entail loss in cost not paid from current earnings, and which correspondingly make for value. [Mo. K. & T. Railway Co. vs. Love, 177 Fed., 496 (1910).]

> The difference between a dead plant and a live one is a real value, and is independent of any franchise to go on, or any mere good will as between such a plant and its customers. * * * That there is a difference between even the cost of duplication, less depreciation of the elements making up the Water Company's plant, and the commercial value of the business as a going concern, is evident. [Omaha vs. Omaha Water Co., 218 U. S., 180; 30 Sup. Ct., 615, 54 L. Ed., 991 (1910).]

There are two solutions. One is to capitalize the losses or deficiencies below a fair rate and all the other elements which are said to be included in going concern. The other is to charge all such expenses to operation, to attempt to make no fine-spun distinctions and then to permit the Company to charge in later years rates sufficient to offset its deficiencies below a fair return in the first few years. [Queensboro Gas & Elec. Co. Case (June 23, 1911), New York Commission, First District.]

Whether going value should constitute an addition to the cost new of the property, or to the value in its present [or depreciated] condition, is a matter which must be decided largely on the circumstances in each individual case, or, rather, cost of reproduction new, physical value in present condition, original investment, and going value, are all elements to be considered in ascertaining the actual value of the property. [Application Oconto City Water Supply Co., 7 W. R. C. R., 497 (1911).]

The inconvertible evidence in this case discloses that appellant's plant for the year preceding the first hearing failed to produce revenue sufficient for operating expenses; current repair, and lay aside an amount for depreciation. During the time of development there is a loss of money actually expended and of dividends upon the property invested. [The Pioneer Telephone & Telegraph Co. vs. Westonhaver and State of Oklahoma, 29 Okla., 429; 118 Pac., 324, 38 L. R. A., U. S., 1209 (1911).]

The court comments favorably in the above case upon the Wisconsin method of calculating going value.

The going concern value will then be largely represented by the cost of developing the business as distinct from the cost of securing the physical structure. This going concern value may include the cost of soliciting business, cost of advertising, cost of inducing consumers to take service, cost of occasional free installation, and also the dearth of adequate returns during the early development. [Passaic Gas Case, New Jersey Public Service Commission, Dec. 26, 1912.]

The problem involved in the question of allowance for initial operating deficit, or what is more generally described as cost of securing going concern value, is far more difficult of solution. It is the reasonable contention of petitioner that upon completion of its facilities, under the most favorable conditions, it cannot anticipate business and resulting revenue sufficient to pay operating expenses, care for depreciation, and make a return upon the capital invested. That on the other hand, it must anticipate a deficit of the amount by which its earnings failed to meet this adequate return; that this deficit constitutes the cost of building up the business of the concern; that in their totality they must be contributed by the stockholders; that it forms an integral part of the investment, and may as justly be capitalized as capital contributed for the creation of the physical facilities; as loss of interest during the period of construction. * * * In view of the condition with which common experience shows practically every public utility is confronted in acquiring business in the early months of its operations we believe that the best interests of both the corporation and the rate paying public will be served by allowing a reasonable sum to be added to capital in the first instance to meet the cost of acquiring business. [Application of Northern Michigan Power Co. for authority to issue stocks and bonds. Michigan Railroad Commission, 1913.]

The cost of a gas plant includes not merely the loss of interest while the plant is in course of construction and is building up a paying business, but even in the case of an old established plant, for the manufacture and distribution of a commodity to the use of which the public has become so accustomed that it seems a necessity, there must be loss while pipe lines are extended to await the coming of consumers as the city extends. * * * [The Court cites other items such as cost of securing customers, cost of experiments, obsolescence not covered by current expenses, etc.] The legal question is whether these items constitute a going value upon which the company is entitled to a return if the individual rate is to be just and reasonable. To this we answer Yes. [Passaic Gas Case Opinion, Supt. Court of New Jersey (New Jersey, July, 1913).]

In the light of these two general principles it appears just and reasonable that a fair present day estimate of cost necessarily and judiciously sunk in establishing the business and not thereafter recouped from revenue should enter as an element into the base upon which a fair return should be allowed. [Gately & Hurley vs. Delaware & Atlantic Telegraph & Telephone Co., New Jersey Commission, 1913.]

While there is undoubtedly some merit in the contention that values must sometimes be recognized in the cost of business development, it is certainly manifest that to authorize a corporation to capitalize its losses over a period of 10 years would lead inevitably to conclusions that could not be reconciled with the principles of sound finance. [Application (No. 498) of Cloverdale Light & Power Co., California Commission, 1913.]

We believe that there is no constitutional rule nor any equitable reason requiring an appraisal of the entire expense of building up all of the business connected with a utility property, in a valuation of the same, upon the strict reproductive cost basis, but that much weight should be given to the amount which the building up of such business, in the way it has actually been built, has actually cost the owners of the property, either in money originally invested by them or in returns not received upon their investment in early years. [Sale of Berlin Electric Light Co. to Twin State Gas & Electric Co., New Hampshire Commission, 1913.]

Making proper allowance for the matters just considered and perhaps for others which do not occur to me, I define going value for rate purposes as involved in this case to be the amount equal to the deficiency of net earnings, below a fair return on the actual investment due solely to the time and expenditures reasonably necessary and proper to the development of the business and property to its present stage, and not comprised in the valuation of the physical property. [People ex rel. Kings County Lighting Co. vs. Wilcox et al., New York Court of Appeals, 141 N. Y. Sup., 677 (1914).]

Should the Government today take note of that surplus for the purpose either of so reducing the rates of the company that no earnings can be made upon this much of the property, or with a view to in some sense turn that surplus back again into the hands of the public? During all this period the excess has gone into the property, which has gradualy become more valuable, and this increased value has reflected itself in the market price of the securities of that company. It is impossible to restore what has been improperly taken in the way of excessive rates to those persons from whom it has been received. The Government, under those circumstances, cannot lay hold on this surplus as a fund held in trust for the public. [Spokane vs. Northern Pacific Railway Co. (1909), 15 I. C. C. R., 376.]

The foregoing is taken from the decision of Commissioner Prouty bearing upon the claim of the City of Spokane that surplus earnings in excess of a fair interest rate do not belong to a railway, but to the public.

It is the opinion of the Commission that this expresses fairly the importance of going concern value as a factor in a Company's valuation. It cannot be said arbitrarily that any given percentage on the valuation of the tangible property should, in all cases, be allowed, but the whole past history of the Company must be examined to discover whether there actually is any net unrequited cost of developing the business which should now be capitalized in order that the Company may secure a fair return. [John H. McMurray et al. vs. Bridgeport Gas Light Co., Conn. Public Service Commission, 1914.]

The Connecticut commission above quoted cites the decision of Justice Miller in the Kings County Light case and approves his definition of going value.

The California commission in a recent decision, Town of Antioch vs. Pacific Gas & Electric Co., decision No. 1655, condemns estimates of going value based upon hypothetical data and affirms its belief in allowance for going value based upon the actual deficits incurred. It cites its decision in the City of Palo Alto vs. Palo Alto Gas Co., also its decision No. 1534 in the case of Thomas Monahan vs. San Jose Water Co. Likewise quotes from the Wisconsin Railroad Commission decision in the City of Milwaukee vs. Milwaukee Railroad & Electric Light Co. (10 W. R. C. R. 1). Also it quotes the decision of Mr. Justice Miller in People vs. Wilcox, 141 N. Y. S. 677, apparently approving his definition of going value.

In addition we have to calculate something for developing the business and bringing the plant up into a going concern. This is enjoined upon us by the Court of Appeals in the so-called Kings County Case (141 N. Y. Sup., 677). [Application of the Federal Telephone & Telegraph Co., New York Public Service Commission, Second District, Aug. 4, 1914.]

The Public Service Commission of Indiana in the case of City of Richmond, Ind., vs. Richmond City Water Works, decided June 20, 1914, apparently endorses the Wisconsin method of calculating going value and assigns a small going value of $25,000 to a property whose total appraised valuation is $750,000.

Utilizing Hydraulic Principles to Locate a Leak in a Submerged Pipe.

(Staff Abstract.)

The detection and location of leaks in submerged pipe lines supplying islands or areas isolated from the main distribution system by rivers or channels is a problem in water works operation requiring special treatment. Detection of leakage on such lines is comparatively simple, but the location of the same is an entirely different matter. Any of the usual means of measurement fitted for the size of main, with perhaps special arrangement for large mains, will determine the presence and size of leakage if simultaneous readings are taken on both sides of the stream.

Several points should be noted which have a bearing on the problem of leak location and which affect the method to be used for such location. Owing to the expense attached to the examination and repair of submerged pipes, it is not worth while to do anything with them unless the amount of water going to waste is worth more than the probable expense of making repairs, or unless the pressures in the area supplied are materially reduced, or serious damage is anticipated from a continuation of the leakage.

In general, the above considerations would limit the complete investigation to leaks of such size as would make applicable the following method which has been used in New York City on a 12-in. crossing from Rikers Island to North Brothers Island and is considered sufficiently successful to warrant making preparations for use on other river crossings.

Where the velocity of water in a main due to the leak is 2 ft. per second, a perfectly good gradient consisting of two distinct slopes can be obtained. At the point where the slope of gradient changes is the point where the velocity changes and hence where the waste occurs.

To determine this gradient it is necessary to have the pipe coefficient as accurately as possible, to have the quantity of the flow on the supply and the discharge ends of the submarine pipe, the pressures and elevations at which pressures were taken on both ends, and the distance between pressure points. Flow measurements and pressures ought to be taken simultaneously. Pressure gages should be accurate and of such graduation as easily to estimate to tenths of pounds.

LOCATING LEAK IN 12-IN. LINE BETWEEN RIKERS AND NORTH BROTHERS ISLAND, NEW YORK CITY.

The specific case of the above mentioned crossing between Rikers and North Brothers Island will best illustrate the method.

Some time during the month of July, 1914, a decided drop in pressure on North Brothers Island was reported to the Department of Water Supply and an urgent request was made to have conditions improved. The district repair gang found after valve operation that the trouble was on the 12-in. crossing from Rikers Island to North Brothers Island; this stretch of pipe being a section of a loop from the main land at Barretto Point to Rikers Island to North Brother Island and on through a 6-in. line to the main land at 140th St. Orders were issued to the Water Waste Division to determine, if possible, the location of the break, because North Brothers Island with its hospitals was under these conditions dependent upon the one inadequate 6-in. line. A party was sent out at once and carried through the investigation with satisfactory results in a couple of days.

As no pipe coefficient was available, it was necessary to determine one for a line of similar size and under similar conditions. It was obtained at Barretto Point on the Rikers Island line. With the valve closed on the North Brothers Island end of the broken line, a pitometer placed in the 12-in. line at Barretto Point measured the leakage plus the Rikers Island consumption, then closing the valve on the Rikers Island end of the broken main the island consumption alone was measured. The difference gave the leakage for that height of tide. As soon as possible, then, pressures were taken simultaneously on hydrants located near each end of the flexible submerged pipe. Hydrant elevations and distance were obtained by level and transit respectively, distance being checked roughly from a government chart. The co-efficient C in the Chezy formula, $v = C\sqrt{rs}$, was then determined for the Barretto Point section where a flow was constant throughout its length. Applying the pipe coefficient to the broken section, the slope of the gradient up to the leak was found. Since the valve at the North Brothers Island had been closed, there was no flow beyond the leak, hence a flat gradient obtained from the leak to that point. After figuring the gradient elevation at each hydrant and plotting the gradient to scale the distance of the leak from the hydrant at North Brothers Island was determined as approximately 600 ft.

To check the figures an attempt was made to find the leak by sound. An engineer using an aquaphone with an oar placed in the water was taken in a boat and by means of stadia and transit was directed to the point near where the leak was supposed to be. The sound could be distinctly heard even though the depth of water was about 25 ft. On a circumference of 100 ft. radius, approximately, the sound became indistinct. As found by the diver, the break was 570 ft. instead of 600 ft.

It is possible, we believe, to locate such leaks at least as closely as within 30 ft. and often closer if the pipe coefficient is accurately determined for each crossing and corrected every few years as the pipe ages.

ACKNOWLEDGMENT.

From paper by Mr. Elmer G. Hooper, Assistant Engineer, Department of Water Supply, Gas and Electricity of New York City, before New England Water Works Association.

Seven Years' Successful Operation of Double Sand Filtration Plant at S. Norwalk, Conn., in Removal of Objectionable Tastes and Odors.

(Staff Abstract.)

For many years, prior to the introduction of double sand filtration at South Norwalk, Conn., the water from the city's reservoirs was at times subject to enormous growths of taste and odor-producing and other microscopic organisms. These organisms, including Asterionella, Anabena, Dinobryon and Aphanizomenon, still flourish vigorously in these reservoirs at certain periods, but the bad tastes and odors thus engendered are removed in the process of filtration. The growths are generally greatest in the months of August, September and October, but occur at other times also. These organisms sometimes appear singly and at other times in company. Some of the growths are at times prominent as a scum on the surface of considerable areas of the main reservoirs. The disintegration and decay of these microscopic growths in the waters of the reservoirs, if allowed to occur, produces an intense, vile, pig-pen odor. The present article describes the design and operation of the double sand filtration plant which for something over seven years has successfully combatted these organisms and has produced an effluent of attractive physical as well as hygienic qualities.

The population served by the South Norwalk water works is about 13,000. The water system includes 10 square miles of watershed, 500 acres of land and four reservoirs with a total capacity of 700,000,000 gals. The two principal reservoirs are known as the City Lake and Rock Lake Reservoirs. The total water consumption averages 2,500,000 gals. daily—the per capita being about 200 gals. daily. There are few metered services, it may be remarked.

In March, 1904, the author of the paper here abstracted was retained to advise in regard to improvement of the quality of the water supply which had long been exceedingly disagreeable to city officials and citizens alike. Double sand filtration was recommended. Some experience with this water several years earlier than 1904 and the results of filtration investigations upon the water of Ludlow Reservoir, Springfield, Mass., were the foundation of the advice given.

At Ludlow Reservoir, the old water supply of Springfield, filtration investigations for the Massachusetts State Board of Health and the Springfield Water Board, carried on under the direction of the author during the year 1901, had shown that water from a shallow reservoir containing at times enormous growths of Anabaena and other taste and odor-producing organisms, together with much organic matter, iron and color, could be rendered entirely satisfactory and free from tastes and odors by aeration and double sand filtration.

Briefly, the plan of filtration for South Norwalk was to aerate the water thoroughly, then pass it through a filter containing about 3 ft. in depth of coarse sand, then aeration and a second filtration during that portion of the year when the water was in its worst condition. Rates like those successful at Ludlow were planned for; namely, 2,500,000 gals. per acre daily for the primary filter and 10,000,000 gals. for the secondary filter. The object of this filtration was, let me make it clear, not the improvement of the water bacterially, although of course this followed, but the change of a water at times almost entirely unsuitable for domestic consumption, owing to its disagreeable qualities, to one entirely satisfactory in every respect. For considerable periods of each year, prior to filtration, the taste and odors were decidedly rank and the turbidity of the water very noticeable. On several occasions when visiting the filters in the summer season since their construction, the water over the primary filter has, owing to the organisms present, looked like a thick green pea soup. It is a fact, moreover, that the water board of a certain Massachusetts city visiting South Norwalk on a tour of inspection became decidedly opposed to filtration on account of the strong odor at that time around this South Norwalk filtration plant. They could hardly be persuaded to look at the improved water after filtration, apparently deciding that a filtration plant would be a nuisance. Mr. William S. Johnson, C. E., of Boston, was associated with the author in preparing the designs of the filters and to him much of the success of the work is due. Mr. Samuel W. Hoyt, C. E., of South Norwalk was in direct charge of construction and the Bunting Construction Co. were the builders.

DESIGN OF THE PLANT.

The filters are located about 1,000 ft. south of the city's largest reservoir known as City Lake and water flows from the lake to the filter through an 18-in. pipe. City Lake is about 260 ft. above the city level, which is practically sea-level. The filters were built during 1906 and 1907 and were put into operation on June 22, 1908. They are of concrete construction and covered. The primary filter is divided into three sections, each 78.4 ft. wide and 145 ft. long inside measurement, slightly more than ¼ acre, the floor is 15 ins. thick under the piers and 6 ins. midway between. There are 50 piers in each section, 28 ins. square at the base and 20 at the top. The concrete roof is of groined-arch construction, 6 ins. thick at the summit of the arch. It is not reinforced. Each span is 11 ft. 8 ins. and the arch is half an ellipse with a rise of 2 ft. 6 ins. There are 30 manholes in each section. Near the center of the floor of each section an effluent channel is placed, 2 ft. 10 ins. wide and 8 ins. high covered with reinforced concrete slabs. From this main channel, lateral lines of 10-in. split vitrified pipe are laid in the invert of each vertical curve across the filter beds. The underdrains are covered with 14 ins. of graded gravel. The sand in each filter is 3 ft. 9 ins. deep and of an effective size from 0.35 to 0.38 of a millimeter.

CONSTRUCTION OF THE PLANT.

No sand could be discovered within about seven miles of the filter and the railroad was many miles away. There was, however, a gravel deposit just a mile distant across country, and we finally, after extended investigations, decided to use the sand contained in that gravel. To obtain 1 cu. yd. of sand it was necessary to handle something more than 3 cu. yds. of material, and the screening was all done by hand, as the circumstances were such that it did not seem to be economical to put in a mechanical screen. Then a new road, a mile in length, was built across country and the sand was hauled to the site of the filter. After reaching the filter it had to be washed to remove the fine material and dirt, taking out about 5 per cent in the process. The cost of the sand placed in the filter was about $2.45 per yard.

The washing at this place was of necessity done inside of the filter, as the wash-water was obtained by gravity from a reservoir, and the head was not sufficient to deliver any considerable quantity of water above the roof of the filter. At first we thought the location of the washing apparatus inside of the filter was going to be a disadvantage, but it proved to be the opposite.

The sand was dumped through one of the manholes into a hopper which fed directly into the washer, and the dirty water was carried off through one of the drains. The clean sand was discharged into wheelbarrows on a plank run, and a constant stream of wheelbarrows passed the outlet of the washer.

OPERATION OF THE PLANT.

The water comes to the primary filter through an 18-in. pipe and passes to the aerator placed in a concrete aerating chamber. The aerator is a steel box 9 ft. 3 ins. long, 6 ft. 6 ins. wide and 4 ft. high. It has 6,836 holes 3/16 in. in diameter spaced 1 in. between centers. This form of aerator was adopted after various experiments made by the author at the Lawrence Experiment Station in regard to the quickest and most thorough method of introducing air into water free from air; that is, water that, owing to the presence of much organic matter in a state of change had exhausted the free oxygen normally present. It was found by these experiments that even weak sewage devoid of oxygen could be nearly saturated with air when dropping from a box of this description through 3½ ft. of air. The small streams coming from these 3/16-in. openings, twist and break and the water becomes a white-foaming mass, about 6 ins. below the aerator pan. The aerator is regulated by a float valve.

The water after passing through the primary filter collects in a central effluent channel and flows to four 14-in. Venturi meters, one for each section of the primary filter and for the secondary filter. These meters register and record the rate of filtration, the elevation of water in each bed and the loss of head. From these meters the water passes to a central chamber under the operating house and from there it may be passed to a secondary filter or to the city mains or to a clear water reservoir with a capacity of 250,000 gals. The secondary filter is of the same design, construction and dimensions as each section of the primary filter.

In the operation of the experimental filter at Ludlow one phenomenon was noticed that occurs often with the primary filter at South Norwalk; that is, during the period of each year when the organic matter or organisms are in the greatest abundance in the reservoir water, the quick oxidation of this organic matter in the sand filter causes a complete exhaustion of the oxygen and the remaining unoxidized organic matter then takes oxygen from the iron and manganese oxides in the sand, iron and some manganese hence coming through in solution. While this adds to the load of the secondary filter, this iron and manganese is thoroughly oxidized by aeration before reaching the surface of the secondary filter and hence acts as a precipitant and the secondary filter removes more organic and coloring matter at such times than during other periods of the year. The question may be asked whether this action could not be avoided by passing the water more rapidly through the primary filter and thus not giving time for oxygen exhaustion. This might be done except for the load of organisms occurring at these periods. Attempts were made at Ludlow to overcome this trouble by the operation of a filter with a shallow depth of sand, and while this was more or less successful, it did not entirely obviate the difficulty.

TABLE I.—REPORT FOR SOUTH NORWALK WATER PURIFICATION PLANT FOR YEAR ENDING MAY 1, 1915.

Total number of gallons of water used	923,256,331
Daily average for year was	2,529,469
Greatest amount filtered on one bed between cleanings	37,095,370
Least amount filtered on one bed between cleanings	2,508,545
Greatest amount filtered on one bed per acre	148,381,480
Least amount filtered on one bed per acre	10,034,180
Total operating cost without supplies	$4,335.20
Operating cost per 1,000,000 gals. filtered	5.23
Average amount filtered per cleaning, gallons	11,398,229
Number of times secondary filter was cleaned	9
Longest run on secondary filter	93 days
Shortest run on secondary filter	9 days
Greatest amount used in 24 hours (Dec. 29, 1914)	3,125,485
Least amount used in 24 hours (Oct. 25, 1914)	2,087,615
Average rate of filtration of primary filter, gallons	3,300,000
Average rate of filtration of secondary filter, gallons	10,000,000

At the Ludlow experimental filters the primary filter caused a very satisfactory removal of tastes and odors until Anabaena became very abundant in the applied water, the number of organisms of this kind reaching at times nearly 11,000 per cubic centimeter and at such periods, the effluent from the primary filter had decided tastes and odors, these tastes and odors being, however, entirely removed by the secondary filter operating at a 10,00,000-gal. rate, and this is very largely the experience at South Norwalk.

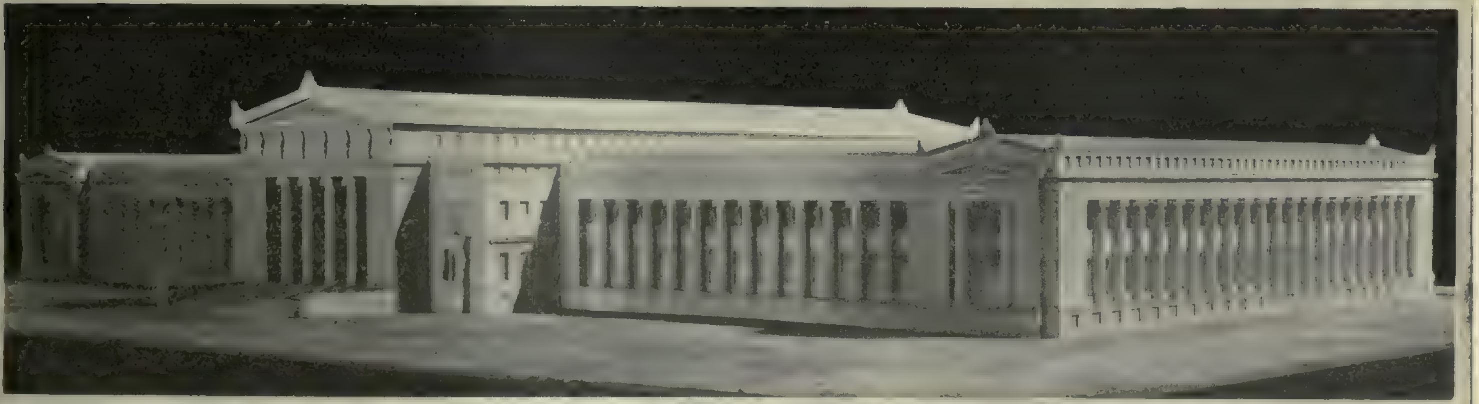
Owing to the level of the filter being nearly that of the reservoir from which water is taken, the lack of water pressure for the operation of the customary sand washing machines has caused some difficulty in washing the sand economically. Generally sand washing is carried on as follows, the sand being washed in place. Water enters at special inlets at the filter's surface and it flows over the sand controlled in fairly narrow channels by wooden baffles placed in the sand. The sand is disturbed by rakes and the accumulated material, dirt, etc., is washed across the bed to specially designed waste drains.

The filter throughout the seven years of its operation to date has been entirely satisfactory and successful in accomplishing the object for which it was constructed. Organisms, tastes and odors are completely removed, together with at least 50 per cent of the coloring matter of the water, the apparent color removal being much greater than this. According to South Norwalk physicians it has also had a beneficial effect upon the health of the community, but the author has no statistics upon this point. The cost of this plant with a total filtering area of 1¼ acres was just about $100,000. The statistics for the year ending May 1, 1915, are given in Table I.

ACKNOWLEDGMENT.

From a paper by Mr. Harry W. Clark, Chemist, for the Massachusetts State Board of Health, before the New England Water Works Association.

BUILDINGS



Photograph of Model of Field Museum of Natural History Now Under Construction in Grant Park, Chicago, Ill., at a Cost of $5,100,000. The Structural Features of This Museum Were Described and Illustrated in Our Sept. 22, 1915, Issue. Photograph by C. H. Carpenter, Official Photographer, Field Museum of Natural History.

Protective Coatings for Metals and Methods of Applying Them.

A resumé of the most effective processes of forming protective coatings for metals has been completed by H. B. C. Allison of the research laboratory of the General Electric Company, Schenectady, N. Y. This review is confined to two types: (a) that in which the metal itself is made more resistant, usually by some chemical treatment; and (b) that in which another metal is used as a surface coating.

In the first type a coating is formed which to be successful must possess the following properties: It must be homogeneous, continuous, resistant to attack by acid or alkali, firmly attached to the base metal, and must have a similar coefficient of expansion. The ideal metal coating also should be homogeneous and continuous, but should be strongly electropositive to the metal base and should form electro-positive alloys with it so that in case of oxidation the coating will be attacked and the base metal protected.

As iron is the metal most commonly used as a base, the processes considered are mainly those used for its protection, although some of them may be applicable to other metals.

OXIDE COATINGS.

It was known for a considerable time before any process was devised that the black or magnetic oxide formed on iron under certain conditions was a very fair protective coating. Attempts to control and improve this coating have led to a number of patented processes, of which the following two may be taken as typical:

Bower-Barff Process.—The pieces to be treated are heated to a temperature of 900° C. in a closed retort. When this temperature has been reached, superheated steam is admitted for 20 minutes, and a coating consisting of a mixture of red and black oxides is formed. Producer gas is then substituted for the steam and allowed to act for the same length of time. After cooling somewhat the pieces are oiled and a smooth, green-black coating is produced, which affords efficient protection from sea water, acid fumes, etc., and will stand a wide variation in temperature.

Gesner Process.—This is a further development of the above process. The pieces to be treated are maintained at 600° C. for 20 minutes, after which steam at low pressure is let in at intervals for 30 minutes. The steam on entering passes through a red-hot pipe at the base of the retort and is thus partially decomposed into hydrogen and oxygen. After this treatment a small quantity of naphtha or hydrocarbon oil is introduced and allowed to act for 15 minutes to reduce any red oxide, and also to carbonize the surface. The coating is said to be a compound of iron, hydrogen and carbon, and analyses have shown that a minimum of 2 per cent of hydrogen is present.

It is an improvement on the Bower-Barff process in that the danger of warping, due to high temperature, is removed, the size of the piece is practically unaltered, and the tendency to scale is much less.

Both of these processes are quite expensive, but users have usually found the protection pair gang found after valve operation that the trouble was on the 12-in. crossing from Rikers Island to North Brothers Island; this stretch of pipe being a section of a loop from the main land at Barretto Point to Rikers Island to North Brother Island and on through a 6-in. line to the main land at 140th St. Orders were issued to the Water Waste Division to determine, if possible, the location of the break, because North Brothers Island with its hospitals was under these conditions dependent upon the one inadequate 6-in. line. A party was sent out at once and carried through the investigation with satisfactory results in a couple of days.

As no pipe coefficient was available, it was necessary to determine one for a line of similar size and under similar conditions. It was obtained at Barretto Point on the Rikers Island line. With the valve closed on the North Brothers Island end of the broken line, a pitometer placed in the 12-in. line at Barretto Point measured the leakage plus the Rikers Island consumption, then closing the valve on the Rikers Island end of the broken main the island consumption alone was measured. The difference gave the leakage for that height of tide. As soon as possible, then, pressures were taken simultaneously on hydrants located near each end of the flexible submerged pipe. Hydrant elevations and distance were obtained by level and transit respectively, distance being checked roughly from a government chart. The co-efficient C in the Chezy formula, $v = C\sqrt{rs}$, was then determined for the Barretto Point section where a flow was constant throughout its length. Applying the pipe coefficient to the broken section, the slope of the gradient up to the leak was found. Since the valve at the North Brothers Island had been closed, there was no flow beyond the leak, hence a flat gradient obtained from the leak to that point. After figuring the gradient elevation at each hydrant and plotting the gradient to scale the distance of the leak from the hydrant at North Brothers Island was determined as approximately 600 ft.

To check the figures an attempt was made to find the leak by sound. An engineer using an aquaphone with an oar placed in the water was taken in a boat and by means of stadia and transit was directed to the point near where the leak was supposed to be. The sound could be distinctly heard even though the depth of water was about 25 ft. On a circumference of 100 ft. radius, approximately, the sound became indistinct. As found by the diver, the break was 570 ft. instead of 600 ft.

It is possible, we believe, to locate such leaks at least as closely as within 30 ft. and often closer if the pipe coefficient is accurately determined for each crossing and corrected every few years as the pipe ages.

ACKNOWLEDGMENT.

From paper by Mr. Elmer G. Hooper, Assistant Engineer, Department of Water Supply, Gas and Electricity of New York City, before New England Water Works Association.

Seven Years' Successful Operation of Double Sand Filtration Plant at S. Norwalk, Conn., in Removal of Objectionable Tastes and Odors.

(Staff Abstract.)

For many years, prior to the introduction of double sand filtration at South Norwalk, Conn., the water from the city's reservoirs was at times subject to enormous growths of taste and odor-producing and other microscopic organisms. These organisms, including Asterionella, Anabena, Dinobryon and Aphanizomenon, still flourish vigorously in these reservoirs at certain periods, but the bad tastes and odors thus engendered are removed in the process of filtration. The growths are generally greatest in the months of August, September and October, but occur at other times also. These organisms sometimes appear singly and at other times in company. Some of the growths are at times prominent as a scum on the surface of considerable areas of the main reservoirs. The disintegration and decay of these microscopic growths in the waters of the reservoirs, if allowed to occur, produces an intense, vile, pig-pen odor. The present article describes the design and operation of the double sand filtration plant which for something over seven years has successfully combatted these organisms and has produced an effluent of attractive physical as well as hygienic qualities.

The population served by the South Norwalk water works is about 13,000. The water system includes 10 square miles of watershed, 500 acres of land and four reservoirs with a total capacity of 700,000,000 gals. The two principal reservoirs are known as the City Lake and Rock Lake Reservoirs. The total water consumption averages 2,500,000 gals. daily—the per capita being about 200 gals. daily. There are few metered services, it may be remarked.

In March, 1904, the author of the paper here abstracted was retained to advise in regard to improvement of the quality of the water supply which had long been exceedingly disagreeable to city officials and citizens alike. Double sand filtration was recommended. Some experience with this water several years earlier than 1904 and the results of filtration investigations upon the water of Ludlow Reservoir, Springfield, Mass., were the foundation of the advice given.

At Ludlow Reservoir, the old water supply of Springfield, filtration investigations for the Massachusetts State Board of Health and the Springfield Water Board, carried on under the direction of the author during the year 1901, had shown that water from a shallow reservoir containing at times enormous growths of Anabaena and other taste and odor-producing organisms, together with much organic matter, iron and color, could be rendered entirely satisfactory and free from tastes and odors by aeration and double sand filtration.

Briefly, the plan of filtration for South Norwalk was to aerate the water thoroughly, then pass it through a filter containing about 3 ft. in depth of coarse sand, then aeration and a second filtration during that portion of the year when the water was in its worst condition. Rates like those successful at Ludlow were planned for; namely, 2,500,000 gals. per acre daily for the primary filter and 10,000,000 gals. for the secondary filter. The object of this filtration was, let me make it clear, not the improvement of the water bacterially, although of course this followed, but the change of a water at times almost entirely unsuitable for domestic consumption, owing to its disagreeable qualities, to one entirely satisfactory in every respect. For considerable periods of each year, prior to filtration, the taste and odors were decidedly rank and the turbidity of the water very noticeable. On several occasions when visiting the filters in the summer season since their construction, the water over the primary filter has, owing to the organisms present, looked like a thick green pea soup. It is a fact, moreover, that the water board of a certain Massachusetts city visiting South Norwalk on a tour of inspection became decidedly opposed to filtration on account of the strong odor at that time around this South Norwalk filtration plant. They could hardly be persuaded to look at the improved water after filtration, apparently deciding that a filtration plant would be a nuisance. Mr. William S. Johnson, C. E., of Boston, was associated with the author in preparing the designs of the filters and to him much of the success of the work is due. Mr. Samuel W. Hoyt, C. E., of South Norwalk was in direct charge of construction and the Bunting Construction Co. were the builders.

DESIGN OF THE PLANT.

The filters are located about 1,000 ft. south of the city's largest reservoir known as City Lake and water flows from the lake to the filter through an 18-in. pipe. City Lake is about 260 ft. above the city level, which is practically sea-level. The filters were built during 1906 and 1907 and were put into operation on June 22, 1908. They are of concrete construction and covered. The primary filter is divided into three sections, each 78.4 ft. wide and 145 ft. long inside measurement, slightly more than ¼ acre, the floor is 15 ins. thick under the piers and 6 ins. midway between. There are 50 piers in each section, 28 ins. square at the base and 20 at the top. The concrete roof is of groined-arch construction, 6 ins. thick at the summit of the arch. It is not reinforced. Each span is 11 ft. 8 ins. and the arch is half an ellipse with a rise of 2 ft. 6 ins. There are 30 manholes in each section. Near the center of the floor of each section an effluent channel is placed, 2 ft. 10 ins. wide and 8 ins. high covered with reinforced concrete slabs. From this main channel, lateral lines of 10-in. split vitrified pipe are laid in the invert of each vertical curve across the filter beds. The underdrains are covered with 14 ins. of graded gravel. The sand in each filter is 3 ft. 9 ins. deep and of an effective size from 0.35 to 0.38 of a millimeter.

CONSTRUCTION OF THE PLANT.

No sand could be discovered within about seven miles of the filter and the railroad was many miles away. There was, however, a gravel deposit just a mile distant across country, and we finally, after extended investigations, decided to use the sand contained in that gravel. To obtain 1 cu. yd. of sand it was necessary to handle something more than 3 cu. yds. of material, and the screening was all done by hand, as the circumstances were such that it did not seem to be economical to put in a mechanical screen. Then a new road, a mile in length, was built across country and the sand was hauled to the site of the filter. After reaching the filter it had to be washed to remove the fine material and dirt, taking out about 5 per cent in the process. The cost of the sand placed in the filter was about $2.45 per yard.

The washing at this place was of necessity done inside of the filter, as the wash-water was obtained by gravity from a reservoir, and the head was not sufficient to deliver any considerable quantity of water above the roof of the filter. At first we thought the location of the washing apparatus inside of the filter was going to be a disadvantage, but it proved to be the opposite.

The sand was dumped through one of the manholes into a hopper which fed directly into the washer, and the dirty water was carried off through one of the drains. The clean sand was discharged into wheelbarrows on a plank run, and a constant stream of wheelbarrows passed the outlet of the washer.

OPERATION OF THE PLANT.

The water comes to the primary filter through an 18-in. pipe and passes to the aerator placed in a concrete aerating chamber. The aerator is a steel box 9 ft. 3 ins. long, 6 ft. 6 ins. wide and 4 ft. high. It has 6,836 holes 3/16 in. in diameter spaced 1 in. between centers. This form of aerator was adopted after various experiments made by the author at the Lawrence Experiment Station in regard to the quickest and most thorough method of introducing air into water free from air; that is, water that, owing to the presence of much organic matter in a state of change had exhausted the free oxygen normally present. It was found by these experiments that even weak sewage devoid of oxygen could be nearly saturated with air when dropping from a box of this description through 3½ ft. of air. The small streams coming from these 3/16-in. openings, twist and break and the water becomes a white-foaming mass, about 6 ins. below the aerator pan. The aerator is regulated by a float valve.

The water after passing through the primary filter collects in a central effluent channel and flows to four 14-in. Venturi meters, one for each section of the primary filter and for the secondary filter. These meters register and record the rate of filtration, the elevation of water in each bed and the loss of head. From these meters the water passes to a central chamber under the operating house and from there it may be passed to a secondary filter or to the city mains or to a clear water reservoir with a capacity of 250,000 gals. The secondary filter is of the same design, construction and dimensions as each section of the primary filter.

In the operation of the experimental filter at Ludlow one phenomenon was noticed that occurs often with the primary filter at South Norwalk; that is, during the period of each year when the organic matter or organisms are in the greatest abundance in the reservoir water, the quick oxidation of this organic matter in the sand filter causes a complete exhaustion of the oxygen and the remaining unoxidized organic matter then takes oxygen from the iron and manganese oxides in the sand, iron and some manganese hence coming through in solution. While this adds to the load of the secondary filter, this iron and manganese is thoroughly oxidized by aeration before reaching the surface of the secondary filter and hence acts as a precipitant and the secondary filter removes more organic and coloring matter at such times than during other periods of the year. The question may be asked whether this action could not be avoided by passing the water more rapidly through the primary filter and thus not giving time for oxygen exhaustion. This might be done except for the load of organisms occurring at these periods. Attempts were made at Ludlow to overcome this trouble by the operation of a filter with a shallow depth of sand, and while this was more or less successful, it did not entirely obviate the difficulty.

TABLE I.—REPORT FOR SOUTH NORWALK WATER PURIFICATION PLANT FOR YEAR ENDING MAY 1, 1915.

Total number of gallons of water used	923,256,331
Daily average for year was	2,529,469
Greatest amount filtered on one bed between cleanings	37,095,370
Least amount filtered on one bed between cleanings	2,508,545
Greatest amount filtered on one bed per acre	148,381,480
Least amount filtered on one bed per acre	10,034,180
Total operating cost without supplies	$4,335.20
Operating cost per 1,000,000 gals. filtered	5.23
Average amount filtered per cleaning, gallons	11,398,229
Number of times secondary filter was cleaned	[illegible]
Longest run on secondary filter	93 days
Shortest run on secondary filter	9 days
Greatest amount used in 24 hours (Dec. 29, 1914)	3,125,485
Least amount used in 24 hours (Oct. 25, 1914)	2,087,615
Average rate of filtration of primary filter, gallons	3,300,000
Average rate of filtration of secondary filter, gallons	10,000,009

At the Ludlow experimental filters the primary filter caused a very satisfactory removal of tastes and odors until Anabaena became very abundant in the applied water, the number of organisms of this kind reaching at times nearly 11,000 per cubic centimeter and at such periods, the effluent from the primary filter had decided tastes and odors, these tastes and odors being, however, entirely removed by the secondary filter operating at a 10,00,000-gal. rate, and this is very largely the experience at South Norwalk.

Owing to the level of the filter being nearly that of the reservoir from which water is taken, the lack of water pressure for the operation of the customary sand washing machines has caused some difficulty in washing the sand economically. Generally sand washing is carried on as follows, the sand being washed in place. Water enters at special inlets at the filter's surface and it flows over the sand controlled in fairly narrow channels by wooden baffles placed in the sand. The sand is disturbed by rakes and the accumulated material, dirt, etc., is washed across the bed to specially designed waste drains.

The filter throughout the seven years of its operation to date has been entirely satisfactory and successful in accomplishing the object for which it was constructed. Organisms, tastes and odors are completely removed, together with at least 50 per cent of the coloring matter of the water, the apparent color removal being much greater than this. According to South Norwalk physicians it has also had a beneficial effect upon the health of the community, but the author has no statistics upon this point. The cost of this plant with a total filtering area of 1¼ acres was just about $100,000. The statistics for the year ending May 1, 1915, are given in Table I.

ACKNOWLEDGMENT.

From a paper by Mr. Harry W. Clark, Chemist, for the Massachusetts State Board of Health, before the New England Water Works Association.

BUILDINGS

Photograph of Model of Field Museum of Natural History Now Under Construction in Grant Park, Chicago, Ill., at a Cost of $5,100,000. The Structural Features of This Museum Were Described and Illustrated in Our Sept. 22, 1915, Issue. Photograph by C. H. Carpenter, Official Photographer, Field Museum of Natural History.

Protective Coatings for Metals and Methods of Applying Them.

A resumé of the most effective processes of forming protective coatings for metals has been completed by H. B. C. Allison of the research laboratory of the General Electric Company, Schenectady, N. Y. This review is confined to two types: (a) that in which the metal itself is made more resistant, usually by some chemical treatment; and (b) that in which another metal is used as a surface coating.

In the first type a coating is formed which to be successful must possess the following properties: It must be homogeneous, continuous, resistant to attack by acid or alkali, firmly attached to the base metal, and must have a similar coefficient of expansion. The ideal metal coating also should be homogeneous and continuous, but should be strongly electropositive to the metal base and should form electro-positive alloys with it so that in case of oxidation the coating will be attacked and the base metal protected.

As iron is the metal most commonly used as a base, the processes considered are mainly those used for its protection, although some of them may be applicable to other metals.

OXIDE COATINGS.

It was known for a considerable time before any process was devised that the black or magnetic oxide formed on iron under certain conditions was a very fair protective coating. Attempts to control and improve this coating have led to a number of patented processes, of which the following two may be taken as typical:

Bower-Barff Process.—The pieces to be treated are heated to a temperature of 900° C. in a closed retort. When this temperature has been reached, superheated steam is admitted for 20 minutes, and a coating consisting of a mixture of red and black oxides is formed. Producer gas is then substituted for the steam and allowed to act for the same length of time. After cooling somewhat the pieces are oiled and a smooth, green-black coating is produced, which affords efficient protection from sea water, acid fumes, etc., and will stand a wide variation in temperature.

Gesner Process.—This is a further development of the above process. The pieces to be treated are maintained at 600° C. for 20 minutes, after which steam at low pressure is let in at intervals for 30 minutes. The steam on entering passes through a red-hot pipe at the base of the retort and is thus partially decomposed into hydrogen and oxygen. After this treatment a small quantity of naphtha or hydrocarbon oil is introduced and allowed to act for 15 minutes to reduce any red oxide, and also to carbonize the surface. The coating is said to be a compound of iron, hydrogen and carbon, and analyses have shown that a minimum of 2 per cent of hydrogen is present.

It is an improvement on the Bower-Barff process in that the danger of warping, due to high temperature, is removed, the size of the piece is practically unaltered, and the tendency to scale is much less.

Both of these processes are quite expensive, but users have usually found the protection as in the case of the first-story walls. The first-story walls contained 310,000 bricks and the second-story walls 101,000. The itemized cost of laying these walls is given in Table V.

Erecting Structural Steel.—The steel frame consists of 6-in. latticed channel columns, 18-in. I-beam floor girders, roof trusses and wind bracing (see Fig. 3) for both columns and trusses. All trusses were delivered entirely riveted up, with the exception of those over the car-erecting and painting shop; these trusses were delivered in two sections. These sections were bolted together on the ground, hoisted to place with a hand-operated breast derrick, and riveted. The second-floor girders were shipped with connection angles riveted to them. Thirty-six hundred field rivets were required, or 54 field rivets per ton of steelwork. These were driven with pneumatic hammers, compressed air being supplied by a portable air compressor, driven by an electric motor. The weights of the various portions of the steel frame were as follows:

TABLE VI.—COST OF ERECTING AND RIVETING STEELWORK.

Item.	Rate per hour.	Total cost.	Cost per ton.
Foreman	$0.60	$100.20	$1.53
Labor	0.45	320.85	4.89
Total		$421.05	$6.42

Item.	Lbs.
Columns	13,350
Column bracing	2,700
Girders at second floor	20,500
Roof trusses over one-story section	57,400
Roof trusses over two-story section	13,100
Lateral bracing for one-story section	15,600
Lateral bracing for two-story section	8,750
Total	131,400

The total and unit costs of erecting and riveting the steelwork are given in Table VI.

Second-Floor Construction.—The second-floor construction consists of 2x6-in. matched yellow pine flooring laid on 3x12-in. joists, and nailed with 20-d nails, two at each bearing. The joists are 16 ft. long and are spaced 2 ft. on centers. Solid bridging, 2x12 ins., was cut to fit between the joists over the I-beams, and one row of 1x2-in. cross bridging was placed between the joists at the center of the span. All material was raised to place by hand. In constructing this floor 24,300 ft. B. M. of lumber were used, divided as follows: Joists, 9,700 ft. B. M.; flooring, 14,000 ft. B. M.; and bridging 600 ft. B. M. The total and unit costs of building this floor are given in Table VII.

TABLE VII.—COST OF CONSTRUCTING SECOND FLOOR.

Item.	Rate per hour.	Total cost.	Cost per M ft. B. M.
Foreman	$0.55	$ 17.60	$0.724
Carpenters	0.45	72.00	2.963
Helpers	0.295	41.30	1.700
Total		$130.90	$5.387

Roof Construction.—The roofs were constructed of 2x6-in. matched yellow pine flooring spiked to 2x10-in. and 3x10-in. purlins, the latter being bolted to clip angles on the trusses. The spacing of the purlins varied from 4 ft. to 6 ft. All material was raised to place by hand. For the roof over the one-story section 50,900 ft. B. M. were used, of which 10,600 ft. B. M. were in the purlins and 40,300 ft. B. M. in the sheathing. The roof over the two-story section required 27,500 ft. B. M. of lumber, of which 5,700 ft. B. M. were in the purlins and 21,800 ft. B. M. in the sheathing. The total and unit costs of constructing these roofs are given in Table VIII.

TABLE VIII.—TOTAL AND UNIT COSTS OF CONSTRUCTING ROOFS.

Item.	Rate per hour.	One-story section. Total cost.	One-story section. Cost per M ft. B. M.	Two-story section. Total cost.	Two-story section. Cost per M ft. B. M.
Foreman	$0.55	$ 58.85	$ 1.156	$ 41.80	$ 1.520
Carpenters	0.45	333.00	6.542	273.60	9.949
Helpers	0.295	123.00	2.434	97.94	3.561
Total		$515.75	$10.132	$413.34	$15.030

The higher unit costs for the roof over the two-story section were due to several factors, among which are: the trusses have a shorter span; they have a steeper slope; and the material had to be elevated a greater distance.

GENERAL COST DATA.

The cost of this building equipped, per square foot of floor area, was $1.284, divided as follows: Building proper, 86.3 cts.; heating, 5.1 cts.; lighting, 1.1 ct.; sprinkler system, 27.6 cts.; tracks and trolleys, 8.3 cts.

The cost given for heating covers that of an indirect system, including fan, heating coils, galvanized iron air distributing ducts, and supply and return mains (each 440 ft. long); it does not include the cost of the boilers. The cost given for the sprinkler system does not include that of the tanks, but does include all other parts necessary to a dry pipe sprinkler system. The cost per sprinkler head was $6, each head covering an area of 21.7 sq. ft. The tracks consist of 70-lb. A. S. C. E. rails laid on 6x8-in. x 7 ft. cross-ties spaced 2 ft. on centers.

Unusual Lighting System to Permit Construction at Night on a Large Reinforced Concrete Building.

(Staff Article.)

In connection with the construction of a large reinforced concrete building in Connecticut the Aberthaw Construction Co., Boston, Mass., found it advisable to prosecute the work in two shifts, as the building was urgently needed for manufacturing purposes.

To enable the night shift to work effectively on all parts of the structure a comprehensive lighting system, consisting of large clusters of electric lights, was installed. This lighting system proved to be so effective that the work proceeds at night with practically the same certainty as during the day time.

Figure 1 is a view of the structure, taken at night, at which time the lighting system was in operation. By handling the work in this manner the date of completion will be several weeks earlier than otherwise would have been possible—a very important item in this case.

Fig. 1. View of Reinforced Concrete Building, Taken at Night, Showing Comprehensive Lighting System in Use.

Cost of Mill Construction for Metallurgical Purposes.

(Staff Abstract.)

The following data will be found of value in estimating the cost of mill construction, particularly mill construction for metallurgical purposes. The figures given are taken from the writer's field notes, and by modification they can be applied to any similar work. Mill construction costs are widely variable and no two mills are alike, nor will their construction be carried on under the same conditions, yet the construction work itself is much the same in all.

PRELIMINARY WORK AND MATERIAL LISTS.

After it has been determined just what kind of a plant is needed, and after the site has been selected and the drawings made, a thorough organization of plans should be established and every detail gone over in the mind's eye.

The first step is to estimate the yardage to be excavated, the amount of masonry or concrete work required, and then a complete list of all material should be made. The tendency is to overlook a multitude of small things which have considerable value in the aggregate. To the machinery specifications should be added a complete list of lumber, doors, windows, all hardware down to nails, pulleys, belts, lime, sand, broken rock—in fact everything that goes into the construction. The cost and weight of this can readily be determined by consulting reliable dealers and adding the necessary freight charges.

DEVELOPMENT PLAN AND ESTIMATE OF COST OF PRELIMINARY WORK.

The next step should be the working out of a thorough development plan and an estimate of its cost. Everything should be made ready, so that when actual construction starts there will be neither confusion nor delay. The cost of this work is considerable and it is often neglected, with the consequent addition of excessive costs to some other part of the work. A great amount of future trouble and worry can be avoided by a careful planning for a few important features, which will be mentioned.

Unloading facilities and material and tools to do it with should be provided. A good road to the plant should be built and convenient deliveries arranged for. It is a noticeable fact that many a well constructed mill has such poor facilities for receiving supplies that the extra cost for a year would probably build everything needed to make such work easy and cheap. Ample room ought to be set aside for timber yards and all lumber should be marked and piled so that a glance will determine just what part of the job it was bought for.

A handy place should be marked off for a storage house and its cost estimated. It is surprising what a number of small things will be lost or misplaced without such storage. Roomy framing plots, as level as possible, should be marked off and handy places for machinery storage determined, keeping in mind pieces which will be first used and their situation. The supply of gravel, sand and rock must be looked into and arrangements made for its cheap delivery at any point. All details for disposing of rock and earth excavated with the least possible amount of handling should be planned.

The labor question must be studied and complete arrangements made for the comfort of the men. Their efficiency will vary directly with the conditions of their surroundings. Recently, in the west, a so-called mining man who had never given human nature a moment's thought attempted to build a mill in an out-of-the-way place with no fit accommodations for anyone but himself. The results were disastrous for the company. Good men could not be kept and the mill was finished up at an excess in cost of more than $50,000. Some of the tanks collapsed on their foundations with the first filling.

The cost of all this preliminary work can be estimated by the man on the ground; it averages from 5 to 10 per cent of the total. If it is neglected, confusion and delays throughout the job are the inevitable result. Good organization is just as essential to the construction of a plant as to its operation.

ERECTION COSTS.

Erection costs are variable and can only be obtained by experience or by comparison with other jobs. If all necessary steps are taken to avoid delays estimates can be made dependable within reasonable limits. Fixed rules cannot be given for this part of the work. They will vary with the wages, efficiency of labor, climatic conditions and the experience of the man in charge. However, if the rules given in this article are applied for summer work in the United States, the estimate will come approximately close to actual cost. Labor wage is based on the average paid in western mining camps.

Superintendence can be figured when conditions are known, and will average, including cost of plans, from 3 to 5 per cent of the total. Excavation by picking, shoveling, and hauling average earth in wheelbarrows, moving 100 ft., will cost about 45 cts. per cubic yard; add one-third of hourly wage of laborer for every additional 100 ft. Where mine cars can be used to advantage this may be cut to 35 cts. per cubic yard, moving 100 ft.; add one-fifth of hourly wage for every additional 100 ft., which covers placing the track. Breaking rock by hand, like hauling conditions, will cost from $1.25 to $1.75 per cubic yard, with 100 ft. haul. It will cost a few cents more per cubic yard than in earth work for every additional 100 ft. There are so many unknown quantities entering into excavating that these figures are only roughly approximate.

MASONRY AND CONCRETE CONSTRUCTION.

Rubble masonry will average $5 per cubic yard, using cement mortar. A mix of one part of Portland cement to five parts of sharp, clean sand will give good results. Such walls will average about 15-in. courses and will require from ¼ to ⅓ cu. yd. of mortar per cubic yard of wall. Concrete work can be figured to a nicety when conditions are known. With a mechanical mixer, $1 per cubic yard will cover the cost of mixing and placing in the average mill. On a large job it is well to determine just what mix is required with the material used. The duty of the sand is to fill the voids in the broken rock and, when the two are mixed, the resultant voids should be filled with cement. It is well to allow 10 per cent excess in each case, but there is nothing gained by using a richer mix for retaining walls and foundation. However, if a weaker mix is desired it can be obtained by puddling instead of cutting down the proportion of sand and cement. In forms of any size puddling is good practice and the strength of the concrete is by no means decreased. Clean, firm rock should be used and the edges should not touch. On the average mill job concrete will not cost more than $7 per cubic yard for large forms, $8 for medium, and $10 for small and heavy-duty machine foundations, including the cost of the forms. By using old iron, reinforced concrete can be made for 50 cts. per cubic yard more. Floors with a 5-in. base and 1-in. covering will average from $10 to $14 per cubic yard.

HAULING.

Unloading and hauling depend upon conditions. There will be a fixed average charge of from 30 to 40 cts. per ton. Small pieces should be handled for less, but large, unyielding pieces, such as a tube mill, can easily cost up to $1 per ton. Probably 75 cts. per ton-mile would be a good average for hauling on any kind of a decent road and grade. By consulting local freighters these things can be definitely settled. The curve of Fig. 1 shows the variable cost of hauling on different grades.

CARPENTER WORK.

Carpenter work with a well organized crew of millwrights will average about $21 per M for framing and erecting; $12 to $15 per M for siding and roofing; and $2.50 per M for shingles, or 75 cts. to $1 per square for corrugated iron roofing and siding. With a picked-up local crew, $28 to $31 per M for framing and erecting, $9 per M for siding and roofing and $2.50 per M for shingles or $1.25 per square for iron, will be the average figures.

TABLE I.—NAILS REQUIRED IN ERECTION PER M. FT. B. M.

	Size, d.	Lbs.
Siding and roofing...........	8	18 to 21
Flooring (1-in. material)....	8	28 to 32
Flooring (2-in. material)....	20 or 30	20 to 25
Studding, etc.	10	14
Shingles (per 1,000).........	4	6

The nails required in this work per M will be about as shown in Table I.

ASSEMBLING AND ERECTING MACHINERY AND EQUIPMENT.

Assembling and erecting machinery depends upon the nature of the machinery. A good point to emphasize here is that poorly stored machinery may easily add several dollars per ton to erection costs. An experienced engineer will size up the job and divide the material into different classes. It is then usually figured on a tonnage basis. Generally speaking, the heavier the piece the less the erection cost per ton. Steel tanks over ⅜ in. thick can be erected for $35 per ton; and ⅜ in. or less from $40 to $45 per ton. To place engines, stamps, crushers, pumps, to line up shafting, set electric motors, including wiring, etc., the cost will be about $45 per ton of iron; to set up concentrating machinery, classifiers, filters, etc., from $50 to $65 per ton. These figures cover the necessary carpenter work, placing pulleys, belts, and adjustments. When the carpenter work is figured separately these figures are high. Under these conditions it will cost from $25 to $30 per ton of iron to place engines, stamps, crushers, line up shafting, etc. To set up concentrating machinery, classifiers, filters, etc., costs from $30 to $45 per ton. This of course includes placing pulleys, belts and adjustments. The pipe work in the average mill will cost from $40 to $45 per ton. Erecting wooden tanks costs around $12 per M. Reduction works constructed wholly of steel are now becoming popular where the winters are not too severe. Framework of steel can be erected for $12 to $15 per ton by contract. A good contractor with a crew of construction men will make money at these figures. However, the amateur will do well if he shades the figures at all.

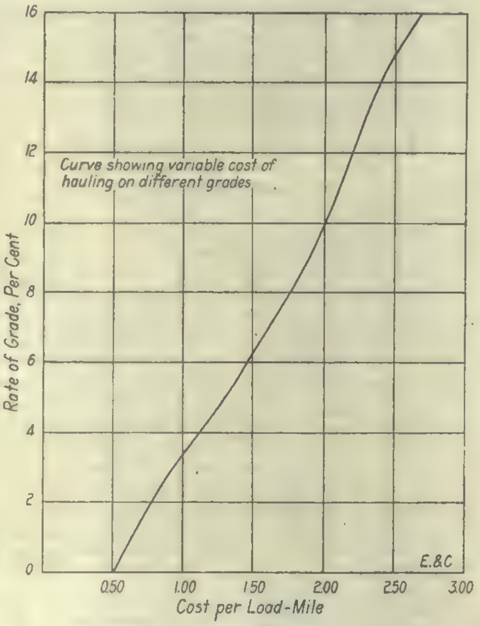


Fig. 1. Curve Showing Effect of Grade on Hauling Costs in Mill Construction.

Recently the construction of a 50-ton combination concentrating and cyanide plant came under the writer's notice. The contract was taken for just a little under $30 per M, and the same price per ton for machinery erection, which also included all foundations and concrete work. The total cost of the mill was around $30,000, but it is just under a finished product in every way and is bound to give considerable trouble that will eventually cost more, not considering delays, than the extra thousand or so dollars it would have taken to make it a finished mill in the first place.

Small items are important and there are a number of them. Considerable timber is required for staging and a number of unavoidable losses must be allowed for. The building should be painted, fire protection and heating arranged for and office and laboratory equipment bought.

COST OF MAKING ALTERATIONS.

The expense of the breaking-in period and the necessary alterations are often overlooked. Here we have the personal equation entering. It is a bet by the designer and constructor on his own ability. It is a good idea to allow 10 per cent of the total cost for possible changes, while any excess is often useful to cover the expense of unavoidable delays. The writer has in mind two mills, designed by two well-known metallurgists, where the starting up period in one case took 5 per cent of the total expenditure and 15 per cent in the other. The operator has a problem different from that of the man who follows construction only. When the former designs and constructs a mill he must worry through the breaking-in period and come out with a mill that is satisfactory in every way. On the other hand, the construction man generally has a contract and his responsibility ends by turning over a mill that is up to specifications, which may mean a good mill or a very poor one from the operator's standpoint.

DIFFICULTIES OF WINTER CONSTRUCTION.

In the northern United States winter work is a tough undertaking at its best and should be avoided if possible. With an average winter the excess cost will easily foot up to 33 per cent of the total labor expenditure. With an open, mild winter these figures are high, but with a cold, snowy winter they may easily reach 50 per cent. Concrete work often costs 35 per cent more, as complete arrangements must be made for heating and protecting against frost until after the preliminary set. After 12 hours, freezing can only retard the final set, but cannot injure the concrete.

A brief description of methods used in a winter concrete job should be of interest. A steam coil 12x12 ft. was made out of 2-in. pipe spaced 1 ft. apart, and perforated every 6 ins. with 3/16-in. holes. This made it possible to keep plenty of broken rock heated ahead of the mixer. Barrels were arranged on the mixer platform so that the water could be heated to the boiling point with steam. A 10 per cent salt solution was made, which in no way seemed to damage the concrete. The sand was not heated. Live steam was turned into the forms before pouring, sufficient time being allowed to draw the frost a few inches. Large forms were simply well covered with canvas after filling; the concrete remained above the freezing point for a couple of days even in the coldest weather. Small forms were protected by steam hose and fires for 12 hours. Calcium chloride is probably better than sodium chloride, since its solution freezes at a lower temperature and it also increases the waterproof quality of the concrete. It has been proven that concrete with 2 per cent of calcium chloride gives the best resistance. More than 2 per cent of it unduly increases the speed of setting and weakens the concrete. Since from 10 to 15 per cent of water is used in mixing concrete, a 2 per cent mix would be given by using a 15 or 20 per cent solution. A 20 per cent sodium-chloride solution freezes at about 7° F., while a 20 per cent calcium-chloride solution will not freeze until it reaches about the zero mark.

On a winter job of any size an inclosed framing shed will pay for itself many times over. It is not only useful during the framing period, but is a happy addition on a bitter cold day during the erecting period when the carpenters would otherwise have to be laid off. There are always launders, doors, plate beds, and a multitude of small things that they can work at under protection from the weather. When the mill is finally under cover it can be kept comfortable and the work will go on much more efficiently.

REMODELING OLD MILLS.

Remodeling old mills is in a class by itself and each case presents a special problem depending upon the extent of the work and the condition of the mill. Like a new mill the cost of excavating, concrete, machinery, etc., can be rather accurately figured on, but the amount of hardware and lumber than can be used again and the amount of new material required is often misleading. The carpenter work and assembling of machinery will generally cost twice as much as in a new plant. It is a tearing down and building up process that no rules can be given for.

GENERAL COMMENT.

The main causes for underestimates are:

Guess work, lack of good organization, false economy, omissions and change of plans, neglect of preliminary work, too much reliance placed on general figures, and inefficiency of labor resulting from surroundings. Under unavoidable circumstances may be mentioned unexpected strikes or inefficient labor, bad-weather delays and the failure of railroads or supply houses to deliver material as expected.

Any reputable machine house will give valuable information. Nearly all have one or more experienced engineers and will gladly go into all details with the buyer. It is a mistaken idea to think that they let their responsibility end with the last car of machinery that leaves their plant. This is far from being the truth, as the writer knows through personal experience that they will go to considerable expenditure of time and money to start a plant right or to give sound advice at any time. There are plenty of would-be metallurgists who are always willing to build a plant for half the bid of a reputable house, but without exception they are a most expensive "economy." This also applies to the manufacturer of untested goods. Almost without exception a small mining company cannot afford to experiment with such things. If there is merit in the innovation the larger companies will soon pick it up and demonstrate it.

While realizing that these figures are subject, to a certain extent, to the criticism of experienced construction engineers, they are given with the hope that they may be useful to some operator who finds himself up against a mill-construction job. If the plans are followed, a good organization maintained, and efficient labor secured, the figures will be found a little higher than actual costs. Mill construction is by no means an exact science, but experience will give every one his own empiric formulas upon which he can bank. Sectionalized machinery for mule-back haulage cannot be erected at these prices.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Harry T. Curran, in the Engineering & Mining Journal.

ROADS AND STREETS

Brick Monolithic Construction of County Highways.

The dictionary gives the meaning of monolithic as "something which is constructed all in one piece," and while the road which is to be described has a concrete base with a brick wearing surface, the brick are placed directly on the concrete while it is still green, so that to all intents and purposes the road is made up of one solid slab.

Since the first monolithic brick road was laid, April 1 and 2, 1915, at Paris, Illinois, our common enemy, the so-called sand cushion, has found some very strong and able defenders. The writer was of the opinion that every one conceded that the only reason for the layer of sand between the concrete base and the brick wearing surface was to take up the irregularities in the concrete base and the paving block, but it seems there are those who believe that it acts as a cushion. With the old type of construction, when sand or asphalt filler was used and each brick might act, at least partially independent of the other, this might have been true, but if sand acts as a cushion it must give or move and this is fatal to a cement grout filled brick road.

Many engineers have aimed at the elimination of the sand cushion and a brief account of such work as the writer has been able to find a record of might not be out of place.

Baltimore constructed a street some four or five years ago and in place of using the ordinary sand cushion, a dry mortar cushion, one part cement to five parts sand, was used. This cushion was spread on the concrete base, struck off to a thickness of one inch as in ordinary construction. The brick were then laid and rolled, after which water was applied on the top of the brick in sufficient quantity to set the cushion. I believe that Baltimore is doing more work along this same line at the present time.

The city of St. Louis is putting in some of the same kind of work this year, except a 1½-in. dry mortar cushion is used, said cushion being made up of one part cement to four parts sand. In 1914 there was laid in Cleveland, Ohio, a strip of pavement which was along the same line as the work we have done in Paris. The 6-in. concrete base was laid and 5-in. brick were immediately placed on the green concrete, rolled by a light roller and grouted. This was put in by a cold storage company, but the name of the company or the exact location is not a matter of record. In the Pennsylvania Railway station in New York there is an example of this work which was laid on a dry mortar cushion. The brick were only 2½ ins. thick and were fire clay brick. The writer has been told, but has been unable to verify it, that paving of the same kind has been laid in Springfield, Missouri, along the street car tracks. It is very probable that other work has been done along these same lines of which there is no record.

Where grout filler is used the sand cushion is not so much a convenience as a constant source of annoyance and worry, if the work is to be properly constructed.

One specification is, that sand must not be rolled up between the brick more than ½ in. This means that any brick pavement that receives a rain before the brick have been rolled is very apt to need to be taken up and relaid. It makes inspection exceedingly difficult in that it is hard to tell just where to draw the line. And then, again, we know that the sand does not need to be rolled up over the entire length of the road but if it occurs at any place it is liable to cause trouble where no cross expansion joints are used. We do not use cross expansion joints and are firm believers in not only their uselessness, but their destructiveness to brick roads. The cross expansion joints provide that which we are trying to avoid, that is, a chance for the pavement to give. A pavement without cross expansion joints does not move in expansion if it is properly confined but only tends to move. The force is always there, however, to move it when the restraints are removed. A good illustration of this was seen at Paris this summer. A brick road, with no cross expansion joints, 4,500 ft. long and 17 ft. wide, was laid on a 1-in. sand cushion terminated at one end against an 80-ft. steel bridge. Due to the construction of a new dam it became necessary to remove this bridge and put in a new one some 8 ft. higher than the old structure. This necessitated the removing of some 400 or 500 ft. of the above described road. Just as soon as these brick were removed the pavement began to creep and has moved some 3 or 4 ins. since the restraint was removed.

The writer visited a pavement at Chrisman, Ill., during the past summer that had blown up. This pavement was constructed in 1914, the brick being laid on a 2-in. sand cushion and rolled with an 8-ton roller. When I began to examine the brick that had blown up I found that in a majority of the cases the sand had been rolled up between the brick at least one-half the depth of the brick, or about 2 ins. To any one familiar with what brick will do under such conditions it is no wonder at all that this pavement refused to stay in place.

In order to get away from the constant worry of how the sand cushion was acting this type of pavement was developed. Mr. Blackburn, of Paris, Illinois, made the first sample of this work and the details of the construction have been worked out by Alan J. Parrish, a contractor, of Paris, Illinois.

When the weather stopped the state aid work in Edgar County in 1914 we had enough donated money left to build 400 ft. of 10-ft. brick road. When this construction was brought to the writer's attention he immediately secured the consent of the State Engineer to build this 400 ft., using this type of construction. The work was started April 1, 1915, and 200 ft. laid, the remaining 200 ft. being laid April 2. Since that time we have constructed in and near Paris 13,150 sq. yds. of this type of brick road and have under contract at the present time 11,780 sq. yds. of state aid work which will be constructed this year. Before starting work this spring we were wondering as to how it would work out in practice. We found that it not only worked out completely satisfactorily but it is an easier type of construction in every way than if we were using the old methods.

In the preparation of the subgrade the rough work is generally done with a traction engine and a grader, the engine thoroughly compacting the subgrade. The subgrade is dressed up by hand, after which a 5-ton self-propelling roller is kept constantly at work while the material is being hauled. Steel forms 8 ins. in depth and 12 ft. long are then set true to line and grade. The concrete base is 4 ins. thick and the brick are 4 ins. in depth, making when completed an 8-in. monolithic pavement. Steel forms, while not absolutely essential, are a great convenience in this type of construction.

LAYING THE BASE.

The concrete for the base was a 1 to 6 mixture of cement and washed gravel. The gravel tested very close to 50 per cent through a ¼-in. square mesh. The base for the state aid work now under contract will be 1 part cement, 3½ parts fine aggregate and 6 parts coarse aggregate. Enough water is used so that the concrete is of a quaky consistency but will not flow.

It was found that an excess of water caused no trouble in keeping the brick up to a true surface. In order to get approximately the right thickness of concrete before cutting it with the template, a small wooden guide is used.

The steel template used is necessary in order to secure accurate results on this type of work. This template, as you can see, is made up of a 6-in. I-beam in front and a 6-in. channel behind. They are placed 2 ft. apart and supported by four rollers, one at each end of each member. The rear edge of the template is set exactly 4 ins. below the top of the forms and the front edge is set 4 3/16 ins. below the top of the form. The hopper like space between the two edges is kept filled with a dry mix consisting of 1 part cement to 5 parts sand. The template is drawn forward

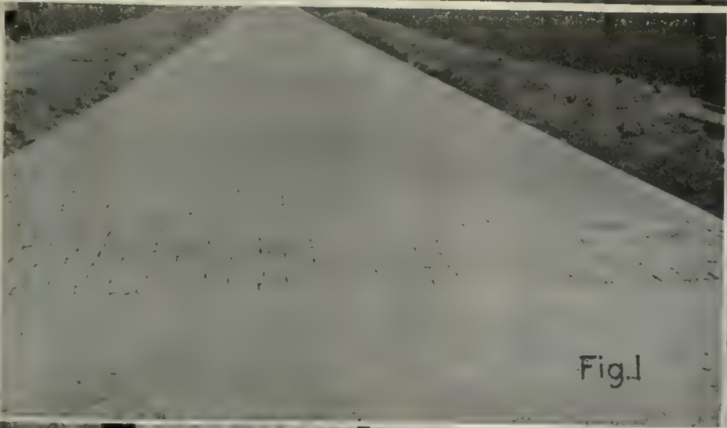


Fig.1

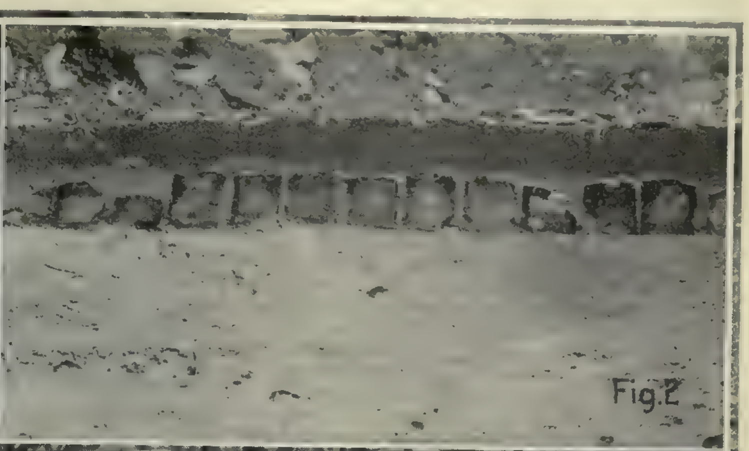


Fig.2

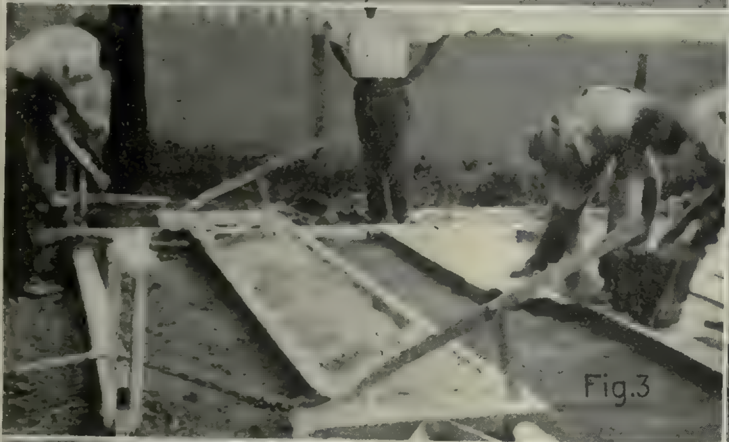


Fig.3

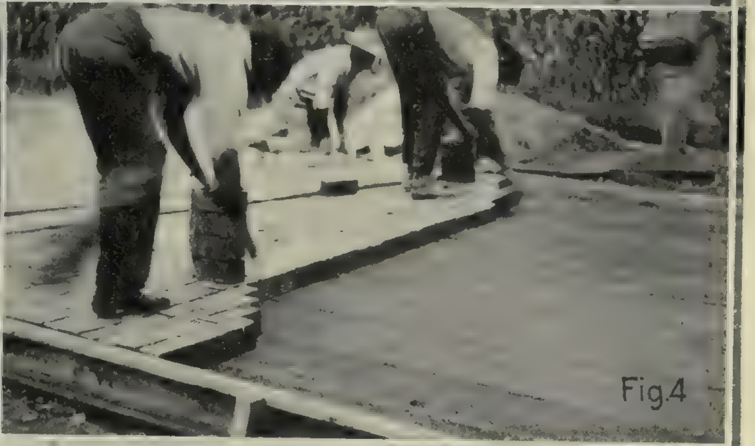
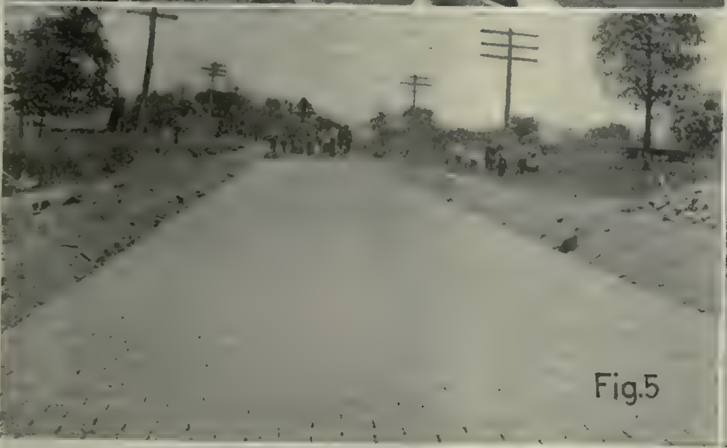


Fig.4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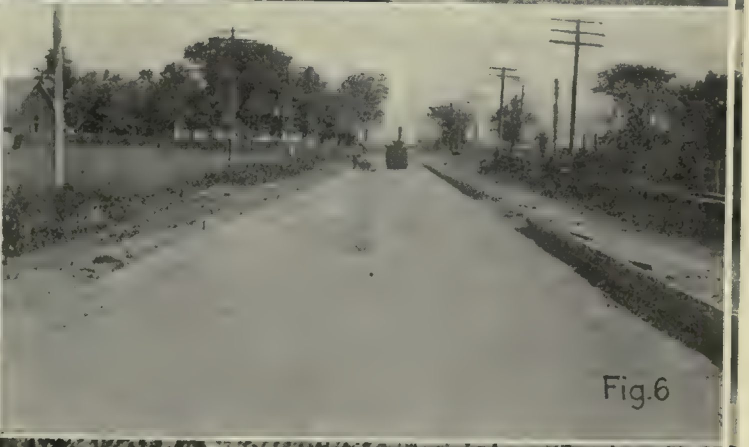
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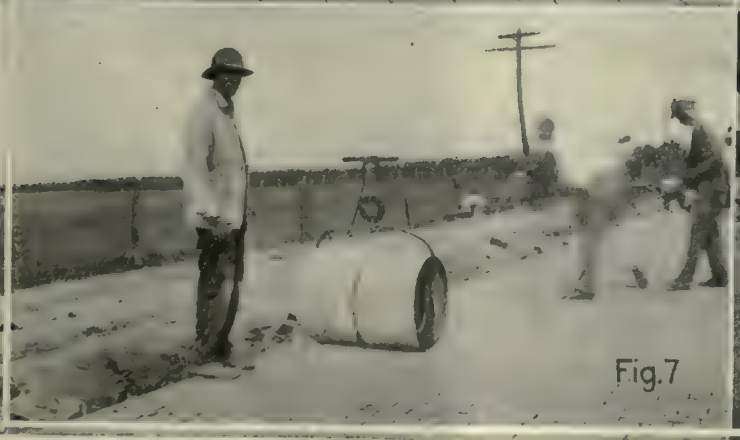
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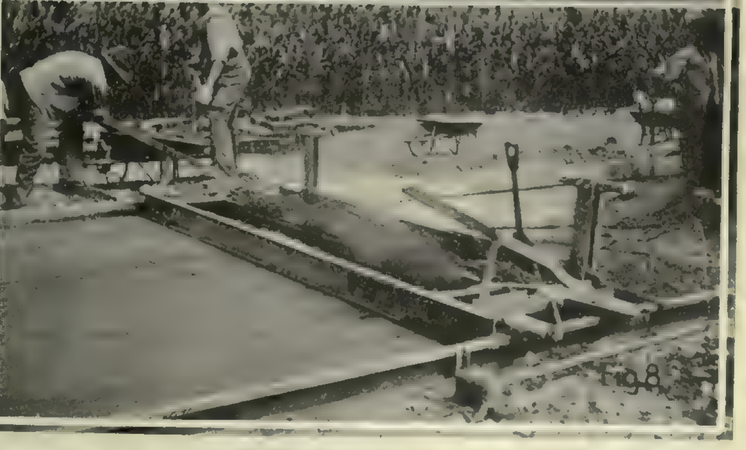
Fig.8

Construction Views of Brick Monolithic Road Construction in Illinois.

Fig. 1—View showing end of one day's work and the beginning of another. Fig. 2—View showing edge of road; note the grout filler **extends** to bottom of the brick. Fig. 3—A close view of the template; note the dry mortar mix between two edges of the template. Template is now ready to move ahead. The wooden guide is shown just in front of template. Fig. 4—View showing a strip of the concrete base covered with a thin film of dry mortar; note the plank that is used for the carriers to walk upon as they come onto the pavement. The man who is doing the batting is seen only about 6 ft. behind the brick layers. Fig. 5—Brick rolled ready to be grouted. Fig. 6—Finished subgrade, showing steel forms in place. Fig. 7—View showing the roller used. Fig. 8—View of the template.

by means of a cable and a friction clutch on the mixer. As the template is drawn forward, the front edge cuts the concrete 3/16 in. below the grade and a thin film of dry mortar is spread over the concrete, filling all the little depressions in the surface. Theoretically, the dry mortar coat should be exactly 3/16 in. in thickness. In reality it does not have any noticeable thickness but is sufficient to give a perfectly smooth surface on which to lay the brick.

LAYING THE BRICK.

Practically the only place where more care need be taken with this type of construction than where a sand cushion is used, is in the laying of the brick. It is essential to have the brick rolled within 20-30 minutes after the concrete base is laid and to do this culling must be reduced to a minimum. The carriers are required to deliver the brick to the setter so that he can easily lay them in the road with the good face up and the lugs all one way. In this way the most of the culling is done by the carriers and but very few brick need be turned after they are placed in the road. It is necessary for the setter to use a little more care than where a sand cushion is used, but he is the only man in the gang who does not work at top speed. It is advisable to have two planks 1x12 in. and of a length equal to the width of the pavement for the carriers to use when coming on the pavement. This saves tracking dirt on the brick and also prevents uneven places in the pavement, due to the fact that the carriers will all come on the pavement at about the same place.

As soon as the brick are laid the necessary culling and batting is done, the pavement swept and rolled. A two section roller 30 ins. long and 24 ins. in diameter and weighing about 750 lbs. is used. This roller is easily handled by one man and leaves a much better surface than it is possible to secure using the old type of construction. The brick are not embedded more than ¼-in. in the base.

A 1 to 1 mix of cement and sand is used for the grout filler. This is mixed dry in a small batch mixer and then conveyed to the grout boxes on the pavement by means of wheelbarrows.

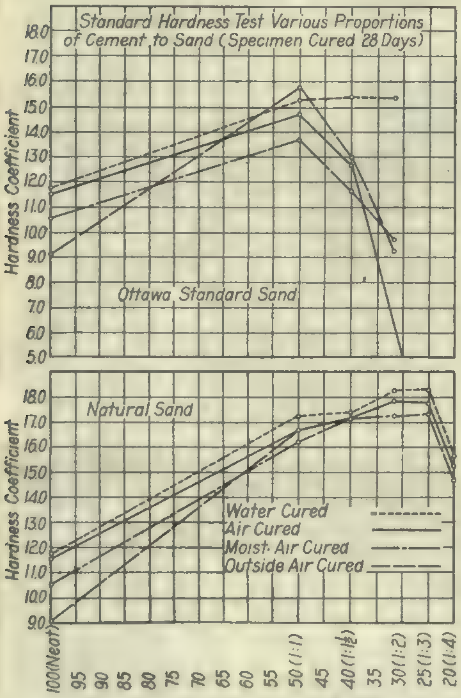

Fig. 1. Results of Hardness Tests of Cement Mortars.

The maximum size of batch allowed in the boxes is 2 cu. ft. of the mixture. Water is added slowly and the mortar built up gradually, after which it is thinned to a consistency that will flow readily into the joints. The grout is stirred constantly while being removed from the boxes with scoop shovels. The joints are filled completely full at the first application but after settling the top of the grout is about ½ in. below the top of the brick. Before the first application has taken its initial set the joints are filled a second time. The second application of the grout is mixed to a consistency of thick cream. In making this second application enough surplus is left on the road so that the surface can be gone over again without bringing the boxes back. The surface is finished with a squeegee, the joints being left entirely filled.

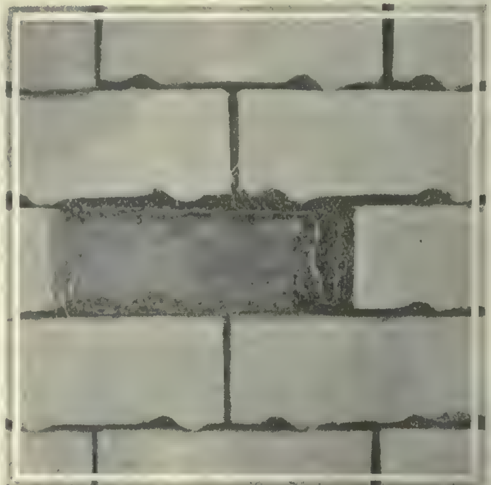

Fig. 9. One Brick Removed Showing Film of Water Which Has Been Rolled Up to Top of the Concrete Base.

In order to secure the best obtainable surface the squeegees are pulled over the road at an angle of 45° with the joints. This prevents the squeegee from dragging mortar out of joints and leaving them lower than the surface of the brick.

The pavement is covered the following day with ½ in. sand or earth which is kept wet at least 5 days. The side forms are removed the second day. The pavement is allowed to set 10 days before the side roads are graded, three weeks before being opened to traffic.

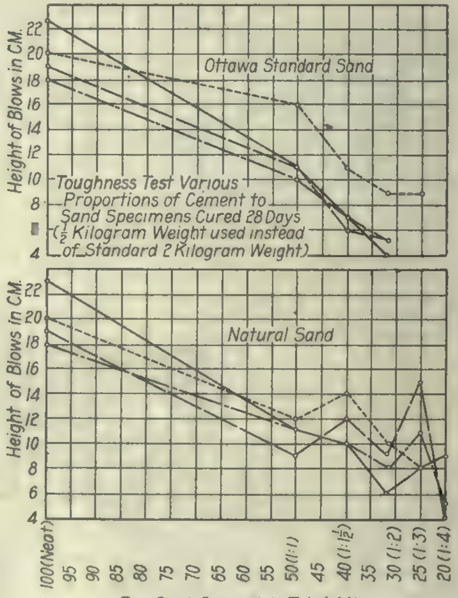

Fig. 2. Results of Tests of Cement Mortars for Toughness.

ADVANTAGES OF NEW TYPE.

(1) A better surface can be obtained.

(2) The work is easier on both contractor and inspector.

(3) There is no guess work at any point of the construction.

(4) Under similar conditions it represents a saving of from 10 to 12 cts. per square yard over the old method.

(5) Eliminates the breaking down of the filler at a construction crack, as each brick has a rigid support.

(6) Opens the field for experiment with thinner brick.

(7) The filler is sure to reach the bottom of the paving block.

(8) Removes need of a flush curbing.

(9) Eliminates the rumbling in brick pavements.

Some 200 engineers and contractors have visited the work at Paris and without exception they have been very enthusiastic over the possibilities of this type of construction.

ACKNOWLEDGMENT.

A paper by Rodney L. Bell, Division Engineer, State Highway Department, Illinois, read before the Northwestern Road Congress at Cedar Rapids, Iowa.

Financing Good Roads in Canada.—The building of good roads in Canada, while stopped to some extent by the lack of funds, continues in many sections of the country. During the fiscal year 1913 Quebec Province expended $3,303,882 on the good-roads movement. A fairly large amount was spent last year also. Saskatchewan is another Province making excellent progress with the building of good roads. Ontario for some years has made a policy of better roads of primary consideration. It is building roads to assist settlers in Northern Ontario and also in the more settled communities. Now being constructed is a concrete highway from Toronto to Hamilton, a distance of about 40 miles.

Comparative Tests of Hardness Toughness, and Strength of Mortar.

(Staff Abstract.)

The diagrams, Figs. 1, 2 and 3, show the relative hardness, toughness, and crushing strength of mortars mixed in different proportions and in which two different sands were used. These diagrams are self-explanatory. Their interest lies chiefly in the light which they throw on the wearing quality of different mortars for concrete roads. They are redrawn from a bulletin on concrete roads by C. H. Moorefield and J. T. Voshell, highway engineers, U. S. Department of Agriculture.

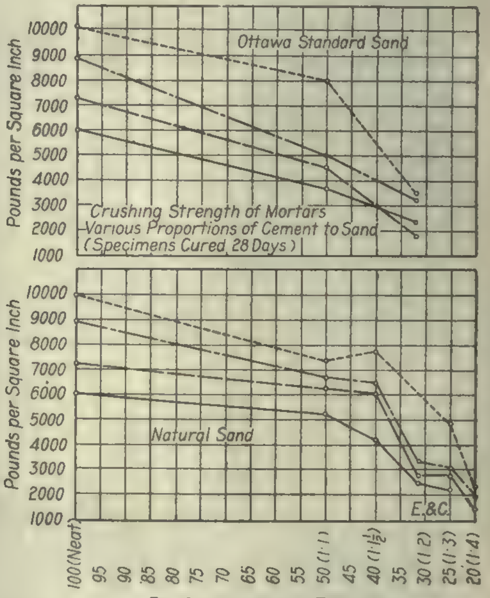

Fig. 3. Results of Crushing Tests of Cement Mortars.

RIVERS AND HARBORS

Combination Concrete Pavement and Board Mattress Bank Protection.

(Staff Abstract.)

The protection described was used on the Red River near Shreveport, La. After grading the river bank to a slope of about 1 to 2, the subaqueous mattresses, which were built upon pontoons, were sunk into place. These mattresses were of the lumber type, lumber being used because of the scarcity of willow brush, and were similar to those which have been used by the Mississippi River Commission. The mats were built in sections of convenient length, having widths varying from 75 to 125 ft., as required in order that they might extend at least 25 ft. along the river bed beyond the bottom of the bank slope.

In the construction of this type of woven mattress, 1-in. plank was used in widths of from 4 to 6 ins. and in lengths of about 12 ft. The marginal strips or head blocks consisted of 1x6 in. plank arranged in two layers. The under layer of the head block, which consisted of a single thickness of plank, was first laid in continuous lengths with lapped joints securely nailed and wired with No. 10 galvanized wire. On this section of the head block were then placed the so-called weaver boards, set at right angles to the head block with their ends securely spiked thereto. These weaver boards being spaced 3 ft. 9 in. on centers were thus arranged so the 12-ft. transverse boards when woven under and over them would span four weavers.

The transverse planks, which were securely nailed to each weaver board, were laid with open spaces of 4 to 5 ins., so that the mattress would be less buoyant than if made with close joints and still have opening sufficiently small to retain the stones used for weighting down. After the weaver boards were secured to the under half of the head block, the head block was then completed by setting a similar strip of 1-in. plank on top of the weaver boards to which it was securely wired and nailed.

Galvanized steel wire cables ⅝ in. in diameter were made fast to the head blocks and to four of the weaver ends nearest the outer edges of the mattress. These cables were passed around the weavers and securely fastened to them with staples while under tension from a capstan. At 25 ft. intervals cross binders consisting of two or three thicknesses of planks well nailed together were spiked to the top stringers and wired to the mattress. The mattresses were built on working platforms supported by pontoons from which they were sunk into place by loading with large stones which varied in weight from 20 to 100 lbs.

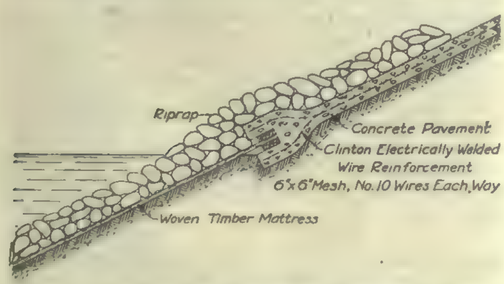
Riprap
Concrete Pavement
Clinton Electrically Welded Wire Reinforcement 6"x6" Mesh, No. 10 Wires Each Way
Woven Timber Mattress

Fig. 1. Connection Between Concrete Pavement and Timber Mattress.

The upper bank, or portion of the levee above ordinary low water stage, after being carefully graded to the proper slope, tamped and rolled, was covered with a 4-in. slab of reinforced concrete. The concrete pavement was laid in alternate sections 5 ft. in width. This was accomplished by placing 2x4 in. wooden strips extending up and down the bank dividing the slope into panels.

The reinforcement consisted of Clinton Electrically Welded Wire of 6x6 in. mesh with No. 10 gage wires in each direction. This material was rolled out on the slope with lapped side joints and elevated above the ground at intervals by extending over the 2x4 in. strips. The material was held in this position by additional strips placed over the wire and nailed to the under strips. The concrete was then poured in alternate 5-ft. panels, being distributed into place by sectional chutes extending from a movable mixing plant operated on the top of the bank. After a series of these panels had set, the wooden strips were then removed and the intervening panels concreted from a second traveling mixer operating from the top of the bank. The concrete was mixed in the proportions of 1:4:6 and was carefully spread and tamped into place.

At the connection between the subaqueous mattresses and the concrete pavement covering the upper portion of the bank, great care was taken to secure a suitable joint which would resist washing and subsequent tendency to separate. This was accomplished by casting the lower edge of the concrete slab in the form of a fork, Fig. 1, with one prong extending under and one over the upper edge of the timber mattress. As an additional precaution this was covered with a layer of riprap.

The work was designed by Major Frank M. Kerr, chief of the State Board of Engineers, assisted by Mr. Gervais Lombard, while the contract was executed by the Miller Engineering Co. of Little Rock, of which Mr. Charles H. Miller is president and Mr. A. C. Butterworth vice-president. The total cost of the project, which includes about 5½ miles of levees, is estimated at $350,000.

ACKNOWLEDGMENT.

Extract from an article in "Steel Fabric," published by the Clinton Wire Cloth Co., Clinton, Mass.

Improved Method of Setting Bench Mark for Determining Hydraulic Slope in Channels.

(Staff Abstract.)

A favorite method of determining the hydraulic slope of water is by leveling between the tops of nails sharpened at both ends and driven into stakes whose tops are below the surface of the water. An evident drawback to this method is that driving the double-pointed nail dulls the top. Without a fine point the top of the nail does not give a good "bead" at the water surface. Also with a sharp top the nail is not a good base on which to rest the level rod. Both objections are overcome in a device used by F. C. Scabey, irrigation engineer, U. S. Department of Agriculture. An ordinary flat headed wire nail is used and is driven by the device shown in Fig. 1. This device consists of a motor-cycle spoke soldered into a hole near the edge of the surface exposed by cutting off a ⅜-in. punch. The spoke is bent in the form of a buttonhook and carefully sharpened. The end of the spoke forming the pointed hook was originally threaded for the nipple, which was retained and served as a protection to the point in carrying the device. The final sharp point is in the same plane as the clean cut end of the punch. Therefore, if the wire nail is driven by means of the punch, in much the same manner as a carpenter sets a nail below the surface of wood with a carpenter's punch, then the top of the wire nail is just flush with the surface of the water when the sharp point of the hook shows at the surface of the water as an ordinary hook gage. This presupposes that the punch has been held truly vertical in setting the nail. This is assured in the following manner: Near the top of the punch two holes 1/16-in. in diameter are bored at right angles to each other. Through these holes a well-oiled fishline forms a four-tie suspension for a perforated disk. The hole in the disk is a trifle larger than the punch which passes through it, so that when held truly vertical the disk acts as a plumb bob, not touching the punch at any point. A very slight leaning of the punch causes the disk to touch, which of course warns the operator that the punch must be plumbed.

Methods and Cost Survey of Trinity River, Texas.

(Staff Abstract.)

The River and Harbor Act approved July 25, 1912, provided for an allotment of $100,000 for an accurate instrumental survey of the Trinity River below Dallas, Tex., including a line of precise levels. The control of this survey has been completed, and it is the object of this article to indicate the methods considered for horizontal control, and the method adopted—primary traverse.

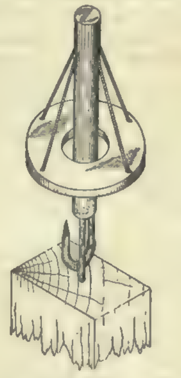

Fig. 1. Hook Device for Setting Nail Head Flush with Water Surface.

There is no question of the superiority of control by triangulation, but, as is usually the case with the best, it is the most expensive. It is desired here to bring out the fact that for difficult river surveys, such as the Engineer Department is being constantly called upon to make, horizontal control by primary traverse is sufficiently accurate for the purpose, and that it has the great advantages over triangulation of much less cost and considerably less expenditure of time. The primary traverse line of this survey, connecting, as it did, two triangulation stations approximately 394.5 miles apart and in adjusted systems, affords a good example of the accuracy that can be expected.

FIELD OPERATIONS.

In order that the best results might be secured, it was decided to carry on the control work using three parties, viz.: a locating, a primary traverse, and a precise level party. Each party was under its own chief of party, and all three parties were under the supervision of the junior engineer in charge of the survey. That plenty of time might be allowed the chief of the locating party to cover thoroughly the ground, and to make the best selection of line, his party was placed in the field well in advance of the other parties. The last two parties started at approximately the same time, and soon combined as one party for transportation and subsistence purposes.

Locating Party.—This party was organized at Lock and Dam No. 7 (Mile 463), and began field work on Nov. 13, 1912. It was provided with two small boats, 16x30 ft., with loaded draft of 11 ins. These boats were used as mess boats, and to carry supplies. The party occupied tents as quarters. The composition of the party was as follows:

1 chief of party;
1 foreman (in charge of moving boats);
1 instrument man;
2 rodmen (1 placing monuments);
1 cook and 1 assistant;
14 laborers.

This party was charged with the locating and clearing of the control line with the view of selecting a line that would serve to the greatest extent practicable the needs of the topographic work. This necessitated its being as near as possible to the river bank, for most of the topographic work is in or near the river channel. However, on account of the extreme crookedness of the river, and the desire to keep the line as short as possible, it was impracticable to keep near the river bank at all points. Further, it was desired to keep the line on the left bank of the river throughout, thus avoiding crossings which increase the difficulties of the traverse and level work.

It will be seen from the above that much depended on the good judgment of the chief of this party.

All turning points were marked by *bois d'arc* hubs in such a manner as to last the period of the survey. At intervals of about 1 mile there were placed two concrete monuments, 12x12 ins. by 4 ft., in each of which was set a 3-in. galvanized iron pipe 4 ft. long with brass cap marked U. S. E. D. Elev. —— B. M. No. ——. Four hundred and forty-three of these monuments were placed. These monuments were placed in pairs, marking the ends of a course, so that an azimuth might be obtained at any bench mark. All monuments served both as bench marks and as reference points. At intervals of about five miles, a glass insulator was placed inside and 2 ins. below the top of the galvanized iron pipe. The cap on this pipe was the same as others, except that it could be screwed off and insulator point used as precise bench mark. One hundred and ten of these monuments with glass insulators were placed. Sand and gravel for bench marks were secured along the river.

It is worthy of note that a glass insulator, used as described above, is considered a good level bench mark, because its rounded top permits the bottom of the rod to assume only one elevation and because the mark can not be changed in elevation. It is either broken, or it is the same elevation at which it was placed. No kind of a metal plug has this advantage; it may be driven down, in which case its change of elevation is not evident.

The operation of the locating party was about as follows: The chief of party carried on a reconnaissance ahead, locating the line. The line, once located, was cleared out; its length and bearing were determined by the instrument man, and monuments were placed. The instrument work was almost identical with that of the primary traverse party, though much less accuracy was attempted.

It is possible that a justified saving could have been made by eliminating all instrumental work; still, in view of the extreme length of the line, and of the fact that there would be no chance to check it at intermediate points, it was considered that the results obtained by this party would serve as a good check on a possible large error of the traverse party, such as the dropping of a part of a tape length, etc.

This party located, cleared, and placed monuments on 351 miles of line. The cost of this party was as follows:

Wages field party	$ 4,098.24
Placing monuments (553)	805.16
Material in monuments	2,461.29
Subsistence	1,892.67
Equipment[1]	530.29
Boats[2]	481.58
Hauling[3]	404.79
Traveling expenses	99.82
Superintendence	896.55
Total	$11,670.39

[1] Includes only 50 per cent of value of certain equipment that was later turned over to topographic parties; a transit belonging to the office was used and no charge made.

[2] Includes 50 per cent of cost of boats; balance charged to topographic survey.

[3] This party was furnished a team for hauling supplies. This item includes upkeep of team, and hire of additional teams when needed; first cost of team, etc., $597.50, was charged to equipment.

From the standpoint of economy in connection with the topographic work to follow, the locating of this line was one of the most important features of the control work. The work falling on this party was very hard and disagreeable, and great credit is due to Mr. C. A. Ridenour, Junior Engineer, for the successful manner in which it was done.

Primary Traverse Party.—This party was under the charge of Mr. E. L. McNair, Topographer, whose services were obtained from the U. S. Geological Survey by transfer. The organization of the party was as follows:

1 chief of party.
2 chainmen.
2 axemen.
2 boatmen.
1 cook.

Starting on Dec. 5, 1912, at Dallas, Tex., from the U. S. Geological Survey triangulation station, Caruth, longitude 96° 46′ 27.42″, latitude 32° 51′ 38.25″ (about five miles north of Dallas), this party ran a line along the Houston & Texas Central R. R. to Wilmer; thence along highways to Lock and Dam No. 4 (Mile 482½); thence along highways via Lock and Dam No. 6 to Lock and Dam No. 7 (Mile 463), where the topographic survey was to begin. This line to Lock and Dam No. 7 was approximately 43 miles in length; it was run in 14 days.

In running the line to Lock and Dam No. 7, the party was subsisted in towns along the way, and at Locks and Dams Nos. 4, 6 and 7. After leaving Lock and Dam No. 7, the party was quartered in tents and had a mess boat similar to that of the locating party.

This party was overtaken at Lock and Dam No. 7 by the precise level party, and the two parties were combined for transportation and subsistence.

The instructions under which this party worked were as follows:

> All angles were to be measured with transits reading to twenty seconds. The methods of reading were to be the same as those used by the United States Geological Survey. (See page 78 of "Topographic Instructions of the United States Geological Survey.") Distances along the traverse line were to be measured both forward and backward, with a limiting error of 1:10,000.

This party ran 394.5 miles of line in 1,930 courses. It made 66 observations for azimuth. Observations for azimuth were made on Polaris at any hour.

The line was closed on June 28, 1913, on the U. S. Coast and Geodetic Survey triangulation station Wiggins No. 2. This station is located on the shores of Turtle Bay, an arm of East Galveston Bay. Triangulation Station Wiggins No. 2 is in a system of the Coast and Geodetic Survey along the Gulf coast. Triangulation Station Caruth is in the system of the U. S. Geological Survey, which system has been tied to the Coast and Geodetic triangulation system along the 98th meridian. This latter system is tied to the Gulf coast system at Corpus Christi Bay.

The co-ordinates of the Triangulation Station Wiggins No. 2 are given as 94° 42′ 10.728″ longitude, 29° 49′ 23.682″ latitude. From the computations of the primary traverse line, they were found to be 94° 42′ 08.164″ longitude, 29° 49′ 21.608″ latitude, giving a difference of 02.564″ longitude, and 02.074″ latitude, or 225.85 ft. and 209.51 ft., respectively.

As stated previously, the allowable error in an individual course was 1:10,000. It will be seen from the above that the error of closure was approximately 1:6,761.

The weather conditions were so bad, and so much time was lost in moving camp, that though the party was in the field 202 days, work was possible on the line but 95½ days. The cost of the field work of this traverse line was as follows:

Wages field party	$2,687.58
Subsistence	905.40
Traveling expenses	291.38
Equipment[1]	312.64
Boats[2]	271.94
Miscellaneous	162.57
Instruments	410.50
Superintendence	1,386.22
Total	$6,428.23

[1] There is charged to this work only 50 per cent of the cost of equipment, later turned over to the topographic parties.

[2] Fifty per cent of cost of boats is charged to this work; balance to topographic survey.

Precise Level Party.—This party, under the charge of Mr. W. P. Stewart, Junior Engineer, was organized as follows:

1 observer.
1 recorder.
2 rodmen.
1 sun-umbrella man.
1 wind-shield man.

It started on Dec. 1, 1912, from the U. S. Coast and Geodetic Survey Bench Mark A-2 at the Court House, Dallas, Tex. (Elevation 433.969 ft. M. S. L.), and ran a line along the most direct practicable route to Lock and Dam No. 2 (Mile 489½), thence along the west bank of the river via Lock and Dam No. 4, thence along highways via Locks and Dams Nos. 4 and 6, to Lock and Dam No. 7 (Mile 463), where the survey was to begin. This line was 38½ miles in length, and was run in fourteen days.

This party was quartered and subsisted in the same manner as the primary traverse party, to which it was attached later for convenience of transportation and subsistence.

The methods employed by this party were in general those used by the Mississippi River Commission. After the combining of this party with the primary traverse party, it was necessary for it to increase its rate, and in order to do this the method of observing was changed, and back sights were always read first, both on direct and reverse lines. The instrument used was Buff & Berger precise level No. 2768. The rods were of the Molitor design, the reading of the bottom of each one being zero. Foot plates were used for turning points for about 10 per cent of the line, and iron pins for the remaining distance.

At Wallisville, about 2½ miles from triangulation station Wiggins No. 2, this party left the control line, and ran a line around Turtle Bay through Anahuac, to a bench mark near Round Point, Tex. The work on the line was completed July 3, 1913. The elevation of the bench mark at Round Point was determined by the U. S. Engineer Office, Galveston, Tex., by simultaneous tide gage readings at Round Point, Red Fish North, and Red Fish South, in connection with a general determination of levels of various points in or near Galveston Bay. (See Report of the Chief of Engineers, U. S. Army, 1891, pp. 1879-1890.)

The elevations of this bench as determined by the Galveston office and by this precise level line were:

	M. S. L. ft.
U. S. Engineer Office, Galveston	18.416
Precise level	20,404

From a comparison of the above elevations it appeared that there was a large error in the precise level line, and to determine its amount, an auxiliary line was run from Liberty, Tex. (Mile 41), to Houston, Tex., where a connection was made with the U. S. Coast and Geodetic Survey Bench Marks J-8 (Elevation 46.516 ft. M. S. L.). This line was run July 7 to 24, 1913. The elevations of this bench as given and as determined by the Dallas office were:

	M. S. L. ft.
Dallas Office	46.516
U. S. Coast and Geodetic Survey	45.006
Error	1.510

Special difficulties were encountered in running this line, on account of the heat. To verify the line it was re-run Nov. 18 to Dec. 12, 1913, with the following results:

	M. S. L. ft.
Dallas Office	46.685
U. S. Coast and Geodetic Survey	45.006
Error	1.679

The error 1.51 having been previously distributed uniformly in the distance Dallas to Liberty, no change was made following the re-running of the Liberty-Houston line. The same unit correction was applied to the distance Liberty to Anahuac, and the corrected elevation of the bench mark near Round Point was found to be 18.904 ft., or a difference of 0.487 ft. from that obtained by the U. S. Engineer Office, Galveston, Tex., by simultaneous tidal observations.

The precise level from Dallas to Round Point is 398.2 miles in length. In connection with this line there were run several short lines to locks, etc., with a total length of 14.2 miles.

The total length of precise level line run between Dallas and Round Point was 412.4 miles. About 80 per cent of it was run along the river bank and about 20 per cent of it along roads and across open country. There were numerous bluffs along the line, and many creeks, but on the whole the conditions were favorable, and comparatively little trouble was experienced in securing fair closures. Nine per cent of the line was rerun.

The party was in the field on this line 215 days. Field work was done on 132½ days. The cost of the field work on the precise level line was:

Wages, field party	$2,747.10
Subsistence, field party	945.44
Traveling expenses, field party	76.85
Equipment[1]	351.48
Boats, etc.[2]	217.94
Superintendence	1,536.23
Total (412.4 miles)	$5,875.04
Cost per mile run	14.246

[1] There was charged to this work only 50 per cent of the cost of such equipment as was later turned over to the topographic parties. The precise level and rods were borrowed from the Lake Survey.

[2] Fifty per cent of cost of boats is charged to this work; balance to topographic party.

The auxiliary line, Liberty to Houston, was 41.5 miles in length; it was run along the highways and the railroad.

The cost of the field work of the precise level line from Liberty to Houston was:

Wages, field party	$348.00
Travel	72.25
Subsistence	113.50
Total	$533.75
Cost per mile run (41.5 miles)	12.86

The cost of re-running this line in November and December, 1913, is not given, as a special party was organized for that work.

COMPUTATIONS.

The computing of the primary traverse line was done in the Dallas office. Work was begun on May 10, 1913, and completed on Aug. 25, 1913.

As stated above, the error in closure was 225.85 ft. in longitude, and 209.51 ft. in latitude. The line was adjusted for these errors, the errors being distributed equally throughout.

The cost of the computations and adjustments was:

Wages	$1,248.83
Superintendence	75.00
Miscellaneous	19.88
Total	$1,343.71
Average per mile	3.26

The formula used in these computations is that of the U. S. Coast and Geodetic Survey, i. e.:

$$-\Delta\phi = S \cos a \; B;$$
$$\Delta\lambda = S \sin a \; A' \sec \phi';$$
$$-\Delta a = \lambda \sin \phi'.$$

When

S = Distance in meters between stations;
ϕ = known latitude;;
λ = known longitude;
ϕ' = unknown latitude;
λ' = unknown longitude;
$\Delta\phi$ = difference in latitude;
$\Delta\lambda$ = difference in longitude;
Δa = difference in azimuth;
A' and B = L. M. Z. coefficients.

The use of the U. S. Coast and Geodetic Survey formula, rather than that of the U. S. Geological Survey, was decided upon for the following reasons:

(*a*) With the U. S. Coast and Geodetic Survey formula, each course must be computed separately, and therefore the labor involved is more than that with the U. S. Geological Survey method which computes by combining several courses in one computation. However, the U. S. Geological Survey method introduces a cumulative error, which is undesirable, and this error becomes serious when the combined courses exceed approximately 4,000 ft. in length. For accurate work, therefore, the U. S. Coast and Geodetic formula is better.

(*b*) The computer was familiar with the use of the U. S. Coast and Geodetic Survey formula.

(*c*) To derive any benefit from the use of the U. S. Geological Survey method of computation, a special computing machine was necessary, which would cost more than the labor it might save.

The following tables were used, and are recommended for use by those making similar computations:

Logarithms of Sines and Tangents for Every Second; by Robert Shortrede. Published by Charles and Edwin Layton, London, England. $10.50.

Logarithmic Tables of Numbers and Trigonometrical Functions; by Baron von Vega. Published by Lemcke & Buechner. 30-32 W. 27th St., New York, N. Y. $1.88.

Formulæ and Tables for the Computation of Geodetic Positions, Department of Commerce, U. S. Coast and Geodetic Survey.

The computations for the precise level line were made in the Dallas office. Work was begun July 24, 1913, and completed on Aug. 24, 1913.

The cost of the computations and adjustments was:

Wages of computers, etc.	$250.00
Superintendence	75.00
Total	$325.00
Average cost per mile	0.79

RESUME OF COST.

As stated before, lines were run from Dallas or vicinity to Lock and Dam No. 7 (Mile 463), where the survey work was to begin. The conditions under which these 40 odd miles were run were so different from those governing on the control line, that the cost is kept separate in the following summation:

Cost of locating control line (351 miles)	$11,670.39
Cost of horizontal control, Dallas to Lock aid Dam No. 7 (43.5 miles)	225.35
Cost of horizontal control, Lock and Dam No. 7 to Gulf (351 miles)	7,546.60
Cost of vertical control, Dallas to Lock and Dam No. 7 (38.2 miles)	382.10
Cost of vertical control, Lock and Dam No. 7 to Gulf and to Houston (412.4 miles)	6,351.69
Total cost	$26,176.13

CONCLUSIONS.

From the above it will be seen that the results of the primary traverse work were very satisfactory. Having a triangulation station at each end made it possible to obtain a check on the results, and to make an adjustment. The error in this case was so small that no appreciable error would have appeared in the final maps had there been no adjustment.

The precise level work was not satisfactory. While sufficiently accurate for the purposes of the survey, it is regretted that the results were not sufficiently high grade to be received with full credit by the U. S. Coast and Geodetic Survey.

The cost data were kept carefully, and are reliable. No account was taken of the value of the equipment at the end of the work, and since that value was undoubtedly greater than the value of the old equipment used, the cost is slightly higher than it should be, rather than lower. Conditions as to old equipment and equipment on hand at the end of the work are about what would ordinarily obtain in an Engineer district.

There is no question of the superior accuracy of control by triangulation, and it is not the intention to dwell on the primary traverse method as its equal. It is maintained, however, that the triangulation method for river surveys like that of the Trinity River is too expensive for the results desired, and that control by primary traverse is well adapted to such surveys.

An examination of the cost data above will show that the big single item of the cost of the control was the locating of the traverse line. If triangulation had been used for control, this same traverse line would have been necessary. In addition, lines connecting the traverse line with triangulation stations would have been necessary. With triangulation, the instrument work on the traverse line would not have had to be so carefully done, but the saving in cost on account of this would not compare with the extra cost of the additional lines connecting traverse with triangulation stations. So the conclusion that the traverse line would cost more with triangulation than without it is unavoidable.

Of course there was the danger of errors in the primary traverse line, but since the actual work on the line cost but $7,771.95, it could have been re-run at least four times for the estimated cost of the triangulation.

To Capt. Ernest Graves, Corps of Engineers, is due the principal credit for the methods adopted for the horizontal control, and for the computations. Captain Graves also outlined the general scheme of locating and marking the control line. The field work was under the immediate charge of Mr. T. B. Warden, Junior Engineer, and great credit is due him for the satisfactory results obtained, both in the successful prosecution of the control work, and the completeness of the cost data.

ACKNOWLEDGMENT.

Extracts from a paper by Maj. T. H. Jackson, Corps of Engineers, U. S. A., in "Professional Memoirs" for July-August, 1915.

GENERAL

The Interstate Commerce Commission and Its Work.

(An address by E. E. Clark, of the Interstate Commerce Commission, before the National Industrial Traffic League, at Toledo, O., Sept. 9, 1915.)

In some quarters the tribunal of which I happen to be a member is accused of entertaining, and of exercising, a spirit of hostility toward the railroads. If a railroad, whose financial history has been little, if anything, less than a public scandal from a time that antedates the enactment of the act to regulate commerce, goes into the hands of a receiver, certain publications solemnly announce that it has been forced into bankruptcy through the hostile and unreasonable policy and actions of the Interstate Commerce Commission. If the commission finds that certain proposed increased rates are reasonable, those same writers sneeringly assert that it is a delayed and reluctant granting of but a small part of that which should be granted to the railroads. If the members of the commission disagree as to the propriety of, and justification for, the proposed increased rates, they assail those members who disapprove and laud those who approve. Thus, if a commissioner happens to be on one side in one case and on the other side in another case, he is both approved and disapproved.

From another quarter we are accused of being desirous of doing only those things that the railroads wish us to do; and the assertions and accusations from that quarter are as extreme and as violent as are those emanating from the quarters first mentioned.

And so, dependent upon the point of view, we are different beings, animated by different impulses and doing things which are diametrically opposed to each other. But is the one who will not see more than one side of a question, who attributes dishonesty to every-one who does not see as he does, and as narrowly as he does, necessarily the only one who sees rightly? Is his point of view infallible? May not some of his conclusions or deductions be wrong?

I remember reading when a boy a poem which described the trip of six blind men of Hindustan to see an elephant. The first approached the animal and, happening to fall against its side, exclaimed, "Why, bless me, but the elephant is very like a wall!" Another chanced to grasp the elephant's tusk and asserted that the beast was like a spear. The one who came in contact with the elephant's ear declared that the animal was like a fan; the one who grasped the elephant's tail was sure that the elephant was much like a snake; the one who laid hold upon the elephant's trunk was certain that the animal resembled nothing but a tree, etc.

And so these men of Hindustan
Disputed long and loud,
Each in his own opinion
Exceeding firm and strong,
Though each was partly in the right
And each was in the wrong.

Every nation or people has a national sport, pastime or game. I have long known that in the United States we had two national games. The first is played in small parties, and generally in private. Of that one I will only remark that no one cares to play with the man who continually grumbles because he cannot win every pot. The second, baseball, is played in public; the crowd is always with the home team, and many of the onlookers find their greatest enjoyment in roasting the umpire. Of late I have been almost inclined to think that a third pastime—finding fault with the Interstate Commerce Commission—is becoming so popular as to be almost national, and I am disposed to pattern after the manager of a Texas baseball team, who appealed to the crowd, "Don't shoot the umpire, he is doing the best he can."

IMPORTANCE OF QUESTIONS CONSIDERED.

But, seriously, the questions which you gather together to discuss, and with which you deal, are parts of a problem of tremendous importance. Transportation is the very life blood of the commerce of the nation. The railroad industry of this country is probably, with the exception of agriculture, the greatest of our industries. Efficient and adequate railroads are essential to the maintenance and expansion of our commerce. Under our plan of private ownership railroads have been, are and will be, built only when those who promote and further the enterprise have faith that in due time it will be profitable. Excepting the lands which were granted to some roads, a railroad has only transportation to sell and no other source of revenue. The railroad company, created by public grant of franchise, is obliged to assume certain obligations, among them the regulation by public authority of many of its affairs, and is given certain privileges and guarantees, among them the right of eminent domain and protection against confiscation of its property through regulation or other means.

It must submit to regulation because otherwise, as has been amply demonstrated, unjust discriminations, undue preferences and unreasonable rates would be indulged in and imposed, and commerce, instead of flowing in natural channels, would thrive or languish according to the will of those who possessed the transportation facilities. Business, manufacturing, producing and marketing would all be subject to artificial domination and control. It must be accorded the right of eminent domain, as, otherwise, spite and greed would throw insuperable obstacles in the way of its construction. It must be protected against confiscation because it is, after all, private property which the public has no right to use except upon the payment of reasonable compensation.

REASONABLE COMPENSATION FOR PROPER SERVICE.

I do not doubt, and I have never doubted, the willingness of the great majority of the people to pay reasonable compensation for reasonable and proper service. I do not doubt the willingness of the great majority of those who manage the affairs of our railroads in these days to furnish good service in return for reasonable compensation. The difficulty comes in the difference of opinion as to what is reasonable compensation, either as a whole from all of the traffic, or in individual instances. These differences are often so acute that they must be decided by some disinterested, impartial tribunal, and manifestly they should be heard in an open forum in which all parties' rights are respected and protected.

Under our form of government these questions, insofar as they do not involve confiscation of the carriers' property, are within the jurisdiction of the legislative branch of the government. Acting within its lawful powers, the Congress has delegated certain authority to a body created for the purpose of deciding controverted questions of unreasonable, unjustly discriminatory or unduly preferential rates, rules, regulations or practices. That body, like the Texas umpire, is doing the best it can. I do not mean that it is doing the best it can to please everybody. It does not aspire to accomplish the impossible. It is doing the best it can to discover and establish that which is right, reasonable and just. It stands with its face to every wind that blows, decides the questions that come to it in a judicial spirit, endeavors to be helpful when it can in promoting harmony and thorough understandings between the carriers and their patrons, and does not worry about whether or not its decision or action is going to be popular.

The act to regulate commerce has been on the statute books since 1887, but it can fairly be said that real regulation under it dates back only to 1906, when by amendment the act was given vitality. The problem was not then, and is not now, to devise a model system of rates and regulations for railroads not yet built, or for industries and communities not yet located or developed. The conditions of trade and transportation that had grown up in a rapidly developing country served by railroads that had always been operated as private industries, free from governmental control, each going its own way in accord with the policy or ideas of those who for the moment were in control of it, had to be dealt with.

PURPOSE OF ACT.

I think the court was perfectly right when it said that the purpose of the act was to promote and not to hamper trade and commerce. We may see situations and conditions which are wrong and which apparently should be corrected. But if, upon thorough investigation, it is demonstrated that in order to correct it other situations equally as bad, or worse, will be created, no real progress is made by forcing such action. The conditions which the law was enacted to correct or overcome did not grow up in a day and they cannot be corrected or overcome in a day without doing inestimable and irreparable injury. The evils at which the law is aimed were not created by one party to the transactions. No railroad official ever paid a rebate except to some receptive shipper. The ideal situation cannot be attained except through a general disposition and desire on the part of both railroad officials and shippers to support and observe the principles which form the foundation and cornerstone of the law. Just such associations as yours and the various traffic clubs of the country assist in getting men to think alike, and when they think alike there is little trouble about getting them to act alike. The solution of these profoundly important and far-reaching problems must be approached and dealt with in a broad way. The foundation must be laid in sound principles of right. If a railway company imposes wrongs upon, or deals in bad faith with, an individual or a community, its owners may expect hostility against the company and its interests. If a shipper defrauds or attempts to defraud the railway company by falsifying as to his shipments or his claims he cannot expect its officers to attach much importance to his representations in a matter that is of real importance to him, and in which his contentions are right. Every temporary or transient advantage that is secured by trickery or by evasion of truth and right retards the progress toward the conditions which we all should seek to enthrone.

The law provides that the patron of the railway shall be accorded reasonable and nondiscriminatory rates and service. If he has been charged an unreasonable rate or has been damaged by an unlawful discrimination he may recover reparation. If the railway maintains an unreasonably low rate it cannot repair losses sustained as a reason thereof on past transactions. If the railway maintains unreasonably low rates as to some traffic or as to some communities, it may not recoup itself by laying unreasonably high charges against other traffic or other communities. This principle has been well established in recent decisions of the courts.

WHAT CONSTITUTES A REASONABLE RATE.

And this leads to the query, What is a reasonable rate? There is no statutory definition of it. No scales or yardsticks are provided by which it can be weighed or measured. It cannot be determined solely by the cost of the service, because that cost, plus a reasonable profit, might, as to some commodities, be prohibitive. It cannot be measured alone by the value of the service, because that would open the way for the railway to absorb, as to some traffic, the profits that legitimately belong to the shipper. It cannot be ascertained from a consideration of distance only, because so to do would destroy competition between producing fields and in common markets. In the last analysis it is a question of judgment, and, very properly, the judgment that finally controls is that of a disinterested, impartial tribunal, whose decisions must be made only in the light of full hearings and proper investigations, and are, as to matters of law, reviewable in the courts.

Some questions, which to my mind are of fundamental importance, remain to be decided by the commission and the courts, or to be disposed of by the Congress.

As I have suggested, the laws guarantee the owners of the railways against confiscation of their properties. What constitutes confiscation? What is the reasonable profit which the railway may lawfully demand? Upon what property may that profit be based? I think that the courts have clearly laid down the principle that the carrier is entitled to earn a reasonable return upon the property that is devoted to the public use, as of the time of its use. Now come the questions, What is the value of the property, and how is it to be determined? Certainly not by figuring a return upon the outstanding bonds and stocks. Two railroads may have been built in a common territory, under substantially similar conditions, at approximately the same time, and should have cost approximately the same per mile. Throughout its construction and operation one of them may have been conservatively managed and financed as a straight-out business venture, while the other one may have been the prey of graft during construction and of plunder under operation. The capitalization of the one may represent actual investment and outlays, while that of the other may represent all the money that those in control of its affairs have been able to borrow, or to raise by the sale, at ruinous rates of discount and interest, of securities far in excess of the cost or value of the property, or of stocks that can never have any value.

Being in common and competitive territory, their rates must, under the law of competition, be the same. Will anyone say that the capitalization of these properties forms any reasonable basis for determining what they may properly earn from serving the public?

Within a period of two or three years in proceedings before the commission and the courts one railway company proved by witnesses several different valuations of its property, and the differences in those valuations exceeded one hundred million dollars. The item of interest during construction was variously shown in sums which differed so widely that it seemed obvious they were not taken from any records which were considered reliable or permanent.

Such experiences as this led to the conviction that an official and dependable valuation of the railway properties should be had, and by authority of the Congress that work has been undertaken. The law which was adopted for this purpose is exhaustive and requires the performance of a vast amount of detail work and the determination of many vexed and vastly important questions. No one has blazed the path. The results ought to be sound, equitable and right. When these valuations are finally fixed they will be of great assistance to the commission and to the courts in connection with cases which involve alleged confiscation of property of carriers. It will not be possible for each railroad to earn the same return upon the value of its property, because controlling competition in transportation and in commercial life will require substantially equal charges in competitive territories, and we have so many railroads and such a vast commerce that there is not much territory that is not competitive.

There are those who think that if the railroads in a particular section of the country can, as a whole, show that their net return from operation is unusually or unduly low they should all be permitted to increase their charges on all of the traffic or upon important parts thereof. If all of these roads had been constructed, financed and operated on business principles and as business concerns, and the net results of their operation showed an improperly low return, I would find no difficulty in accepting the view that they were justly entitled to such increases in their charges as would render their operation properly profitable. But in such a case the tribunal that authorized such an increase should have the power also to fix the minimum rate, so that the burden might not be inequitably distributed. The carrier has a right to fair compensation for each service performed by it, and for its services as a whole. The public should pay such compensation. The carrier is entitled to earn a profit from legitimate enterprise and effort, but when it comes to increasing rates in general or upon an important part of the traffic, I find difficulty in accepting the theory that because certain roads are in financial straits all roads in that section may properly increase their rates, when the greater number of those roads have for a series of years been able, under existing rates, to maintain their properties in splendid condition, pay all fixed charges and taxes, declare each year handsome dividends upon their stocks and carry rather liberal sums to their surplus accounts.

I do not wish to draw invidious comparisons, but I want to make this point clear. I do not attempt to analyze the reasons for the conditions to which I refer as to some carriers, and I refer only to matters that are public property and common knowledge. The Burlington and the Rock Island systems are very generally strongly competing systems. They have operated in common territory and largely under common scales of rates. The one has maintained in good condition a splendid transportation system, has a strong and healthy financial standing, and has regularly paid fair, if not liberal, dividends to its stockholders. The financial condition of the other, and in general the reasons therefor, you all know.

And so I say that, while desirous of according that which is right to the carriers as much as to the shippers, one may well hesitate about assuming responsibility for approving large increases in rates for the purpose of relieving a financial strain that is composed of the average of the necessities of such roads as the Burlington, the Northwestern, the Union Pacific, the Great Northern, the Northern Pacific and the Santa Fe on the one hand, and the Frisco, the Rock Island, the Alton, the Wabash, the Great Western and the Missouri Pacific on the other hand.

The commission has consistently declined to prescribe rates based alone upon the favorable conditions obtaining as to the short line and the strongest, richest carrier. It should, of course, decline to approve rates based only upon the conditions and needs obtaining upon the line of the carrier that is poorest and that has an unfortunately located line.

I have traveled some upon the railroads of Europe. They have some roads which, for those countries and for the services demanded from them, are excellent, well-equipped transportation agencies, which perform an acceptable service. They would not, however, be able to meet the demands in our country. Taking into consideration circumstances and conditions, I think that we have the best railroad service in the world. There are many improvements that might be made, and some that ought to be made, but in general it is good and efficient.

REVENUES AND CAPITALIZATION IN VARIOUS COUNTRIES.

The latest figures available show that the charge for the transportation of freight is much lower per ton mile in the United States than it is in other countries. Glancing over comparative figures for recent years we find that the ton mile revenue in various countries is: United Kingdom of Great Britain, 2.39 cts.; Germany, 1.37 cts.; France, 1.3 cts.; Austria, 1.45 cts.; Norway, 1.6 cts.; Belgium, 1.14 cts.; Switzerland, 2.92 cts.; New South Wales, 1.76 cts., and South Australia, 1.94 cts.; while for the United States it was, in 1913, 7.29 mills.

These figures, however, do not tell all the story. Referring to other figures, we find that the railroads of the United States move 2,737 tons of freight one mile per capita per annum, while in Germany, where the movement by rail is heavier than in other European countries, the railroads move only 582 tons one mile per capita per annum. I believe it has been recognized by successful business men that a large volume of business with a small profit on each transaction is more desirable than a small volume and larger profits on each deal.

The railroads of Europe are capitalized much more heavily than are those of the United States. They are much more completely equipped with signal and other safety devices than are our roads, and generally their roadbed and stations are more expensively constructed and with a view to more permanency.

In many of those countries the railroads are largely or wholly owned and operated by the governments. But on the whole such ownership and operation has not proven entirely satisfactory, and it certainly has not afforded the people cheaper transportation than could have been furnished under private ownership, properly regulated.

We have 250,000 miles of railroad, serving a broad territory, in much of which the commerce and traffic is heavy, and in all of which the commerce and traffic is growing rapidly. We hear much about inducements to build new roads. In my judgment, what is needed is not so much the building of new roads, but the development of those that are already built, so as to make of each an efficient agency, properly equipped with terminals and rolling stock, all maintained in such condition as to afford prompt, dependable and safe service.

If the public demands such roads it must be willing to pay reasonable prices for the services performed by them. If the railroads desire to have and to operate with profit such roads they must convince the public that they are, and are to be, operated along business lines and at rates that fairly compensate for the service performed and yield a fair profit upon the value of the property which is devoted to the public use.

Both the railroads and the public must contribute to the effort to bring about this nearly ideal condition. Each, while guarding its own rights and interests with appropriate jealousy and zeal, must recognize and respect the rights of the other. But even when that is done there will be honest differences of opinion which must be decided by a third party, whose decisions must be based in law and in right, and in whose integrity and fairmindedness both have confidence.

SUGGESTED CHANGES IN THE LAW AND IN ITS ADMINISTRATION.

And now a few words as to changes in the law and in its administration. I know that you are giving attention to these questions and I disclaim any desire or intent to influence your conclusions or actions. I express a few thoughts along those lines for what they are worth.

The Supreme Court of the United States has decided that the courts have no jurisdiction to review a negative order of the commission, and some think that this gives the carriers a right that is withheld from the shippers. Personally I see no reason why the law should not give the shippers the same right of appeal that it gives to the carrier. I do not think that such right would be of great benefit to the shippers. The Supreme Court has laid down the limits within which the courts can review the findings of the commission. The court may inquire whether or not the commission has proceeded lawfully, whether or not its findings are supported by competent evidence, and whether or not its order invades the constitutional rights of the carrier. If the proceeding has been conducted lawfully, and the findings are supported by evidence, and the order does not invade the carrier's constitutional rights, the court may not set aside the order or substitute its judgment for that of the commission.

Of course the shipper has just as much right to a lawful proceeding and a finding based upon competent evidence as has the carrier. The constitutional rights of the shipper are not at all the same as those of the carrier. The law does not attempt to regulate the shipper's selling prices.

As has been seen by the annual reports of the commission, we think that there is a defect in the law in that the periods of limitation within which the carrier may demand the payment of uncollected undercharges are much longer than the period within which the shipper may bring action for recovery of an unreasonable charge. In a few instances this has caused real hardship.

Conditions that are probably different from those that were anticipated have sprung from the most recently enacted amendment to the act to regulate commerce. It has been strongly urged that the amendment was never intended to apply to shipments by express or to the transportation of baggage. We have been unable to discover any clear indication that it attempts to draw any distinction between carriers by rail and express companies. The Supreme Court has held that that portion of the law applied to the transportation of baggage. Congress knew of that decision and it made no provision in the amendment for excluding baggage from its terms. By the canons of statutory construction, therefore, the law must be held to apply to baggage. If Congress desires to exempt the transportation of baggage and shipments by express from the operation of this provision it can, of course, effect that by further amendment.

The question of reparation for damage suffered from the exaction of an unreasonable rate or from an unjust discrimination has been and is one upon which decided differences of opinion are entertained and expressed. The Supreme Court has made it clear that in a discrimination case the damage suffered may be more or less than that measured by the exact extent of the unjust discrimination, and the true measure of the damage suffered must therefore be shown by competent proof. There are those who assert that the same rule should be applied in awarding reparation because of the exaction of an unreasonable rate. The commission has not accepted this view, but has held that the one who bears the unreasonable charge has been damaged to the extent that the charge exceeded that which it has been found would have been reasonable.

CONCERNING THE REORGANIZATION OF THE COMMISSION.

A good deal has been said and written about the necessity for a reorganization of the work of the commission, or the commission itself. No one realizes more fully than do the members of the commission the magnitude and the complexity of the duties placed upon the commission. The system under which our courts are organized and their several jurisdictions defined is often pointed to as a pattern for organizing the work of the commission. Inasmuch as in ordinary litigation before the courts the parties affected are generally before the court, while in matters coming before the commission the whole public is interested and many who are not before the commission in the case may be affected by the conclusion reached, we may well doubt the wisdom and practicability of dividing the jurisdiction geographically, with the certainty that at times cases involving substantially the same facts and the same principle will be decided differently in different jurisdictions. The Supreme Court pointed out the impossibility of maintaining the underlying principles of the act if the courts in their several jurisdictions were to pass upon questions of an administrative or a quasi-legislative nature.

The commission has given much thought to this subject and to the various plans that have been suggested for simplifying and expediting the work of the commission, and has reached the conclusion that the largest measure of relief and the best results would be secured by enlarging the membership of the commission and authorizing it to divide itself into groups or divisions, each division to have and exercise all the powers of the commission in the matters or cases referred to it. This would give us a mobile but still a centralized body, which could change its divisions and assignments to divisions when and as circumstances might require.

Personally, I feel that the valuation work is of such magnitude and importance and of such a technical nature that a commission or a division of the commission should give its undivided attention to the new and intricate problems which will arise in numbers as that work progresses, and especially as the time for fixing upon a valuation approaches.

The commission can perform the many duties devolving upon it only by thorough organization of its several bureaus and calling to its aid the most competent assistants available. Some features of our administrative work, as, for example, the safety appliance features, are so well organized and the principles of those laws are so well defined and established that they give the commission but a minimum of trouble and demand but little of the time of the commissioners. Where work or business expands with rapidity it is not always possible to extend an efficient organization as rapidly as might be wished.

The development of effective and beneficial regulation of the affairs of an industry of such magnitude and vital importance as that of transportation in this country is absorbingly interesting. It inspires one who is actively engaged in the work to bring to it his best thought and efforts. It brings to one a tremendous responsibility, plenty of hard work and, like all public service, more or less unjust criticism. Bearing responsibility does not wear heavily on the one whose heart is in his work and who has the courage of his convictions. Hard work does not hurt one, and unjust criticism, while unpleasant at times, will never affect the judgment or influence the actions of the man whose conscience tells him that he has done the right thing in the light as it is given him to see.

NEED FOR CO-OPERATION.

But, be he ever so able, the commanding general cannot win battles without assistants and soldiers; the manager of a successful industrial concern or railroad must have the loyal co-operation of his forces; the executive or administrative official who succeeds must have the cordial support of others who desire to see and participate in his success. And so, in order that those conditions which all right-minded men would be glad to see in the transportation business may be attained and firmly established, it is necessary that you and many others contribute each his part, no matter how small. As the light grows stronger and better days dawn for railroads and their patrons as a result of these efforts, everyone who has contributed to the better order of things by some helpful word or action will experience a sense of satisfaction over a good deed done.

Unit Costs of Steam Shovel Work in Cuba.

Contributed by Julius M. Bischoff, Assoc. M. Am. Soc. C. E., Sagua La Grande, Cuba.

The Cuban Central Railways, Ltd., with general offices at Sagua la Grande, Santa Clara Province, Cuba, began an extensive program of extension work in October, 1910, and continued until March 1, 1914, when all construction work was closed down. Owing to the unsuitability for surfacing and ballasting, of much of the material along the various extensions it was decided to secure better material at certain points on the line where satisfactory material was to be found. It was decided to excavate this material by means of a steam shovel and to haul it, where desired, by work trains.

As the railroad company did not have a steam shovel, a contract was entered into whereby the contractor was to furnish a steam shovel and crew, also all materials except water, explosives, and track material. The contractor laid and shifted all pit tracks at his expense. The railroad company paid force account plus 10 per cent for drilling and provided an inspector at the pit to measure up the excavated material. The contract price on the Cifuentes to Esperanza Extension, was 35 cts. per cubic meter aboard cars. The actual cost to the railroad company being about 40 cts. as the cost of explosives, drilling and inspection was about 5 cts. per cubic meter. The material was what is commonly designated as hardpan. The railroad company furnished locomotives, train crews, standard gage flat cars of 20 ton capacity, hauled and unloaded the material. Each car carried about 15 cubic meters of material and each train was made up of a locomotive, tender, ten flat cars and caboose.

The next contract entered into with the same contractor on the San Juan de los Yeras to Matagua extension called for furnishing material aboard cars at 25 cts. per cubic meter. On this extension the railroad company only furnished water and work trains, besides maintaining an inspector at the shovel pit. The contractor was not paid extra for explosives and drilling. The cost per cubic meter to the railroad company was about 27 cts. including inspection, which amounted to 2 cts. per cubic meter.

The contractor was operating two steam shovels on this extension and as another shovel was needed on the Panchita to Sierra Morena extension, the railroad company decided to purchase a steam shovel and operate it by administration forces. Another incentive was to bring down the cost per cubic meter as the contract price was considered to be too high. Accordingly in the fall of 1912 a Marion 41 was purchased from the Marion Steam Shovel Co., which shipped the shovel to Isabella de Sagua, the port of Sagua la Grande. The shovel was erected in the Sagua yards of the Cuban Central Railways and was sent out to Rancho Veloz, 6 kilometers from Panchita, where work was begun on Feb. 17, 1913.

The organization for the work is shown by Fig. 1. No salaries are shown for the chief construction engineer and the chief clerk, as only part of their time was given to this work. All salaries and wages were paid in American currency and ten hours constituted a day's work, from 5 a. m. to 11 a. m. and 1 p. m. to 5 p. m. Two hours for noon meal and rest are generally allowed at the middle of the day except at such time of the year when the daylight hours are fewer. Then the noon rest is cut down so as to get ten hours work per day.

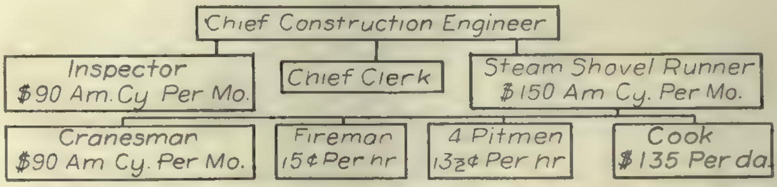

Fig. 1. Organization Chart for Steam Shovel Work in Cuba.

The two work trains were under the orders of the general track foreman while on the extension and under the orders of the inspector while in the ballast pit. The general track foreman was under orders of the chief construction engineer as tracklaying and surfacing was done by administration. Between Rancho Veloz and Panchita the line was in operation and much delay was experienced by the movements of the mixed trains, there being two trains per day each way between Sagua and Panchita. The form of daily reports was a modification of form M. W. 100 recommended in the Manual of the American Railway Engineering Association.

STEAM SHOVEL COSTS.

Panchita to Sierra Morena Extension, Feb. 17, 1913 to May 1, 1913: Material, sandy white clay known locally as "Jaboncilla"; also some rock and indurated clay, which required blasting. Much time lost waiting for cars due to mixed trains operating between the ballast pit and the extension. Number of days shovel worked, 58; number of cubic meters excavated, 18,645; cost per cubic meter aboard cars, 9.22 cts. (labor and supplies). Cost per cubic meter for interest at 6 per cent, also depreciation and repairs at 15 per cent or a total of 21 per cent on $9,000. Cost of shovel on a basis of 264 working days per year, 2.22 cts. This is an arbitrary fixed charge. Total cost per cubic meter aboard cars, 11.44 cts. (exclusive of overhead charges).

It should be borne in mind that a cubic meter is equivalent to 35.29 cu. ft. or 1.31 cu. yds.

The record of the steam shovel for the period June 25, 1913, to Nov. 23, 1913, is given in Table I to show the variation in production and the resultant variation in cost per cubic meter due to varying conditions. It should be noted that these adverse conditions are not under control of the officer responsible for the output of the shovel.

The steam shovel was sent to the Malezas to Cumanayagua extension of the Cuban Central Railways on June 25, 1913, and placed in the Caraballosa ballast pit, which had previously been opened by another steam shovel. Most of the available ballast, or surfacing material, had been excavated and very hard rock was encountered. The shovel was cut in, pit tracks laid, and hand drilling begun. No air or steam drills were available nor on hand as it was not desired to have the shovel work in rock. Hardpan and sand being the materials desired. Scarcely any work was done in July because locomotives and flat cars were not available. However, the crew had to be retained as the traffic department expected to furnish the work trains every day. This is a condition that must constantly be kept in mind, especially where experienced or skilled labor is scarce.

In the meantime, due to new and additional requirements for material arising, it was decided to move the shovel to the Mamon ballast pit and additional land was asked for, as only one cut could be taken by the shovel within the limits of the right of way. As this matter of extra land had to be taken up by the legal department and as the owner of the land was antagonistic to the railroad company, much delay was experienced in acquiring the extra land desired and as a consequence the shovel was again forced to lie idle for a period. After the extra land was finally secured, work began in earnest when unfortunately a work train broke allowing six steel frame flat cars loaded with about 20 cubic meters each of sand ballast, to escape on a 2 per cent grade. This accident, in which fortunately no lives were lost, caused such traffic regulations to be imposed as to materially hinder the output of the shovel and consequently to increase the cost of production.

A fixed charge of $7.16 per working day is made to cover interest at 6 per cent, also depreciation and repairs at 15 per cent, or a total of 21 per cent on $9,000, the cost of the shovel, based on 264 working days per year. The total cost for laying and shifting ballast pit tracks was $448.45, or, say, 1.9 cts. per cubic meter. It should be mentioned that no track gang was maintained at the shovel. Instead the work was either done by the construction track gang or by combining several maintenance of way section gangs and the cost charged against the shovel work. This method was found to be expeditious and economical and caused less delay to the shovel. The overhead charges may seem small, but this was because the chief construction engineer's time was divided amount the other works in hand and only a portion of his time was devoted to the operation of the steam shovel. No charge was made for track material such as ties, rails, switches, etc.

TABLE I.

Month.	Cost per cu. m. aboard cars.	Total cost per cu. m. aboard cars.	Cost per cu. m. for train service.	Total cost per cu. m. delivered.
June and July	112.76c.	135.75c.	116.76 c.	252.51 c.
August	23.60c.	31.67c.	33.90 c.	65.57 c.
September	16.40c.	23.10c.	27.80 c.	50.90 c.
October	8.35c.	13.20c.	29.00 c.	42.20 c.
November	11.22c.	16.35c.	31.705c.	48.055c.

Month.	Cost aboard cars.	Total cost aboard cars.	Cost of train service.	Total cost delivered.	Number of cu. m excavated.
June and July	$ 736.25	$ 886.48	$ 762.44	$ 1,648.92	653
August	644.79	865.48	926.62	1,792.10	2,733
September	748.00	1,053.54	1,267.87	2,321.41	4,561
October	793.48	1,254.52	2,754.78	4,009.30	9,500
November	725.42	1,056.79	2,049.37	3,106.16	6,463.7
Totals	$3,647.94	$5,116.81	$7,761.08	$12,877.89	23,910.7

Total number of cubic meters excavated, 23,910.7.
Number of days shovel worked, 76.
Number of days between arrival and departure of shovel, 150
Average length of haul each way, 57 kilometers.
Average cost per cubic meter aboard cars for labor and supplies, 15.25 cts.
Average total cost per cubic meter aboard cars based on 264 working days per year, 21.40 cts.
Average cost per cubic meter for train service, 32.46 cts.
Average cost per cubic meter delivered, 53.86 cts.

Remarks—The above figures are the cost for work done on this job. However these should not be taken as a criterion for steam shovel work owing to the exceptionally adverse conditions under which the work was done.

The total cost per cubic meter will be understood to mean cost delivered at point where material was needed. This does not include unloading, which cost on the average of ⅔ cts. per cubic meter. The cost per cubic meter aboard cars will be understood to mean cost for labor supplies (oil, coal, explosives, tools, etc.), one-half of the overhead charges, salary of ballast pit inspector, fixed charges (interest, depreciation and repairs) and track charges. The cost per cubic meter for train service includes engine service, conductors, brakemen, switchman, train inspectors, miscellaneous expenses and one-half of the overhead expenses. The engineman's and fireman's salary were included in the charges for engine service, which was per engine $30 per day of 12 hours and an extra charge for overtime. Flat cars were charged against the shovel at 32 cts. each per day. The traffic department cross-charged the salary of conductors and brakemen, the charge being $3 per day for a conductor and one brakeman. The switchman was paid $25 per month.

JUNE, 1913.

Labor	$ 95.70
Supplies	0.00
Engine service	13.71
Car service	2.18
Conductor and brakeman	3.00
Switchman	4.17
Overhead charges	18.75
Inspector	8.33
Fixed charges	0.00
Track charges	0.00
Total for June	$145.84

Ballast excavated, none. No charge is made for cutting in shovel as this charge was apportioned on the cubic meter basis for the whole job. The expenses for June are added to the expenses for July in order to secure unit cost figures.

JULY, 1913.

Labor	$ 562.61
Supplies	77.94
Engine service	491.00
Car service	96.00
Conductors and brakemen	93.00
Switchman	25.00
Overhead charges	50.00
Inspectors	45.00
Fixed charges	50.12
Track charges	12.41
Total for July	$1,503.08
Add June expenses	$ 145.84
Total	$1,648.92

PERFORMANCE.

Number of days shovel worked, 7; average number of cubic meters per day, 94.7; ballast excavated, hardpan, 527 cu. m. (blasted); solid rock, 126 cu. m. (blasted); total, 653 cu. m.

UNIT COSTS.

Total cost per cubic meter	$2.5251
Cost per cubic meter aboard cars	1.1276
Total cost per cubic meter aboard cars	1.3575
Cost per cubic meter for train service	1.1676

The greater part of the month was spent in drilling while awaiting engines and cars.

AUGUST, 1913.

Labor	$ 547.73
Supplies	97.06
Engine service	613.50
Car service	84.16
Conductors and brakemen	72.90
Switchman	25.00
Overhead charges	50.00
Inspectors	165.00
Miscellaneous	6.06
Fixed charges	78.76
Track charges	51.93
Total for August	$1,792.10

Performance—Number of days shovel worked, 11; average number of cubic meters per day, 248.5.

Ballast excavated—Hardpan, 877 cubic meters (blasted); sand, 1,856 cubic meters (blasted); total, 2,733 cubic meters.

UNIT COSTS.

Total cost per cubic meter	65.57 cts.
Cost per cubic meter aboard cars	23.60 cts.
Total cost per cubic meter aboard cars	31.67 cts.
Cost per cubic meter for train service	33.90 cts.

The greater part of the month was spent in awaiting the expropriation of land and for the new ballast pit at Mamon.

SEPTEMBER, 1913.

Labor	$ 594.32
Supplies	153.68
Engine service	934.00
Car service	153.28
Conductors and brakemen	105.59
Switchman	0.00
Overhead charges	50.00
Inspectors	115.00
Fixed charges	128.88
Track charges	86.66
Total for September	$2,321.41

PERFORMANCE.

Number of days shovel worked, 18; average number of cubic meters per day, 253.4.

Ballast excavated—Sand, 4,261 cubic meters (blasted); earth, 300 cubic meters; total, 4,561 cubic meters.

UNIT COSTS.

Total cost per cubic meter	50.9 cts.
Cost per cubic meter aboard cars	16.4 cts.
Total cost per cubic meter aboard cars	23.10 cts.
Cost per cubic meter for train service	27.80 cts.

Land was expropriated for the Mamon ballast pit and shovel began work on Sept. 8. The output was held down by reason of an insufficient car service.

OCTOBER, 1913.

Labor	$ 564.24
Supplies	229.24
Engine service	1,951.25
Car service	336.96
Conductors and brakemen	265.17
Switchman	25.00
Overhead charges	87.39
Inspectors	165.00
Miscellaneous	32.71
Fixed charges	171.84
Track charges	180.50
Total for October	$4,009.30

Performance—Number of days shovel worked, 24; average number of cubic meters per day, 395.8.

Ballast excavated—Earth, 493 cubic meters; sand, 7,977.6 cubic meters (blasted); hardpan, 1,029.4 cubic meters (blasted); total, 9,500 cubic meters.

UNIT COSTS.

Total cost per cubic meter	42.20 cts.
Cost per cubic meter aboard cars	8.35 cts.
Total cost per cubic meter aboard cars	13.20 cts.
Cost per cubic meter for train service	29.00 cts.

Owing to traffic regulations an extra engine was used to pick up empties in the Ojo de Agua station yard, haul them to the ballast pit to be loaded; and then haul the loaded cars back to Ojo de Agua where they were picked up by the material trains. This spotting engine was only allowed to haul six cars at a time. The operation of a mixed train also interfered with the movement of this engine. The shovel as a consequence was idle about three hours per day.

NOVEMBER, 1913.

Labor	$ 547.43
Supplies	177.99
Engine service	1,383.50
Car service	240.00
Conductors and brakemen	230.41
Switchmen	30.83
Overhead charges	88 34
Inspectors	136.49
Miscellaneous	33.80
Fixed charges	114.56
Track charges	122.31
Total for November	$3,106.16

Performance—Number of days shovel worked, 16; average number of cubic meters per day, 404.

Ballast excavated—Sand, 6,463.7 cubic meters (blasted).

UNIT COSTS.

Total cost per cubic meter	48.055 cts.
Cost per cubic meter aboard cars	11.22 cts.
This figure includes cost of moving shovel from Mamon to another location. Total cost per cubic meter aboard cars	16.35 cts.
Cost per cubic meter for train service	31.705 cts.

The material classified as sand while in the hill was very hard and compact and acted like a grind stone on the dipper teeth. Panama reversible teeth were used and became dull in two weeks' service. Therefore this material was blasted in order to lengthen the life of the teeth.

SUMMARY.

During June and July the amount of ballast excavated only represents two days' work under ordinary conditions. Therefore the unit costs for these two months should not be considered for steam shovel work under ordinary conditions.

During August the shovel only worked eleven days on account of waiting for the expropriation of land. Therefore this month's unit cost should also be disregarded.

During September eight days were lost waiting for the expropriation of land and therefore this month's unit can not be considered as representative.

The results obtained in October and November can be considered as fairly representative even though the work was rendered more costly than necessary owing to the traffic regulations imposed after the accidental breaking of a loaded train. Furthermore the cost was higher than necessary because it was imperative to have train inspectors in order to facilitate the movements of the ballast trains. This cost should be unnecessary as the conductors of the ballast trains and the station agents along the route should consider it their duty to make the runs without the numerous and long delays which these trains suffered. However this is a universal complaint of all having work, or ballast, trains under their supervision. The work train is considered a pariah and to have no rights. Trains of every class being given preference over work trains, which are often held unwarrantably so that by no possible chance of fate will they delay any other train.

Considering the work during October and November as fairly representative, we obtain the following unit costs:

UNIT COSTS DURING OCTOBER AND NOVEMBER.
(Based on 264 working days per year.)

Total number of cubic meters excavated	15,968.7
Number of days shovel worked	40
Number of days shovel was idle	18
Average length of haul each way (in kilometers)	53
Average cost per cubic meter aboard cars	9.51 cts.
Average total cost per cubic meter aboard cars	14.47 cts.
Average cost per cubic meter for train service	30.10 cts.
Average total cost per cubic meter delivered	44.57 cts.

The estimate of 264 working days per year is too high for the conditions under which the steam shovel would be used. It is thought that 168 working days per year would be more nearly true. This assumption would only affect the fixed charges which would become $11.25 per shovel working day instead of $7.16 as used in the above data. Therefore in the unit costs for the fairly representative months of October and November the following changes would be necessary:

Average total cost per cubic meter aboard cars	15.50 cts.
Average total cost per cubic meter delivered	45.60 cts.

From the foregoing it is evident that the railroad company saved money by operating the steam shovel with administration forces. On the bases if 23,910 cu. m. excavated on this one job the following comparison is shown:

	Cost per cubic meter.	Total cost aboard cars.
1st contract price	40 cents	$9,564.00
2d contract price	27 cents	6,455.70
Company operation	21.4 cents	5,116.74

The first contract was made before the writer assumed the duties of chief construction engineer. The second contract was made during the writer's incumbency, and the administration forces were under his direction.

Interlining a Timber and Steel Lined Shaft With a Cement Gun.

(Staff Abstract.)

Gunite may be defined as a mixture of sand, cement, and water blown on a solid surface by a high pressure of compressed air forcing it through a hose and nozzle. An essential part of the gunite coating is the use of some form of reinforcing wire to be applied to the surface to be coated before the cement is blown on. Gunite has been used to interline the Cary "A" shaft, at Hurley, Wis. Figure 1 shows details of the method adopted in applying the cement coating and its reinforcing. "A" shaft is a steel five-compartment shaft, sunk to a depth of 1,320 ft. in the quartzite. The steel sets are blocked in place with wooden blocking, and the lining of the shaft consists of 3-in. tamarack plank wedged into the flanges of the I-beams, which form the wall plates and the end pieces.

The purpose of the gunite coating was, first, to fire-proof the lathing and wooden blocking; second, to protect the lathing from contact with the air in the shaft, so retarding its decay; third, to form an air and water-proof coating over the shaft lining, keeping air from entering the space between the timbers and the rock, and keeping in the water which is flowing along in th same space. This last feature is expected to retard the decay of the blocking as well as the lathing as this will be water-logged all the time. The gunite coating, by reason of its wire reinforcement, which will be further described, is expected to reinforce the lathing and partially take its place in the event of decay actually occurring. The coating was applied not only to the walls of the shaft, but also to the steel dividers, the intention being to protect these from rust and incidentally reinforce them after the manner of a reinforced concrete beam.

The application of the gunite coating in "A" shaft was done in two experimental sections, one being from the collar of the shaft to the third level, the other from the eighth to the tenth level. In the first the machine was placed on surface and the hose lead down through the shaft to the point of application; in the second the machine was placed on the eighth level.

The first step in the application of the coating was to clean thoroughly the entire surface to be covered, which was done partly with water under heavy compressed air pressure, partly by sand blasting and party by chipping the rust and accumulated coating off the steel. Next the reinforcement was applied. This consisted of No. 7, American Steel & Wire Company's triangular mesh reinforcing wire for the side walls. This was originally intended to be applied as shown in the upper part of Fig. 1. This consisted of a nail driven into the space between the tamarack lathing and the flange of the I-beam. This nail was then stapled, together with the reinforcing wire, onto the lathing. This method was discarded as it placed too much reliance on the holding power of the staples in the wood, which might later rot. A method was substituted for this which is also shown in Fig. 1. This consists in stapling the reinforcing wire directly to the steel I-beams, and was used for most of the work. The reinforcing wire was also stapled to the laths at intervals between the steel sets.

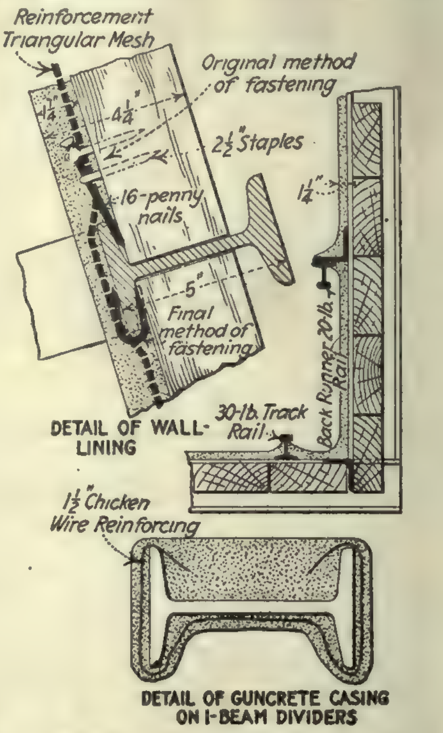
Reinforcement Triangular Mesh
Original method of fastening
1¼"
4¼"
2½" Staples
16-penny nails
1¼"
5"
Final method of fastening
20-lb. Back Runner Rail
DETAIL OF WALL-LINING
30-lb. Track Rail
1½" Chicken Wire Reinforcing
DETAIL OF GUNCRETE CASING ON I-BEAM DIVIDERS

Fig. 1. Details of Gunite Interlining for a Mine Shaft.

An important point in the application of the reinforcing wire is that it should be separated by a short distance, say ⅛ in., from the surface to be covered. This is so that the cement can get in behind the reinforcing and form a unit with it. This was accomplished by stapling the reinforcing wire on with nails under it. The I-beams, before the cement was applied, were covered with 1½-in. mesh chicken wire, clamped on with wire clamps. The dividers were filled in completely on their upper faces resulting in their reinforcement for bearing a downward load. This increase in strength is figured at nearly 20 per cent. The work progresses downward and it was found best to coat the entire sidewalls before coating the dividers. The thickness of the coating in "A" shaft was 1½ ins. and it was found that the operator was able to gauge this thickness with astonishing accuracy. The cement was applied in from two to three coats.

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The cost of lining "A" shaft as described came to $9.2978 per linear-foot of shaft. The total area of wall surface covered was 14,260.90 sq. ft., the total area of steel covered, measured along the contact of the cement with the steel, was 3,749.96 sq. ft. The material used was as follows: Sand, 102½ cu. yds.; cement, 173 bbls.; reinforcing, 14,260.90 sq. ft.; chicken wire, 3,749.96 sq. ft. Fastening staples and wire were also used. The work was accomplished by one foreman and six men in thirty-two working days. The total linear feet of shaft covered were 263.13.

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F. P. BURT,
Business Manager.

Sworn to and subscribed before me this 27th day of September, 1915.

C. E. MEINDERS,
Notary Public.
(Seal.)
(My commission expires June 7, 1916.)

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The Lighter Side of Engineering and Contracting

Just a Reminder: Smoke Up.

SKINNER MULVEY is watching the mails with great anxiety these days. He has a rich uncle on the firing line in France and he fears that he will not get shot. But that is not the only reason for the interest he takes in the postmen. He hopes that every delivery will bring him a story for this page. Four weeks ago the Skinner hung up a prize of $5 worth of tobacco for the best contribution submitted during September and October. He takes this opportunity to call attention to the offer and to remind his friends that now is the time for them to get busy. So smoke up and send in your stories.

Hell Got the Job.

A FEW years ago one of the busiest railroad contractors was a man who bore the somewhat startling name of John Hell. One time a letting was held at Denver and Hell was one of the bidders. A Chicago firm needed this job pretty badly and had figured it very closely, and fully expected to get it. One of the members of the Chicago concern went to Denver. Shortly before the hour for opening the bids the officials of the railway announced that the new line would not be built that season. The Chicago man much disgruntled wired his partner: "Work gone to Hell." The partner, sitting in his office surrounded by prospective subcontractors, opened the telegram and exclaimed: "What do you know about that? Johnnie Hell's got a job up in Maine and 20 miles of line in California, and now he's copped that Colorado work."

A Seltzer Engineer Lands a Job.

A GOOD all around man has just been named chief engineer of the water works department of one of Indiana's principal cities. The remarkable versatility of this individual is indicated by the fact that he was recently a candidate for sheriff. He has, in turn, been an active candidate for all jobs leading to pay checks drawn on either the county or city treasurer. He is said to be admirably qualified to discharge the duties of his new office, having worked three years as a machinist in the local railroad shops about ten years ago. A special qualification for the managership of a water department controlling three large pumping stations is found in his recognized ability to handle a loaded seltzer bottle.

The Troubles of a Right of Way Man.

RIGHT of way agents sometimes have their troubles. The route for one of the branch lines of the Frisco ran directly through the farm of a crabbed old citizen. The agent after much dickering made an offer of $1,000 in cash and $2,000 in stock for the right of way. The farmer thought it over and then came to a decision. "No, sir-ee!" he said. "I won't have no railroad runnin' through my farm. First thing I know ye'll be killin' some o' my live stock an' I'd have to help pay for it as a stockholder."

A Busy Street.

(By Judd Mortimer Lewis, in Houston Post.)

I love a busy, hustling town!
One day they put the paving down,
All nice and smooth and sweet; and then
Next day they tear it up again.
From one end of the street back to
Its other end—that's what they do;
And then they get it smooth and flat,
And give it its last loving pat.
And then there is a shriek of fear
Comes from the city engineer—
He has mislaid his monkey wrench!
And instantly they start a trench
And toss the pavement all around
Until the monkey wrench is found!
And then they tamp the dirt in tight,
And get it leveled off all right,
And surface it with hard concrete,
And make a street as is a street
By putting sand and brick on that.
And the steam roller makes it flat.
Then they pierce that pavement through
and through
To lay a line of pipe or two!
Then they repair that, and it lies
Smoothly beneath the summer skies
For, it may be, a day or two,
Then there's a sewer to run through!
Now, when some one you chance to meet
Talks of the "busy city street,"
That's what he means, in this man's
town,
The street that's getting up and down
And rolling over that way, till
It just seems like it can't lie still.

Fire.

MICKY DUGAN, the immortal dirt mover, met an old friend the other day. They stopped for a talk. "D'ye know Tom Ryan?" inquired the friend. "He's th' lad that bangs ye in the chist ivry toime he sees ye and yells 'how are ye?'" "Sure I know him," replied Micky. "I'll bet he's smashed twinty cigars on me, but I'll git even with him now." "How that?" inquired Dugan. "Listen, I'll tell ye; Tom always hits me over the vist pocket where I carry me cigars. He'll hit me just once more. There's no cigars in me vist pocket this mawning. I've got a stick o' dynamite there instead."

A Much Needed Invention.

THE Germans have been crossing carrier pigeons with parrots, so verbal messages may be sent on the wing. Next thing Edison will give our new naval board a phonographic aeroplane with camera eyes, "clam-shell" beak, and—but let it go at that for a starter.

The Best Railroad Story Since Our Last One.

GEORGE, the colored switchman on a southern railway, tried to push an engine off the track with the usual result. The claim agent broke the news to the widow. He found her visiting with a neighbor. The agent got out his papers. "Now then, Melissa," he said, "you just sign here, agreeing to bring no action against the company for your husband's death and I'll make you a present of these five nice, new $100 bills." Melissa's eyes bulged. Chloe, her neighbor, gasped. "Mah goodness, Melish., what you all gonna do wif all 'at money?" "Oh, ah'll buy chickens, an' watermelons, an' a new home, an' 'bout a hundred dresses, an' jes whateverah ah wants fo' de resta mah life." "Don't you all need anotho husband?" asked Chloe. Melissa fanned herself with one of the new $100 bills. "Well, ah don't know 'bout dat, but ef ah evah does get married agin, it'll shorly be to a railroad man."

Will Have to Wait For His Pay.

IN a recent accident in the New York subway an Irishman employed on the construction had his legs crushed by a beam. He was carried to the hospital and after a couple of days the doctors operated, amputating both his limbs at the knees. When the Irishman came from under the influence of the ether the physician was standing by the bed. "Well, Pat," said the doctor, "how do you feel?" "Awful, doctor," groaned the victim. "Awful, an' Oi hope that ye won't make me pay the bill till I'm up on me feet agin."

Look Out! The Good Die Young.

SOME engineers are so straight they will measure a post hole and give the contractor the benefit of the measurements. It is even stated that one engineer when instructed to run in a railway curve indignantly resigned because he wouldn't be a party to a crooked transaction.

Skinner Mulvey says: "I've studied mules nigh onto 40 years. I might write a book, 'Mulvey on the Mule,' but it would be a heap more interesting to most men to have a book on 'The Mule on Mulvey'—and derned if that ain't been the case pretty often, as them ten Mulvey toenails can testify."

CURRENT NEWS

The Doings of the Week.

The general business trend during the past week was favorable. The outstanding feature was the underwriting of the $500,000,000 Anglo-French credit loan. This in combination with the increased demand and enhanced price for cotton caused a visible stimulation of business. In the south conditions are brightening fast and as a consequence it is likely much construction will be undertaken in this section of the country during the fall and winter. Other important developments of the week include: a high volume of bank payments reflecting rising activities and consequent greater employment of money; reports from railroads showing increased earnings during August and September, and new demands for iron and steel products by the carriers. In the construction field there has been a falling off in activities. Few important undertakings reached the call for bids stage during the past week. A considerable number of minor jobs, however, came up for advertising. A great deal of the season's work is yet to be let and it is likely that many larger improvements will come up for letting this fall. In the iron and steel markets signs of increased domestic buying are becoming more apparent. Railroad buying is now becoming a real factor. No disappointment was felt in the new demands the past week for iron and steel or the products of allied branches, and the industry is now looking forward to a prolonged period of prosperity. The large steel companies have advanced prices to 1.40 cts., Pittsburgh, for bars, plates and shapes for this year's delivery. One eastern plate mill has put its price at 1.45 cts., Pittsburgh. Car buying included 4,000 cars, the larger part of this total being for the New York Central lines. Inquiries are being made for about 20,000 cars of which 10,000 are for one trunk line. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Sept. 29 were as follows:

Finished Iron and Steel.	Sept. 29.	Sept. 22.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.509	1.509
Iron bars, Pittsburgh........	1.35	1.35
Iron bars, Chicago...........	1.35	1.35
Steel bars, Pittsburgh.......	1.35	1.35
Steel bars, New York........	1.569	1.519
Tank plates, Pittsburgh.....	1.35	1.35
Tank plates, New York......	1.569	1.519
Beams, etc., Pittsburgh......	1.35	1.35
Beams, etc., New York......	1.569	1.519
Skelp, grooved steel, P'gh...	1.35	1.35
Skelp, sheared steel, P'gh...	1.40	1.40
Steel hoops, Pittsburgh......	1.40	1.35

Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	1.90	1.90
Galv. sheets, No. 28, P'gh...	3.50	3.50
Wire nails, Pittsburgh......	1.75	1.75
Cut nails, Pittsburgh........	1.60	1.60
Fence wire, base, P'gh......	1.60	1.60
Barb wire, galv., P'gh.......	2.60	2.60

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.35 cts. to 1.40 cts.

Railways.—Southern railways have displayed some activity in the construction line during the past week, and there are good prospects that quite a bit of work may be placed this fall and early winter. The Chesapeake & Ohio R. R. has awarded double track contracts to J. C. Carpenter and Major Bros., Clifton Forge, Va. The Southern Ry. let about 34 miles of second track construction in Virginia., W. W. Boxley & Co., Roanoke, Va., receiving 20 miles, Hall, Crawford Construction Co., Macon, Ga., 4 miles, and Robert Russell, Danville, Va., 10 miles. The Macon Terminal Co., Macon, Ga., closes bids on Oct. 12 on its $1,500,000 project at Macon.

Roads and Streets.—No state highway lettings of any great size appear to have come up for advertising during the past week. California is asking bids on three contracts—largest one covering 9 miles of concrete road in Placer County. The larger street improvement jobs advertised recently include a $163,000 contract at Logansport, Ind., and $181,000 of work for Philadelphia, Pa. The Cocke County Pike Commission of Newport, Tenn., is asking bids on 9 contracts calling for the expenditure of $150,000. The County Highway Commission at Dayton, Tenn., let a $209,000 road contract to the Freeman-Robins Co., Knoxville, Tenn. The Moberg Contracting Co., Bemidji, Minn., received a $200,000 contract for highway construction for Cass County, Minnesota. The State Highway Commission of Connecticut awarded 8 contracts, the largest amounting to $31,000. Guthrie Center, Ia., let a $69,878 paving job; Ontario, Cal., awarded a $57,000 contract and St. Charles, Ill., let work amounting to $55,000. The Park Commissioners of Kansas City, Mo., will readvertise the Pasco Ave. and Myers Blvd. work, estimated to cost about $275,000.

Bridges.—Numerous small bridges for counties are being advertised. No particularly large structures, however, reached the call for bids stage. The Virginia Bridge & Iron Co., Roanoke, Va., was awarded contract at $90,000 for viaduct at Macon, Ga., for Central of Georgia Ry. City of Philadelphia, Pa., opened bids on three bridges, largest of which will cost $34,500. State Highway Commissioner of Pennsylvania awarded contracts for several bridges. State Highway Commission of Connecticut is asking proposals on a two span 100 ft. each, through truss steel bridge, and two smaller bridges.

Drainage and Irrigation.—The U. S. Reclamation Service awarded contracts for first 10 miles of Fort Laramie Canal, North Platte Project (1,206,000 cu. yds. earth work in all) to Winston Bros. Co., Minneapolis, Minn., at $121,348 for Schedules 1 and 2 and to Fred M. Crane Co., Omaha, Neb., at $77,960 for Schedules 3 and 4. New work advertised in irrigation field includes 510,000 cu. yds. excavation for Cameron County Irrigation District No. 1 of Harlingen, Tex. County Drainage Commissioners at Henderson, Ky., are calling for bids on a 169,000 cu. yds. job. A number of tile drains in Minnesota also are ready for proposals.

Water Works and Sewerage.—No particularly large undertakings in either of these fields appear to have been advertised during the past week. Several small cities are calling for bids for constructing water works, and a considerable amount of sewer construction also is ready for proposals. Most of these jobs, however, are of no great importance. Mansfield, O., will call for bids in a few days on sewage disposal plant to consist of Imhoff tanks, dosing tanks, sprinkling filter, secondary tanks and sludge beds. Philadelphia, Pa., opened bids on sewer construction to cost about $150,000. Gretna, La., awarded contract at about $47,000 for water works. Galveston, Tex., is asking bids for constructing submerged watermains to cost about $41,000. Albermarle, N. C., opens bids Oct. 15 for 4 miles of sewers; Hertford, N. C., is asking proposals for material and equipment for water works and sewers. Pleasanton, Neb., is calling for bids for water works. Several contracts for furnishing pumps and other equipment are being advertised.

Rivers and Harbors.—The New York State Superintendent of Public Works is calling for bids on the Barge Canal terminal for Syracuse, N. Y. The Bureau Yards and Docks opens proposals this week on 700,000 cu. yds. of dredging at Norfolk, Va. The U. S. Engineer at Cincinnati, O., is asking bids for reconstructing in concrete part of spillway of Dam No. 4, Muskingum River, Ohio. The low bidder for building shed on 35th St. pier for city of New York was Post & McCord at $279,845. E. X. Shubin, Philadelphia, Pa., 9.88 cts., was low bidder for construction of Bay Head-Manasquan Canal for State of New Jersey; Hill Dredging Co., Atlantic City, was low bidder for extension of inland waterways.

Foreign Labor Supply.

The active participation of Bulgaria, Greece and Roumania in the European war, as now seems probable, will cut off three more sources of the labor supply of the United States. The last mentioned country, to be sure, never has furnished any great number of laborers for the construction field. Bulgarians and Greeks, however, have been of considerable service to contractors. The war not only has drawn heavily on the alien labor supply in this country but also has practically cut off the influx of foreign laborers. It is stated that since the Grecian orders for mobilization were issued 10,000 Greeks have started from Chicago on their way to their native land. Government immigration figures for July show that 27,097 aliens entered this country as compared with 28,499 in the previous month. On the other hand 16,000 aliens departed in July against 21,500 in June. The net gain for the two months therefore was about 16,100. Of the July immigrants 2,448 were from Greece, 1,877 from Italy, 1,125 from England and 912 from Japan. The laborers totaled 4,315. The effect of the war on immigration is clearly shown by the statement that for the two years prior to the outbreak of hostilities the foreign born arrivals averaged 120,000 per month, while the alien departures averaged about 50,000 per month, a net gain of about 70,000 per month or 840,000 per year. For the fiscal year ended June 30 last the net gain by alien movement was about 50,000. Employers of large numbers of non-citizen laborers will find small comfort in these figures. In fact the foreign born labor supply situation appears to be in a rather critical condition at present. If any considerable amount of construction should be undertaken by the railroads, contractors might be confronted by a decided shortage of unskilled laborers.

Irregularities in Bidding.

Many contractors display surprizing carelessness in preparing their bids. There are few lettings at which some proposals are not thrown out because they are irregular. Failure to comply with minor requirements has cost many a contractor a good contract. At a recent bridge letting by the Pennsylvania Highway Commissioner, in several instances, the low bidder did not receive the award because of irregularities in the bidding. Unit prices were omitted, no time was specified for the completion of the contract and, in one case, the bidding blanks were signed by an individual who offered nothing to show that he had the slightest connection with the firm in the name of which the bid was made. Mistakes like the above are of frequent occurrence. The certified check question also has put many contractors out of the running. There have been instances where bids were submitted correct in every way except that they lacked the signature of the bidder. Just why a contractor, who really wants the work, will spend time and money in preparing a careful estimate and then will nullify all his efforts, through sheer carelessness, is an unsolvable problem.

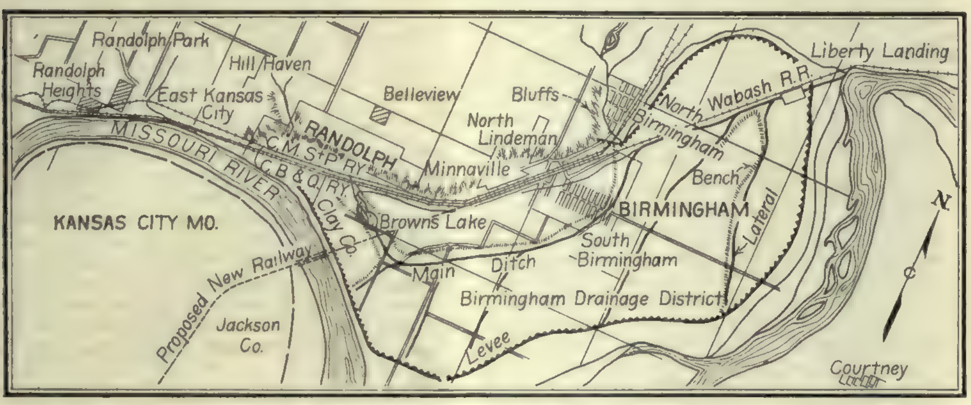
A $500,000 RECLAMATION PROJECT.

Work To Be Done in Clay County, Missouri.

Levee Construction and Drainage System.

Contracts probably will be let in November or December for a large levee and drainage development near Kansas City, Mo. The work will be done for the Birmingham Drainage District, which is located in a bend of the Missouri River in the south and west parts of Clay County, Missouri. The exterior limits of the district and the corporate limits of Kansas City, Mo., are separated only by the Missouri River at the nearest point. A 9-mile radial line extended from the Union Station in Kansas City would intersect the central part of the district. The district is bounded on the north by the bluffs, on the west, south and east by the Missouri River and on the northeast by Shoal Creek.

The district is approximately 4 miles in length and 2 miles in width and includes 5,400 acres of Missouri River bottom land within its limits. The soil may be classed as loam and sandy loam. It is all known as "made soil"—alluvial deposit of the Missouri River and the hill streams. About 1,400 acres of the district is in timber, consisting of burr oak, hickory, elm and near the river willows. The total population is 1,000 and there are five platted towns located wholly or partly within the district. Randolph, in the northwest corner of the district, and Birmingham, in the north central part of the district, are railroad stations.



Location of Proposed Levee and Drainage Ditches.

The trunk lines of the Chicago, Milwaukee & St. Paul Ry., the Chicago, Burlington & Quincy R. R. and the Wabash R. R. pass through the northern part of the district. The district also has the service of the Chicago, Rock Island & Pacific R. R., which uses the tracks of the Chicago, Burlington & Quincy R. R. from Kansas City to Cameron Junction. In addition surveys, plans and estimates have been completed for new trunk lines and a new bridge over the Missouri River 1 mile south and east of Randolph. The object of this plan is to shorten the distance and facilitate traffic to and from Kansas City. The congressional grant for the bridge provides for a highway and trolley car service in addition to railway privileges.

The lands embraced within the district are slightly undulating. The difference in elevation between the highest and lowest ground is 22 ft. and the difference between the average high ground and the average low ground is about 10 ft. The highest land in the district lies between Birmingham and Randolph and is from ¼ to ½ mile in width. The natral drainage of the land in the district is toward the north and east, the lowest point in the district being near the northeast corner. in 1903—the highest water known on the Missouri River since 1844—the water covered practically every acre of ground in the district. Portions of the district are overflowed every year. Morris Branch, at the northwest corner of the district, and Shoal Creek, at the northeast corner, carry fully three-fourths of the hill waters that affect the bottom lands.

The plan of reclamation calls for the construction of a levee around that portion of the exterior limits of the district as follows: Beginning at a point on the south side of the bluff near the northwest corner of the drainage district and thence running in a southerly direction, crossing the tracks of the Chicago, Milwaukee & St. Paul Ry., the Chicago, Burlington & Quincy R. R. and the Wabash R. R. to the north bank of the Missouri River. From here it runs southeasterly along the north and east bank of the river to the south line of Section 14, Township 50 North, Range 32 West; thence east along the south line of the section about ¾ mile and then northeasterly and northerly following along the high ground near the Missouri River to the right bank of Shoal Creek. It then runs northwesterly and southwesterly along the right bank of this creek, finally ending and connecting with the bluff lands north of the railroad tracks and west of Shoal Creek.

The levee is located and designed to protect the district from injury from the flood waters of Morris Branch, Shoal Creek and the Missouri River. The dimensions of the levee are as follows: Sta. 0 to Sta. 432, crown 8 ft., side slopes river side 3 to 1, land side 2 to 1; Sta. 432 to end, crown 6 ft.. side slopes river or creek side 2 to 1, land side 1½ to 1.

From Sta. 0 to Sta. 210 the face of the levee will be paved with one man stone surfaced with 2 in. of spalls. The thickness of the paving will be 12 in. at base and 8 in. at top. The paving will extend over a 5 ft. horizontal toe at the foot of levee slope. From Stations 554 to 557 the face of the levee on the side next to Shoal Creek will be paved with rock.

The maximum fill is 20 ft., the minimum fill 3 ft. and the average fill 13 ft. A muck ditch not less than 3½ ft. in depth will be constructed wherever soil conditions render it necessary. The berm is 20 ft. The material to be used in the construction of the levee will be borrowed for the river side. Sufficient right of way has been secured so that the borrow pit will not exceed 6 ft. to 8 ft. in depth.

From Sta. 10 to Sta. 108 a 40 ft. strip of land will be left between the outer edge of the borrow and the top of reveted bank of the river. This portion of the right of way will not be cleared. The construction of the levee will necessitate the raising of railroad tracks at each side of the district about 8 ft. From Sta. 537 to Sta. 556 the channel of Shoal Creek will be directed to the north side of the proposed levee.

The total length of the levee is 11 miles, of which 4½ miles is located in heavy timber and 3 miles in light timber; 3½ miles is open work. The estimated quantities of work to be done are as follows:

Earth embankment, cu. yds.	1,200,000
Heavy clearing, acres	137
Light clearing, acres	83
Heavy grubbing, acres	46
Light grubbing, acres	27
Rock paving, sq. yds.	5,100

The drainage from 1,000 acres of hill land and the surface water will be taken care of by a main ditch extending from Brown's Lake along the toe of a bench, in a southeasterly and northerly direction to an outlet in Shoal Creek in the northeast corner of the district. The drainage through the main ditch will be by gravity except in flood time, when the pumping plant which will be installed near the outlet will be put in operation. Lateral ditches, following the natural slope and fall of the land, will connect with the main ditch and provide complete drainage to all lands in the district.

The plans and specifications for the main ditch, laterals and pumping plant have not been completed and the contract for this work will not be let until after the contract for the levee has been awarded. The total cost of all the improvements is estimated at $500,000. Bids will be called for on constructing the levee by drag lines and also with teams. Brooks & Jacoby, 512 Shubert Bldg., Kansas City, Mo., are engineers for the district.

LEVEE CONSTRUCTION ON TRINITY RIVER, TEXAS.

Reclamation of Overflow Lands in Dallas, Ellis, Kaufman and Henderson Counties.

Contributed by O. W. Finley, Levee Engineer

A large amount of levee construction is projected for the reclamation of overflow lands along the Trinity River in Dallas, Ellis, Kaufman and Henderson Counties, Texas.

The Kaufman County Improvement District No. 1 contemplates the construction of about 10 miles of levee which will reclaim a little over 9,000 acres of land from overflow. This levee will extend from the Texas Midland R. R. to the Kaufman County south line. Approximately 5 miles is complete and has saved the crops on the 5,000 acres of cultivated land twice the present year. About four or five months will see the completion of this project and in a year or two the entire district will be in a high state of cultivation.

A continuation of the above district, but to be known as the Henderson County Improvement District, extending from the south line of Kaufman County to near Porter's Bluff, will in all probability be constructed immediately on the completion of the Kaufman District. This will reclaim approximately 6,000 acres additional.

On the Ellis County side a bond issue was voted on Sept. 7, without a dissenting vote, for the reclamation by levee of 12,700 acres of overflowed land. This district, known as Ellis County Improvement District No. 2, contemplates the construction of about 18 miles of levee. The work will begin at Slaterock Crossing and extend about 3 miles south of the Ennis-Kaufman Highway.

Another district now being organized and containing land estimated at 18,000 acres is about equally divided between Dallas and Ellis Counties. This district will extend from a point on the river opposite Wilmer in Dallas County to Red Oak Creek in Ellis. That portion north of the Dallas-Ellis line will be known as the Dallas County Improvement District and the remainder as Ellis County Improvement District No. 3, although for all purposes it is one district. The survey will be completed shortly, when the exact acreage will be known.

A smaller levee project, Ellis County Improvement District No. 1, is approximately one-fourth complete. This levee will protect about 5,000 acres.

All work thus far has been done with steam and gas drag line shovels. The one now being used on the Kaufman work, mentioned above, weighs approximately 80 tons and its dipper has a capacity of about 7,000 lbs. of earth and from 40,000 to 50,000 cu. yds. per month. These machines have proven an entire success on levee work and have shown their superiority over teams not only in the matter of cost per cubic yard but in the continuity of the work.

The advantages of the reclamation of overflowed lands in Dallas, Ellis, Kaufman and

Henderson Counties are now well recognized. The prices of river lands in these localities show a decided increase over the values of a year or more ago. In many instances overflowed timber lands that could have been bought a short time ago for $15 to $20 per acre are now practically double that value, while lands near towns and held a year or two ago at $30 and $40 now range nearer $60 per acre. Even a rumor of levee work stiffens prices appreciably.

It will be a matter of only a few years before practically all overflowed land in this part of the state will be protected from the effects of high water. Owners are beginning to take advantage of the means at hand to make this land available for cultivation. Such land, on which rich silt has been deposited for centuries past, is entirely too valuable to remain much longer idle.

AN $885,000 IRRIGATION SYSTEM

Proposed for Terra Bella District, California.

Dams—Canals—Reservoirs — Pipe Distributing System—Pumping Stations.

An extensive irrigation development is planned by the Terra Bella Irrigation District of Terra Bella, California. An important feature of the project will be a distributing system of riveted sheet steel pipe. The other works include a diversion dam, diversion canal, a reservoir, outlet canal and booster pumping stations. The total estimated cost of the works, exclusive of lands, water rights and rights of way is $885,000. Final report on the improvement has just been submitted to the district by Stephen E. Kieffer, Consulting Engineer, San Francisco, Cal.

The principal items in the proposed work, in outline, as now planned, are as follows:

Diversion Dam.—Loose rock fill, slightly manhandled and spalled on faces and crown. Slopes 1 to 1. Crown width 6 ft. Inner face waterproofed and crown covered with 5-in. concrete skin over wire mesh, and footed in trench excavated in granite bedrock. Maximum height of crest above stream bed, 33 ft. Length, 230 ft.

Diversion Canal.—Total length, 24,800 ft. Upper section, 6 ft. bottom width and 5.2 ft. depth water. Lower section, 4 ft. bottom and 3.6 ft. depth water. Capacity, 225 sec. ft. Excavated largely in solid granite. Concrete lined, in part. 1,120 ft. 5 by 7 tunnel in solid rock.

Reservoir.—Capacity, 28,000 acre ft. Five dams, four of hydraulic fill type and one loose rock fill similar to diversion dam.

Dam No. 1 will contain 1,422,000 cu. yds. earth fill. Top width 20 ft. Inner slopes 2, 2.5 and 3 to 1. Outer slopes 2 and 2.5 to 1. Maximum height, 115 ft.

Dam No. 2 will contain 197,000 cu. yds. earth fill. Top width, 16 ft. Slopes same as for No. 1. Maximum height, 78 ft.

Dam No. 3. Loose rock fill. Dry laid water face and top 3 ft. thick. Water face covered with 8-in. reinforced concrete tied to bedrock. Top width, 7 ft. Maximum height, 37 ft.

Dams Nos. 4 and 5. Total 10,000 cu. yds. earth fill. Slopes: Inner, 2 and 2.5 to 1; outer, 2 to 1. Top width, 12 ft. Maximum height, 33 ft.

Outlet Canal.—Total length about 10 miles. Capacity from 54 to 10 sec. ft. At present to be dirt section, but ultimately to be lined with ¾-in. cement mortar over wire.

Distributing Pipe System.—80 miles riveted sheet steel pipe from 26-in. to 4-in. in diameter.

Boosting Pump Stations.—There will be two boosting pump stations equipped with 8-in. and 12-in. horizontal single stage centrifugal pumps, direct connected to electric motors. These will be used to lift water from the outlet canal to lands above that level.

A bill giving the State Board of Health control of the water supply of all water works plants has passed the Legislature of Alabama. The code has also been amended so as to permit municipalities to issue bonds for improvements on water works.

A $1,500,000 Railroad Terminal at Macon, Ga.

Bids are now being taken on the $1,500,000 union passenger terminal for Macon, Ga. The terminal will include a main building three stories in height and 84 ft. by 243 ft. in size. On one side of this will be a 1-story express building, 57 ft. by 134 ft., and on the other side will be the baggage and mail room, 1 story, 57 ft. by 112 ft. The exterior of the station will have a granite base course and the superstructure will be faced with terra cotta or gray brick with terra cotta or limestone trimmings.

The station and trackage and concourse will cover about 10 acres of ground and will be located between Plum and Walnut Sts. and 5th and 6th Sts. Poplar St. will be extended through a subway. This will be constructed of concrete and faced with white enamel brick.

The main concourse will run at right angles to the buildings and will extend under the tracks, 34 ft. wide, for the whole width of the railroad yards. Connection with the main concourse will be had by another subway running alongside the main building.

Provision will be made in the yards for 20 tracks although only 18 will be installed at present. The tracks will be served by nine concrete platforms covered with metal truss butterfly canopies.

The development will be constructed for the Macon Terminal Co., which is composed of officials of the three leading railroads that will use the new station. C. K. Lawrence, Savannah, Ga., is the Chief Engineer, and Alfred Fellheimer, 7 East 42nd St., New York City, is the Architect.

$11,000,000 for Construction Work in Los Angeles County, California.

Extensive construction developments will be undertaken by the city and county of Los Angeles, Cal., if the necessary bond issues are authorized at elections to be held in October. The largest project is the flood control scheme for the county. The contemplated bond issue for this is $6,000,000. Of this sum it is proposed to expend $2,400,000 for damages, rights of way for channels, etc.; $2,000,000 for channel rectification, clearing and protection; $600,000 for spreading grounds at mouths of various canyons, and $1,000,000 for dams. The city of Los Angeles proposes a bond issue amounting to about $2,700,000, the chief of which, $1,000,000, is for constructing the Hyperion and Point Firmin sewage disposal stations. On Oct. 26 a special election will be held in the county to vote a $2,650,000 bond issue for the improvement of new county highways. The proposed expenditures under this issue include $400,000 for the Harbor Boulevard, $750,000 for a highway from San Gabriel Canyon to Sky Line and Devil's Punch Bowl, and $500,000 for a road from Arroyo Seco to Sky Line.

A 700,000-Cu. Yd. Government Dredging Job.

A 700,000-cu. yd. dredging job is being advertised by the Bureau of Yards and Docks, Navy Department, Washington, D. C. The areas to be dredged are located at the U. S. Navy Yard, Norfolk, Va., and Naval Magazine, St. Juliens Creek, Va. The dredging will cover five areas, the largest of which is in the southern branch of the Elizabeth River opposite the entrance to Dry Dock No. 3. The total estimated quantity here is 493,750 cu. yds. The dredging will secure a depth of 35 ft.

The material to be dredged is believed to be mud, sand and clay and some refuse material from sawmill work, sawdust, edgings, etc.; also piles and the remains of an old wharf. The appropriation available is $145,000. Bids will be received until 11 a. m., Oct. 9.

Water Storage Projects in New England.

New England is beginning to realize the necessity of obtaining cheap and abundant power for its manufacturers. In the last few years many important industries have been moved to other states where cheaper power could be obtained, and it is becoming apparent that this exodus will continue unless something is done to prevent it. Numerous new hydro-electric developments have been carried out during the past five years, and existing companies have enlarged and otherwise improved their plants. A great deal, however, remains to be done in the water power field in these states. Conservation of the water supply has become a matter of importance. In Vermont it is probable the next legislature will be asked to pass a bill authorizing a bond issue for the construction of storage dams for conserving the water supply for power plants. The development would be carried out by the state in conjunction with the owners of the plants. Groups of manufacturers also are taking steps themselves for water conservation. A report was submitted recently to the manufacturers of the Naugatuck Valley, Connecticut, by Charles H. Preston, Jr., consulting engineer, Waterbury, Conn., on the feasibility of conserving water on a very large basis in the upper Naugatuck drainage basin for equalizing the stream flow of the Naugatuck River. This project, if carried out as planned, will be the largest undertaking of its kind in New England and will entail a cost of several million dollars. The first of a series of dams recommended has been accepted by the State Board of Engineers. It will be constructed of Cyclopean masonry and will impound 3½ billion gallons. The dam will be 1,300 ft. in length and 140 ft. in height, and will contain 190,000 cu. yds. of masonry.

A New Wisconsin Railroad.

There is some prospect that a new trunk line railroad may be constructed across the state of Wisconsin. Application will be made in a few days to the Wisconsin Railway Commission for a certificate of necessity for building a new railroad from Superior to Madison. The route for the new line is understood to follow very closely the surveys made sometime ago for an extension of the Illinois Central R. R. from its present terminus at Madison to Lake Superior.

The route, as outlined is stated to extend from Superior east across Wisconsin to Champion, Mich., and from that point to Florence, Wis., thence south to the Fox River Valley and from Fond du Lac in the Fox River Valley southwest to Madison. If built over this route the line would be about 360 miles in length. The Michigan Railroad Commission, sometime ago, granted a charter for a line from Huron Bay, a town in Baraga County on Lake Superior to Champion. It is believed that this railway is to be a link in the bigger scheme.

The company which is to apply for a Wisconsin certificate is represented by Chicago attorneys, and the statement has been made that it will be financed through the Columbia Trust Co. of New oYrk City. This trust company has taken part in the financing of many projects in which the Harriman interests were prominent. It is considered likely that the Harrimans also are interested in the new line and that it therefore may be the long projected extension of the Illinois Central to Superior.

A $300,000 Causeway Across Aransas Bay, Texas.

A causeway is to be constructed across Aransas Bay, Texas, to connect the mainland at La Mar with the peninsula at Rockport. The structure will open up the direct route from the north and east sections of the state to the large harbor and Aransas Bay. It will be a link in the all coast highway from Houston to Rockport, Corpus Christi and Brownsville, Tex.

The structure will consist of 1,733 ft. of protected hydraulic fill and 13,000 ft. of concrete bridge of beam and girder type, with a large draw span in midstream. Aransas County, Texas, on Sept. 18 voted $300,000 of bonds for the construction of the causeway.

Whiteaker & Washington, San Antonio, Tex., designed the structure. Percival & Son, Rockport, Tex., are the resident engineers.

NEWS LETTERS

St. Louis Items.

Mulvill Bros. of Alton, Ill., have bought a new steam shovel which they put to work on their Wood River levee job, filling washouts and filling and making new levee. They were awarded an additional 60,000 yds. on this levee last week.

J. C. Herndon & Co., Akron, O., have a couple of steam shovel outfits, also a lot of concrete machinery idle in Pennsylvania that they would like to place on work in any part of the country.

S. H. Liscomb, representing the Bondurant Construction Co., passed through St. Louis last Friday on his way to Hannibal, Mo., to look over some levee work that the Bondurant Construction Co. has opposite there.

The Bondurant Construction Co. of Hickman, Ky., has 80,000 yds. of levee work opposite Hannibal, Mo., to sublet. This is suitable for a wheeler or wagon outfit and about 50,000 or 60,000 yds. of it could be done nicely with a small car outfit or a steam shovel.

J. J. McInerney has finished his levee work at Apex, Mo.

Fred Peckham, representing the Victor R. Browning Co., Cleveland, O., was here a couple of days introducing their steam shovels in this part of the country.

Wm. Nuttal of M. C. Connors & Co. informs us that they have sublet the excavation for the 50,000 ft. of water pipe line at Christopher, Ill., to the Katz Construction Co. of Omaha, Neb.

H. W. Nelson Co. of Chicago were awarded the contract the other day for building a concrete bridge at Rockford, Ill. Also about 200,000 yds. of bridge filling in Illinois and Indiana for the Illinois Central R. R. They are going to work double shift on the Indiana and Illinois jobs, which they expect to complete about the first of the year, then move their outfit to Memphis, Tenn., where they have about 100,000 yds. of levee work to complete.

Dave Griffith has shipped his team outfit which has been in Illinois for some time out to his ranch near Wallace, Kan. Dave is going to quit railroading and spend the rest of his time raising cattle.

Ira Griffith has gone to work for L. A. Johnson at Wamego, Kan., running a steam outfit.

List & Gifford Construction Co., Kansas City, Mo., have started work on a new job on the Kansas City Southern R. R. near Bunch, Okla.

A. W. Jones, general manager of the Floesch Construction Co., who is in complete charge of the drainage ditch digging south of Cape Girardeau, Mo., passed through St. Louis the other day on his way to Pittsburgh, Pa. Jones has been suffering for some time with stomach and bowel trouble and expects the change of climate will relieve him. We hope it does and to see him back in our neighborhood soon again.

R. K. Hall, representing the Ball Engine Co., at Erie, Pa., was with us a day. Hall reports selling an Erie steam shovel to one of our local contractors last week.

L. J. Smith of the L. J. Smith Construction Co. came in from Kansas City to bid on the 600,000 cu. yds. of grading that the Pitzman County surveyors and engineers let here on September 23 for the University Park Realty Co. in the western part of the city. Smith was just a little bit too high.

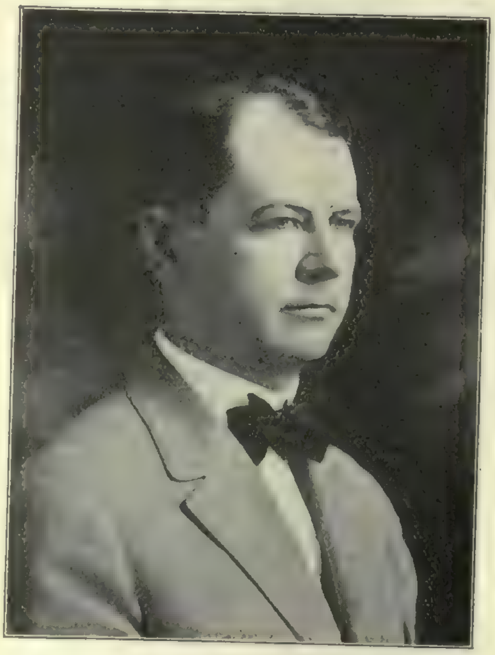
Fruin & Colnon, St. Louis, Mo., were low bidders on 600,000 yds. of grading for the University Park Realty Co. in the western part of the city, bids for which were opened by the Pitzman County Surveyors and Engineers, 615 Chestnut St., St. Louis, Mo., on September 23. Their bid was 16 6-10 cts. Fruin & Colnon will sublet most of this work.

P. J. Murphy of Moberly, Mo., was awarded several bridge filling jobs. Is also building 30 miles of surface ditches for the Wabash R. R. Murphy has just finished a contract of loading ballast at Des Moines, Ia., and has a steam shovel and clam shovel idle which he can place on work on a moment's notice.

A. B. Koenig.

PERSONALS

Mr. J. H. Prior, whose portrait appears on this page, has been appointed chief engineer of the Illinois Public Utilities Commission, with headquarters at Springfield, Ill. Mr. Prior has been in the service of the Illinois Public Utilities Commission for about one year, as assistant chief engineer. He was educated at the Armour Institute of Technology and the University of Chicago. He was formerly assistant engineer in the service of Ralph Modjeski, civil engineer, and he was engineer of design of the Chicago, Milwaukee & St. Paul Railway from 1905 to 1914, in charge of the design of the heavy track elevation work executed by that company in the cities of Chicago, Evanston, Milwaukee, and Minneapolis, during those years. He made some of the first valuations of railroad structures required by state regulatory and taxing bodies. He is a member of the American Railway Engineering Association, the American Economic Association, and the Chicago Engineers' Club, and has been a frequent contributor of technical articles to the columns of this paper.


J. H. Prior, Chief Engineer, Illinois Public Utilities Commission.

The Illinois Commission, which Mr. Prior will serve, has the broadest jurisdiction and powers. It is charged with the regulation not only of steam and electric railways, gas and electric plants, but with the supervision of telephone companies, heating plants, warehouses, water works, wharfingers, and steamboat lines, except such utilities as are municipally owned. The organization of the Engineering Department of the Commission has been proceeding during the past year until the Commission has a staff of nearly thirty engineers engaged in appraisal work, in service inspection, safety appliance inspection, and grade separation work. Mr. Prior has been discharging the duties of chief engineer for the past seven months, pending his appointment.

Professor F. H. Newell, head of the department of civil engineering, University of Illinois, has been appointed by Governor Dunne as a member of the Illinois Board of Examiners of Structural Engineers.

Mr. Franklin Henshaw has been appointed street commissioner of the village of Scarsdale, N. Y. The village is expending a considerable amount of money this fall on the improvement and repair of the streets, and expects by next year to be able to develop a comprehensive system for the care of its 26 miles of improved highways and the development of new roads.

Mr. A. J. Himes has been retained as engineer of grade crossing elimination for the restored Department of Grade Elimination of the New York, Chicago & St. Louis, or "Nickel Plate," Railroad Co., at Cleveland, Ohio. Mr. Himes will also continue his duties as valuation engineer for the company. The work in hand includes the elimination of 25 grade crossings in the city of Cleveland, at an estimated cost of $2,900,000.

Mr. William H. Rights has been appointed city civil engineer of Seymour, Ind., vice Mr. E. B. Douglass. Mr. Rights will take charge of special work in connection with the valuation of property of the private water works company, the rehabilitation of the sewer system and improvement of streets. Mr. Rights is a graduate in civil engineering of Purdue University, and has had 31 years of active practice. He was for twelve years engineer of Columbus, Ind. Prior to that he was with the Big Four and other railroads.

Mr. C. E. Henderson has been appointed to the position of city engineer for Saint Augustine, Fla. Mr. Henderson was graduated in civil engineering from the University of Illinois in 1906. Since that time he has held positions as follows: Assistant engineer, maintenance of way, Missouri, Kansas & Texas Railway, one and one-half years; assistant engineer, masonry construction, bridges and buildings department, Chicago, Milwaukee & St. Paul Railway, two years; instructor in civil engineering, University of Illinois, 1909-10; assistant city engineer, Port Arthur, Ontario, since 1910.

Mr. H. C. Shaw has been appointed general superintendent of water works for the Joplin, Mo., Water Works Co. Mr. Shaw held the position of superintendent at Joplin from 1902 to 1909. Prior to 1902 he was connected with the Jamestown Water Supply Co. of Jamestown, N. Y. On leaving Joplin in 1909 he went to Birmingham, Ala., to become assistant superintendent for the Birmingham Water Works Co., remaining there until February, 1913, when he went to Warren, Pa., as superintendent for the Warren Water Co. These companies are all controlled by the American Water Works & Electric Co., in whose service Mr. Shaw has remained throughout his experience in the water works field.

Mr. Arthur Peabody has been appointed as State Architect of Wisconsin under the newly organized State Department of Engineering. He will have charge of all architectural work for the state of Wisconsin, including the state university, normal school, charitable and penal institutions and other state enterprises. Mr. Peabody has been supervising architect for the University of Wisconsin since 1905. He graduated from the University of Illinois, architectural course, and was in general practice in Chicago from 1895 to 1905. He was also connected with the architectural department of the World's Columbian Exposition at Chicago, and had charge of several of the large buildings there. He has designed 24 of the buildings of the University of Wisconsin, costing in all over $2,500,000.

Mr. Frederick C. Morrow, who has been appointed to the position of assistant chief engineer, Chicago & Western Indiana and the Belt Line Railway Company of Chicago, graduated with the degree of B. S. in civil engineering from Purdue University in 1904 and in 1909 received the post graduate degree of C. E. Upon leaving the University in 1904 he went to work for the Illinois Steel Company, but after several months he entered the service of the Chicago & North Western as rodman, and, later, instrumentman and assistant engineer. He remained with that company until April, 1907, when he accepted a position as field engineer in the division of track and roadway of the Board of Supervising Engineers, Chicago Traction, which he held during the reconstruction of the Chicago surface lines, or until April, 1910. From that time until February, 1913, he was office engineer for the Chicago & Western Indiana, in charge of designs, estimates, specifications, etc. Since that time until receiving his present appointment on September 1, he has been principal assistant engineer for that company. Mr. Morrow is an associate member of the American Society of Civil Engineers, a member of the Western Society of Engineers, and of the Chicago Engineers' Club.

Secretary Daniels has announced the selection of a number of well-known engineers as members of the Naval Advisory Board, among them being Alfred Craven, chief engineer of the New York Public Service Commission, First District; Andrew Hunt, consulting engineer of San Francisco, expert in hydroelectric installation; William L. Saunders of the Ingersoll-Rand Co., president of the American Institute of Mining Engineers, and expert in compressed-air equipment; Frank L. S. Sprague, consulting engineer and vice-president of the Sprague Safety Control & Signal Corporation, and Dr. R. S. Woodward, president of the Carnegie Institute, and for many years connected with the U. S. Coast and Geodetic and Geological Surveys. Of these, Messrs. Craven, Hunt and Sprague were all educated at the U. S. Naval Academy and all served in the navy for a number of years.

The Smith & Boulay Co., consulting engineers, 320 The Nasby, Toledo, Ohio, announce the proposed dissolution of partnership, effective October 1, and the continuance of business by each member along his special lines. The firm of Smith & Boulay has been in business for five years, and has prepared plans and specifications for, and superintended the construction of, engineering work amounting to approximately $3,000,000. This work included paving, sewerage, sewage disposal, water supply, water works, factory buildings, power plants, inspection and reports. The senior member of the firm will conduct an office and business under the name of the A. H. Smith Company, consulting engineers, 320 The Nasby, Toledo, Ohio. The junior member will conduct a civil and sanitary engineering practice at 1248-1251 Nichols building, Toledo, under the name of the L. A. Boulay Company.

Mr. Thomas C. Atwood, the engineer who is in charge of construction of the famous Yale Bowl, has opened an office in the Chamber of Commerce building, New Haven, Conn., to engage in general consulting practice. Mr. Atwood will specialize in water supply and sewerage plants, power developments, athletic fields and country estates. Mr. Atwood graduated from the Massachusetts Institute of Technology in 1897. For three years he was with the Metropolitan Water Board, Boston, Mass., for one year with the U. S. engineers on harbor work at Boston, and for three years with the Bureau of Filtration of Philadelphia on design and construction. Later he was division engineer in charge of three main contracts, design and construction, for the Pittsburgh Bureau of Filtration. He was with the Board of Water Supply of New York City for five years as designing and later division engineer, having charge of 10 miles of the Catskill Aqueduct under contract for $10,000,000. He resigned that position to become division engineer for the Department of Water Supply, Gas and Electricity on the filtration of the Croton water supply. In 1914 he resigned to take charge of construction of the Yale Bowl. He will handle the remaining work on that structure as a part of his regular practice.

OBITUARIES

Captain John Hayes, aged 60, in charge of the Government dredging work near Deer River, Minn., on the upper Mississippi, dropped dead at his post on September 16, of apoplexy. Captain Hayes was for 27 years in charge of the Federal Government work on Red River of the North, and last spring he assumed charge of the work on the upper Mississippi. While in charge of the Government work on the Red River he handled such Federal activities from Caledonia, N. D., to the international boundary. He entered the Government work at Portage, Wis., when a boy in the 'teens.

James Grant, 83 years old, formerly superintendent of the Cumberland, Md., city water and electric lighting system, mechanical engineer and cement expert, died Sept. 21 at that place. Mr. Grant was a native of Scotland and settled at Barton, Md., in 1870. He worked in the mines for a time, then became superintendent of the Round Top Cement Works. He later moved to Cumberland and became superintendent of the Cumberland Hydraulic Cement Manufacturing Co. He built the Potomac Cement Works at Pinto, Md., and the plant at Cedar Cliff. He was for a time water and light superintendent at Cumberland.

Captain Charles M. Greene, one of the builders of the old New Orleans Pacific Railway, which is now part of the Texas & Pacific, died September 14 at his home in Coburg, Canada, aged 75. Captain Greene was a native of Atlanta, Ga., and attained his rank as captain during the Civil War. He entered railroad construction work as a partner of Col. E. B. Wheelock, and John M. Brogan, on the building of a railroad from New Orleans to Alexandria, a stretch of 194 miles. The greatest difficulty encountered was the long stretch of marsh land near Melville, known as the Choctaw Swamp. The road was completed in 1882. It was bought in by Jay Gould, who had already completed his Texas & Pacific to Shreveport. The roads were connected, thus making New Orleans the most important point on the road. Captain Greene and Mr. Brogan then combined to build up a tie and timber contracting business, which became prominent throughout the south, known as the St. James Timber Co., of which Capt. Greene was president at the time of his death.

CIVIL SERVICE NEWS

The Illinois State Civil Service Commission announces examinations as follows:

Waterways engineer; salary, $150 to $250 per month; open to non-residents of state.

Topographical draftsman; salary, $100 to $150 per month; open to non-residents of state.

Engineering clerk, State Highway Department; salary, $50 to $70 per month; open to residents of state only.

Chief sanitary engineer, Board of Health; salary, $250 to $500 per month; open to non-residents of state.

Applications for these examinations must be filed in Springfield before 5 P. M., October 30.

The New York State Civil Service Commission announces the following examinations:

Assistant bacteriologist; Quarantine Laboratory; salary, $1,200 per annum; open to non-residents; Oct. 30. Application must be filed before Oct. 20.

Engineering draftsman; salary, $1,201 to $1,500; open to non-residents; Oct. 30.

NEW CATALOGUES

Water Softeners.—Paper, 8x11 ins.; 16 pp. L. M. Booth Co., New York City.

Describes in brief the Booth Water Softener, Type F, and a number of typical installations, showing views of same, and giving details of operation.

Dump Wagons.—Paper, circular. Troy Wagon Works Company, Troy, Ohio.

Describes the Troy-Ajax dump wagon, giving details of construction and cuts showing special features. Also shows Troy wagons on the job and quotes from commendatory letters received from purchasers.

Motor Trucks.—Paper, 6x9 ins.; 98 pp. B. F. Goodrich Co., Akron, Ohio.

"Motor Trucks of America," Vol. III, the 1915 edition of a handbook for use of truck owners or prospective truck owners. Gives in form convenient for comparison and neat and compact style, specifications and data on the more important makes and types of motor trucks made in America. A copy will be sent on request.

Locomotives.—Paper, 9x6 ins.; 32 pp. The Baldwin Locomotive Works, Philadelphia, Pa.

Record No. 81, describing the triple articulated compound locomotive for the Erie Railroad Company. Reviews the general features of the design and then takes up the construction in detail, showing numerous views and sections.

Outlet Boxes and Covers.—Paper, 4x8½ ins.; 20 pp. Steel City Electric Co., 1207-1219 Columbus Ave., Pittsburgh, Pa.

Leaflet No. 151, a pocket size catalogue and price list of the "Steel City" outlet boxes and covers which are most frequently used. Also gives price list of Fullman "Star" bushings and locknuts, and tables of discounts and net prices. Illustrated.

Armco Iron.—Paper, 6x9 ins.; 46 pp. The American Rolling Mill Company, Middletown, Ohio.

"Defeating Rust, the Story of Armco Iron," is the title of this book, which tells about the rust resistant properties of American Ingot Iron, or Armco Iron, and gives examples of its use for various purposes. Illustrated with views of actual installations.

Fireproof Construction.—Paper, 6x9 ins., 16 pp. The General Fireproofing Company, Youngstown, Ohio.

"The House That Will Not Burn" is the title of an attractive booklet presenting the principles and methods of fireproof construction for dwellings, together with a detailed description of a fireproof house and fireproof bungalow and giving unit cost data. Illustrated.

Piston Rings.—Paper, 9x11 ins.;; 8 pp. Burd High Compression Ring Co., Rockford, Ill.

The above company has begun the publication of a journal appearing at "frequent intervals," devoted to the propagation of knowledge relative to piston ring development and the particular achievements of the Burd organization. The first number under the title of "Burd Ring Wisdom" contains a number of interesting articles and photographs of typical applications of Burd Rings.

CATALOGUE REVIEWS

Concrete Silos.—Paper, 6x9 ins.; 64 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

Bulletin No. 21, entitled "Concrete Silos," numerous such structures and gives details of which explains the theory, development, construction and uses of the modern silos. Shows quantities and costs of materials, methods of building, capacities, etc. Shows block, cement stave, monolithic, plaster or stucco and pit types. This is the tenth edition of the book, which was published by the Association of American Portland Cement Manufacturers.

Electric Service Installations.—Paper, 5x7 ins.; 86 pp. Commonwealth Edison Company, Chicago.

The above company has had compiled and is distributing a book of rules and information pertaining to electric service, meters, wiring and motors. The book is intended for the use of Chicago contractors, architects and engineers, in making installations of service connections, meters, wiring, motors and other appliances which are to be supplied with electricity by the company.

These rules are supplementary to the electrical code of the city of Chicago. Certain useful information relative to the character of the service in different parts of the city and to the appropriate size and arrangement of meters and service cutouts is included. Illustrated by drawings and halftones.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Village Engineering in Large Cities.

Mention of New York City suggests the lower end of Manhattan Island; similarly, mention of Chicago suggests the so-called "loop district." These are the congested value districts where the buildings are tall and where metropolitan importance, in all its branches, holds forth. Around these great centers are grouped a multitude of connecting villages. In these less imposing portions of our great cities engineering problems are much the same as those encountered in small, isolated cities and towns.

It is perhaps but natural that the engineering departments of large cities take most interest in the large and spectacular engineering works with which they have to do. Such works are described in technical literature and rightly so. However, it is regrettable that more publicity is not given to the routine engineering work of such cities. The large city has an engineering staff thoroughly experienced in the construction of modest engineering works of all sorts and capable of writing authoritatively on "good practice" in the handling of such work. The members of such staffs should prepare more profession. papers pertaining to these smaller and simpler works for the benefit of the average practitioner.

"The Greatest Living American."

Naming the greatest man is even more difficult than citing the bravest deed. It is hard enough to determine relative excellence in a single class of mental acts, but, when a composite of all intellectual powers is to be measured, no definite standard is to be had. Michael Angelo is not comparable with Cæsar, so that their relative mental greatness is indeterminate save as greatness is measurable not in terms of the mind power but in terms of the utility of their respective achievements. Even utility of achievement is not easily rated, but at least it has a universality of application that is lacking in any other standard of human greatness.

More and more will the greatness of men be judged by the utility of their works. And as this standard of comparison comes into general use, greatness of achievement will usually be gauged by the totality of benefit rendered to mankind in all countries through all times. Some such standard as this must have been in the mind of Steinmetz when, speaking of the fertilization of soil with nitrogen extracted electrically from the air, he said:

> This I have talked over with my friend, Thomas A. Edison, engineer, wizard, possessor of nearly all present electrical knowledge, sociologist, psychologist, geologist, evolutionist—the greatest living American.

Steinmetz, himself a very great inventing engineer, is certainly a competent judge of Edison's ability, and, although he used his own mental steelyards to weigh the worth of "the American wizard," he must also, perhaps subconsciously, have weighed the vast economies society owes to Edison. This same feeling of social indebtedness to scientific men is fast changing proper standards of human greatness. Yet even now were some newspaper to canvass its readers for expressions of opinion as to "the greatest American" it may be doubted whether an Edison would lead.

School text-books, particularly histories and works on English literature, have long fostered the idea that generals, presidents and authors are the most worthy of men. Pure scientists and inventors, it is true, come in for some mention in the school room—engineers never.

Several high school boys were asked why the sign of the bell appears on so many telephone booths. With one exception the reply was that the bell is symbolic of the ringing that is associated with sending a telephone message! Only one of the boys had ever heard of Bell, the inventor, or, hearing, had been sufficiently impressed to remember his name.

With the exception of that excellent old English book, Smiles' "Self-Help," we can recall no book suitable to stimulate youthful interest in the work of inventors. Certainly such a book should be of greater educative value than the ordinary text-book of history, for example. History is interesting mainly because it is a sort of biography. Science can be made interesting to the beginner by appealing to his "human interest" in *scientists*. Yet who, aside from Smiles, has attempted to do so?

If we are to inculcate a general recognition of the greatness of scientists, inventors and engineers, we must write more books like those of Smiles—and see to it that they are used as text-books in the common schools.

Discussing the Merits of a Proprietary Article.

Many, perhaps the majority of, engineers and contractors are exceedingly reluctant to discuss the merits and demerits of proprietary articles except in private conversation with acquaintances. It is somewhat exceptional to find a thoroughly good discussion of the worth of a manufactured product in technical society proceedings. There is a natural reluctance to condemn an article upon which someone has spent much time and money and upon the sale of which he is dependent for a livelihood. On the other hand, the public commending of a proprietary article is shunned by many for fear of exciting the suspicion that an ulterior motive prompts the confession of faith in the article. Thus the great body of engineers and contractors slowly learn the merits and demerits of machines, devices and materials on the market; the individual conducts his own researches in this field and reaches his own conclusions. Now that we are hearing so much about co-operation among engineers it seems to the editor that there is need for more co-operation in the matter under discussion than has existed in recent years.

A good illustration of the consideration by technical societies of the advantages and disadvantages of a manufactured product is afforded by the papers and discussions pertaining to Leadite before the American and New England Water Works Associations. One of the stock topics in the question box of the American Water Works Association for several years related to the dependability of this material for making joints in cast-iron water mains. Two very valuable papers on this subject were presented before the recent annual meeting of the New England Water Works Association and have since been published in this journal. These articles and discussions have brought out the truth relative to the value of this material—namely, it is a thoroughly good jointing compound when handled by those who understand its peculiarities, but these peculiarities must be understood or partial failure will result. Having established this truth a study has been made of these peculiarities and they are now understood by those who have read and studied the literature of the subject. The final result of all these discussions is favorable to the material, and the doubtful points have all been cleared up. This desirable end could not have been reached so soon or so surely by any other method.

We do not advocate the wholesale discussion of the merits of proprietary articles before technical societies. What we deplore and inveigh against is the opposite extreme. In this as in most other matters the middle ground is best taken.

Those responsible for the conduct of conventions can be depended upon to regulate discussions of this character. Manifestly the manufacturer or his agents should not introduce a discussion of his products, but in all fairness he should be given an opportunity to speak in rebuttal when his products have been discussed to their disadvantage. His remarks can readily be confined, by the ruling of the presiding officer of the convention, to statements of facts and figures. A selling talk is readily recognized as such and can be cut short by a judicious use of the gavel. In this connection it should be remembered that the engineering salesman of the present time is oftentimes no less an engineer because he is a salesman. We have "sales engineers" who can and do speak both authoritatively and impartially about the goods they have to sell. Such men are really engineering specialists of a distinct type and are well worthy of a hearing at opportune times.

Submitting Details in Calling for Bids.

In a recent communication G. Alexander Wright, in discussing the question "Should details be furnished before the contract is signed?" says:

> The difficulty of obtaining full detailed information of what is really wanted when bidding upon work is one of the serious problems which confronts the contractor today, for it is largely the "detail" which determines what work is really worth.

It will readily be conceded by contractors specializing in building construction that the lack of full information at the time bids are asked is an important factor in determining the amount of the bid submitted. The personality of the architect now enters too largely into a transaction in which competitive bidding on the quality and quantity of materials and on the cost of placing them in the finished building should be the governing factor. It is undoubtedly true that the cost of many buildings to the owners has been increased to a considerable extent by this lack of detail, especially in cases where the architect was comparatively unknown or was generally known to be unduly severe in his requirements.

Presumably this lack of detail at the time of asking for bids is due to a desire to advance the date on which construction is started; but is anything really gained in the end by such a procedure? Possibly it better suits the convenience of the architect because it enables him to spread his work over a longer period. As the architect has a right to expect proper compensation for service rendered the question resolves itself into one of ultimate cost to the owner. This cost is to a considerable extent determined by the contractor, and everything possible should be done to promote competition—competition on projects in which the uncertainties are reduced to a minimum. As detail drawings must be made before the work is actually done we believe it is essential to economic construction that they be furnished at the time bids are called for. Although suggestions have been made at various times as to possible solutions of this problem there has been little definite progress toward this end.

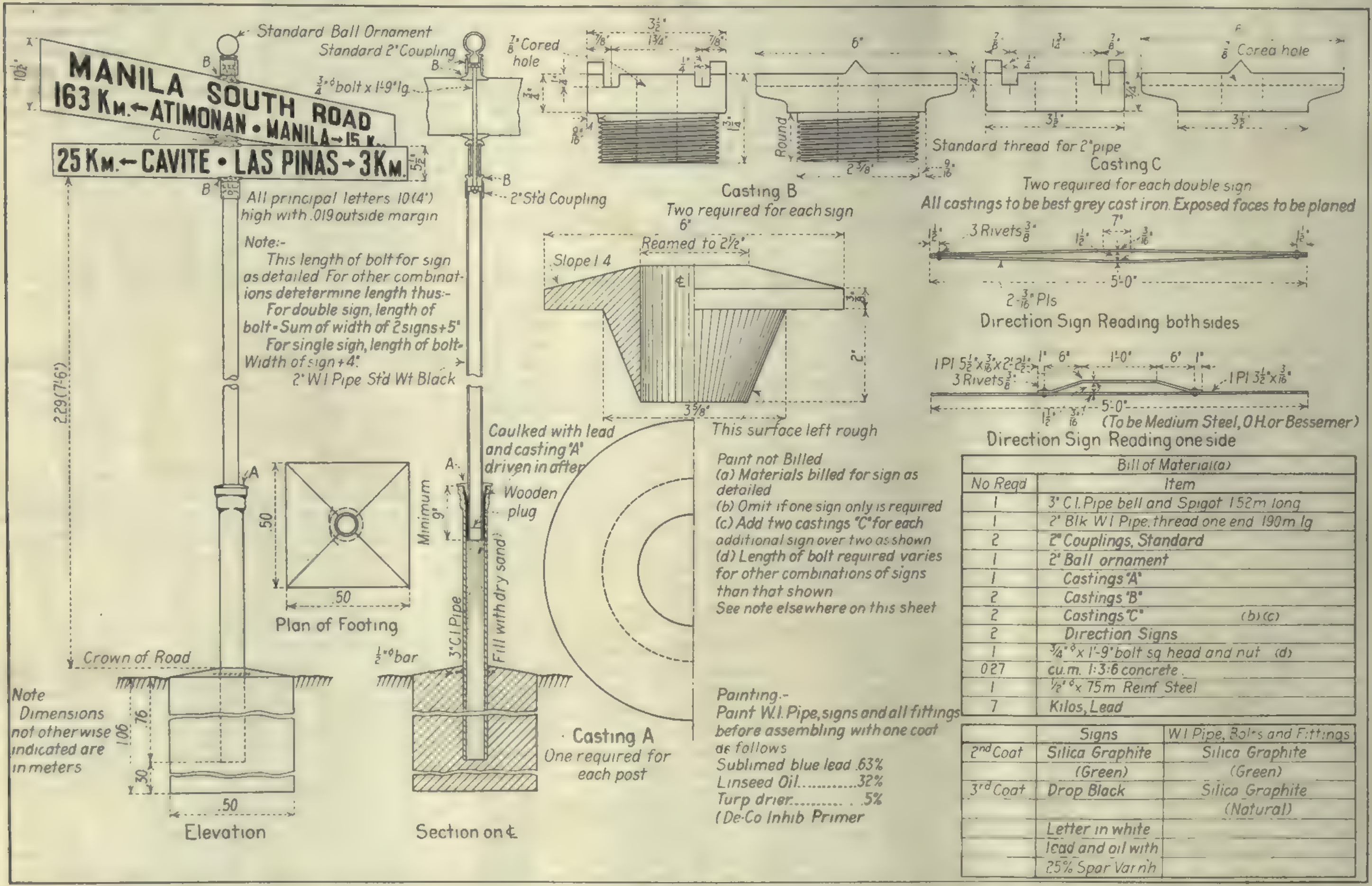
In his communication Mr. Wright suggests that a solution can be obtained by the passage of city ordinances providing that application for building permits, for work above a certain estimated cost, be accompanied by detail drawings, made to a scale sufficient to indicate the character of the work which is to be performed in detail. In the past most of the suggestions which have been made to improve conditions in the building construction field have been general in character; they have resulted in little definite action, although they have been useful in centering attention upon the subject. This suggestion has the advantage that the issue is made a local one and definite action in any city is possible by the concerted action of a few active advocates. In some cities the need for a change in present practice seems especially urgent, and Mr. Wright's recommendation seems to offer the opportunity for favorable action in such cases.

ROADS AND STREETS

Color Schemes for Highway Signs as Illustrated by Practice in the Philippine Islands.

Contributed by J. L. Harrison, District Engineer, Bulacan District.

Whenever a highway system becomes so extensive that a considerable proportion of the people using it are unfamiliar with its ramifications, it becomes advisable to erect signs for the purpose of directing traffic. Too often the signs erected in response to this need are carelessly designed or the work is left entirely to some painter. Naturally the results so obtained are variable and often poor.


Standard Ball Ornament
Standard 2" Coupling
MANILA SOUTH ROAD
163 KM.←ATIMONAN • MANILA→15 K.
25 KM.←CAVITE • LAS PINAS→3KM.
10½"
5½"
B
C
A
¾"ϕ bolt x 1'-9" lg.
All principal letters 10(4") high with .019 outside margin
Note:- This length of bolt for sign as detailed For other combinations detetermine length thus:- For double sign, length of bolt = Sum of width of 2 signs + 5" For single sigh, length of bolt = Width of sign + 4".
2" W I Pipe Std Wt Black
2" Std Coupling
2.29 (7'6")
Crown of Road
Note Dimensions not otherwise indicated are in meters
.76
1.06
.30
.50
Elevation
Plan of Footing
½"ϕ bar
Minimum 9"
Wooden plug
3" C I Pipe
Fill with dry sand
Caulked with lead and casting 'A' driven in after
Section on ℄
Casting A
One required for each post
⅞" Cored hole
3½"
1¾"
⅞"
¼"
6"
Round
2⅜"
9/16"
Casting B
Two required for each sign
Standard thread for 2" pipe
Casting C
Two required for each double sign
All castings to be best grey cast iron. Exposed faces to be planed
Slope 1 4
Reamed to 2½"
℄
2"
3⅝"
This surface left rough
3 Rivets ⅜"
7"
1½"
3/16"
5'-0"
2-3/16" Pls
Direction Sign Reading both sides
1 Pl 5½"x3/16"x2'-2½"
1'-0"
1"
1 Pl 3½"x3/16"
(To be Medium Steel, O.H. or Bessemer)
Direction Sign Reading one side
Paint not Billed
(a) Materials billed for sign as detailed
(b) Omit if one sign only is required
(c) Add two castings "C" for each additional sign over two as shown
(d) Length of bolt required varies for other combinations of signs than that shown
See note elsewhere on this sheet
Painting.-
Paint W.I. Pipe, signs and all fittings before assembling with one coat as follows
Sublimed blue lead .63%
Linseed Oil............32%
Turp drier.......... .5%
(De-Co Inhib Primer

Bill of Material (a)	
No Reqd	Item
1	3" C I. Pipe bell and Spigot 1.52m long
1	2" Blk W I Pipe. thread one end 1.90m lg
2	2" Couplings, Standard
1	2" Ball ornament
1	Castings "A"
2	Castings "B"
2	Castings "C" (b)(c)
2	Direction Signs
1	¾"ϕ x 1'-9" bolt sq head and nut (d)
0.27	cu.m. 1:3:6 concrete
1	½"ϕ x 7.5m Reinf Steel
7	Kilos, Lead

	Signs	W I Pipe, Bolts and Fittings
2nd Coat	Silica Graphite	Silica Graphite
	(Green)	(Green)
3rd Coat	Drop Black	Silica Graphite
		(Natural)
	Letter in white	
	lead and oil with	
	25% Spar Varnih	

Fig. 1. Details of Standard Highway Direction Sign, Bureau of Public Works, Philippine Islands.

Recently the Bureau of Public Works for the Philippine Islands found it advisable to adopt a standard sign for the roads under its jurisdiction. A careful study was made of the signs which had been erected throughout the Islands and of the types in use in the United States as well as those in Europe. As a result of this study it was decided that, because of climatic conditions in the Philippine Islands, wooden signs, though having a low first cost, would not prove sufficiently permanent and that concrete, though of very neat appearance, is too easily damaged. Therefore, the selection finally rested on a sign made up of steel and iron parts, a sign of neat trim appearance but one that could be easily built in any ordinarily well equipped shop. (For details see Fig. 1.)

This sign is erected 3½ meters from the center line of the road with the lowest plate 7 ft. 6 ins. above the center of the road. So located the eye catches it easily during the hours of sunlight and automobile headlights pick it up readily at night.

As originally planned all road signs were painted black and all lettering was done in white. No particular style of letter was prescribed. When these signs were erected it was at once discovered that people using the highways were often passing these signs without seeing them and it was decided that this must be because of the fact that black is not a very conspicuous color. Accordingly, a series of experiments was undertaken for the purpose of determining what color combinations are most satisfactory for this sort of work. Signs were painted blue with white letters, white with black letters, orange with black letters, red with black letters and white letters, green with white letters, etc., and from the study of these color combinations a number of interesting facts were developed.

(1) The black signs had been overlooked because so many objects along the Philippine roads are constructed of unpainted bamboo which, after a few months' exposure, turns to a very dark brown that not only serves as a poor background for black signs but so dulls the eye to dark colors that even when surrounded by objects of different colors, a black object makes no special impression on the senses.

(2) It was thought that a white sign with black letters would prove entirely satisfactory. However, it was at once observed that white failed to accomplish the desired results. There seem to be two reasons for this. In the first place the number of white objects along the highways is quite large and the impression made by the sight of a white object seems to be correspondingly small. In the second place it developed that the color contrast between black and white is too great, especially in the bright sunshine of a tropical summer day, and that the glare of the bright sunlight on a white board makes it hard to read black letters written on it except at very short distances. Moreover, it was observed tnat white signs pick up so much dust that they soon have a dirty, unsightly appearance. Therefore, white was also abandoned.

(3) Combinations of blue were better,

especially light blue with dark letters, but did not seem to be entirely satisfactory.

(4) As was expected combinations of green, because of the amount of green foliage along all Philippine roads, gave very poor results.

(5) Orange with black letters and red with either white or black letters were found to be satisfactory. There are not many red objects along the Philippine roads and a red sign makes an instant impression on the eye. However, as red is ordinarily used for danger signals it was thought best not to endeavor to use it for direction signs. Orange, being in nature similar to red, it was thought best to avoid its use also.

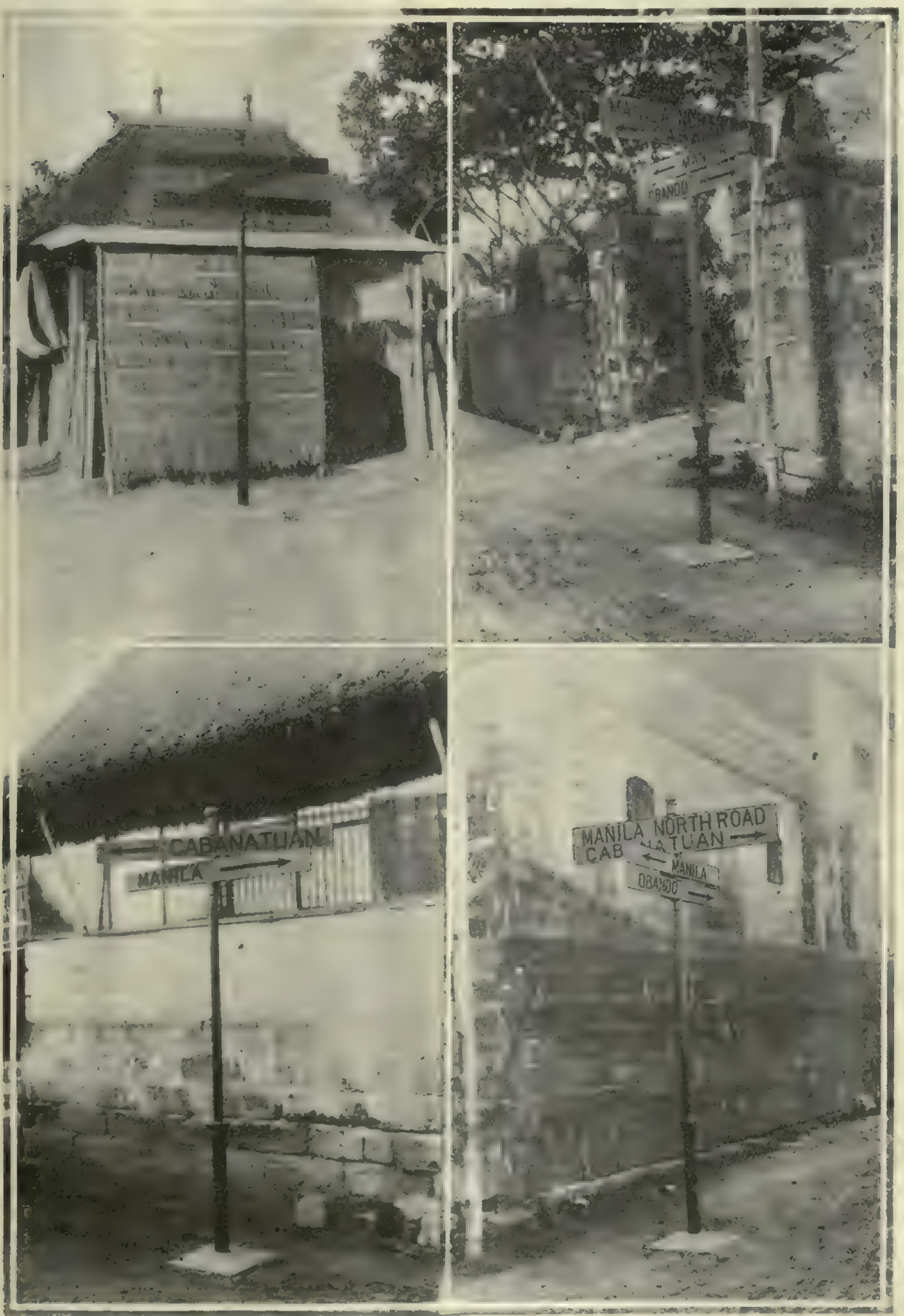


Fig. 2. Philippine Roadside Views Showing Highway Direction Signs.

(6) Yellow signs with black letters were tried purely as an experiment and not because it was expected that they would prove satisfactory, for it was supposed that yellow would prove inferior to white and that it would not produce a good looking sign. However, a very little experimenting demonstrated the fact that this color attracts the eye more quickly than any other color used. Moreover, it was found that these signs could be seen farther than any other color except red and that the color contrast between the yellow sign and the black letters was such as to be distinct both in the bright sunlight and by the light of automobile headlights. Nor is yellow too violent a color. On the contrary signs of this color are neat and very pleasing in appearance.

In order to ascertain whether the conspicuousness of the yellow could be ascribed to the general fact that it is the unusual which attracts attention, a number of trips were made over the highways of Bulacan province for the purpose of ascertaining whether or not yellow objects are actually rare. This "color census" showed that of the commoner colors green is the largest percentage of most backgrounds and that the blacks and browns are the second series in importance. White, blue, and red, in the order named, are common though much less so than green or the dark browns and blacks. But of yellow almost none was observed. In fact, it was often possible to drive for a good many miles without encountering a single bright yellow object. This "census" seemed to establish the fact that the frequency with which a color is encountered has a very direct bearing on its value for road signs and that only the rarer colors attract enough attention to warrant their use for this purpose. Naturally a road sign must present a neat, pleasing appearance, but it is entirely possible to find unusual colors that are also pleasing.

As now erected, highway signs are painted with a priming coat of red lead or blue sublimed lead over which are spread two coats of S. & W. standard lemon yellow buggy paint No. 15, or some other paint of equal color and composition. The lettering is then put on, a carriage black being used for this purpose. Then, to insure a hard finish that will stand the rain and that will catch a minimum of dust, two coats of the best spar varnish are applied. Such painting is a little expensive in first cost, but the better appearance of the signs and the greater lasting qualities of the finished work, are ample to justify the extra high first cost.

Another matter that attracted immediate attention was the fact that there is a great difference in the visibility of letters of different shapes. Heavy lines close together can not be seen as far as lighter lines spaced farther apart. Standard block letters can be read as far as any style that was tried. It was found that the distance between the letters should be at least 50 per cent greater than that ordinarily used for block lettering.

As a result of these experiments the standard highway signs are now painted black for a distance of 3 ft. above the concrete base, the balance being painted yellow. Black letters are used, and an effort is made to secure such a spacing of letters as will permit of the reading of all signs at the maximum distance possible for letters of the height used.

In citing this experience in selecting the colors for a standard highway sign it is not the intention of the writer to assert that a yellow sign is the best sign for all localities. On account of the scarcity of yellow shades in the Philippine Islands a yellow object attracts attention here very quickly where other colors which might be considered more striking, on account of the greater frequency with which they are encountered, produce much less effect. But it is desired to point out that more thought should usually be given to the selection of the proper color for road signs for it not infrequently happens that a good deal of money is invested in road signs which are not properly conspicuous and which are so placed that they do not attract attention. Even a large sign, if improperly colored or placed where the background is unsatisfactory, may be overlooked and almost entirely fail to accomplish the purpose for which it was erected. The experience of the highway engineers in the Philippine Islands has demonstrated the fact that a little study will usually serve to develop a color combination for highway signs that is striking and at the same time pleasing to the eye.

Such a sign, even if of small dimensions, will accomplish a great deal more than a large sign which is improperly colored or poorly placed.

Statistics and Discussion of Roadway Surfaces of State Aid Roads.

(Staff Abstract.)

It is estimated that the United States has 2,300,000 miles of public wagon roads, about 10 per cent of which, roughly speaking, may be said to be improved. Only about 1⅛ per cent, however, of this mileage has been substantially improved with state assistance.

The materials available for road surfacing are: (1) Common earth, sand and clay, suitably combined or treated with some other materials. (2) Gravel. (3) Crushed rock or other substitutes for macadam, such as slag from charcoal iron or blast furnaces, the latter being much preferable. (4) Such combinations of Nos. 2 and 3 as may be found advisable, a gravel base with a macadam top or a macadam base and a gravel top. (5) Bituminous macadam (penetration method). (6) Cement, concrete, using gravel, crushed rock or slag for the course aggregate. (7) Bituminous concrete (the mixing method), by using the materials above named for the aggregate and refined tars or asphalts for the binder. (8) Brick with foundations of concrete, water-bonded macadam, gravel or sand.

Which of the above materials should be used for a given road is a problem for the road engineer to solve, and it is usually capable of an economic solution, leaving the answer beyond reasonable doubt. However, in many cases available funds limits the choice of materials to those close at hand and cheapest in first cost, regardless of whether they are really the most economical, considering the perpetual upkeep of the road or not. But often the materials have to be freighted from a distance, and when the community is rich enough to build the most serviceable road the skilled road engineer can demonstrate his usefulness, providing he has persuasive powers enough to overcome local prejudice for or against particular materials and the arguments of men who may wish to sell these or other materials, regardless of their fitness for the road in question.

The writer has long preached the doctrine that there is no one best material for road surfacing in all places and under all conditions of soil and traffic, and that almost every available road material can be used to advantage somewhere in such a comprehensive system of roads as is required to serve a state.

The accompanying Table I shows the mileage of state aid roads of different classes in 25 states and the percentage of each class now in use.

(1) Sand—clay and top—soil roads comprise about one-sixth of the mileage given (16.4 per cent), showing that these roads are of considerable importance. They are well adapted to a medium horse-drawn traffic with a somewhat larger percentage of automobiles, and can be economically maintained by systematic use of the road drag after rains and the addition of such new material, sand or clay, as may be required. Kansas reports 758 miles of these roads, Louisiana 423 miles and Connecticut 318 miles, showing that they are by no means confined to the southern states, as is frequently supposed, although, so far as I know, the top-soil roads are mostly found in that section.

(2) It will be noted that gravel is the favorite road-building material in most of the states, comprising more than two-fifths of the entire road mileage reported (41.2 per cent). Washington reports 3,900 miles of these roads, Michigan 2,061 miles, Utah 1,319 miles and Vermont 1,053 miles, while three other states report over 400 miles each.

No doubt gravel is used on many roads because it is within a wagon haul of the road and cheap. However, taking Michigan as a fair example, where upwards of 60 per cent of the state aid roads are built of gravel, I am quite sure that in the majority of cases the travel is not so heavy that an economic mistake has been made by using gravel for road surfacing. In other words, when we take into account first cost, plus maintenance, plus repairs, plus interest on the investment, we will have a smaller total than with most of the expensive types of roads.

On the other hand, the writer has in mind several instances where gravel roads have been built on which the traffic, mostly automobiles at high speed, is so heavy that nothing poorer than cement concrete, asphaltic concrete or brick can be expected to last very long nor be kept in a reasonably passable condition by constant maintenance. Such roads, however, are carrying a traffic of from 300 to 500 vehicles daily, about three-fourths of which are motor driven, and constitute but a very small percentage of the gravel road mileage of Michigan, hence they may be considered the exceptions which prove rather than disprove the rule.

The writer knows of many gravel roads where the traffic is between 200 and 300 vehicles daily, with the same percentage of automobiles as above noted, that are standing up admirably and are being maintained at a cost far below the interest on the difference between the cost of these gravel roads and almost any type of more permanent road which might be mentioned.

In Michigan the average cost of the single-track gravel road is about $2,000 a mile, the same width of water-bound macadam $4,500 per mile, while cement concrete roads of the same width cost about $7,000 a mile. In the majority of cases the concrete roads are from 12 to 16 feet wide and cost from $14,000 to $17,000 a mile, or about $1.25 per square yard, plus the grading and drainage structures.

From the foregoing it will be seen that the annual cost of maintenance on a gravel road will have to approach about $250 a mile a year before any community can afford to consider any type of road costing $7,000 a mile or more, so long as the gravel road surface is satisfactory to the public, and in many places it is the most satisfactory type of road built.

(3) The water-bound macadam road rep-

TABLE I.—MILES OF STATE AID ROADS.

	Gravel.	Sand-clay.	Gravel surface (other base).	Macadam (waterbound).	Macadam (bituminous coated).	Macadam (bituminous penetration).	Bituminous concrete (mixing m't'd).	Cement-concrete.	Brick.	Miscellaneous.	Total.
Alabama	48.72	65.35		8.46						[1]10.94	133.47
Alaska	32										32
Arizona											
Arkansas	534	75	90	307		3		30			1,039
California											
Colorado											
Connecticut	327.83	318.17	6.83	527.26		39.11	22.95	12.67	.29		1,255.11
Delaware											
District of Columbia											
Florida											
Georgia											
Idaho											
Illinois	3			7				115	25		150
Indiana											
Iowa											
Kansas	153	758		119	25	1		1.35	4.10		1,061.45
Kentucky	80	20		400	10			4	2		516
Louisiana	147.2	423				9.5				[2]36.3	616.0
Maine	600	5	300	10	2	35	5	8			965
Maryland					150		3	18			171
Massachusetts		1.89	410.81	189.85	661.08	181.49		5.00	0.44	[3]118.01	1,568.57
Michigan	2,060.885	75.671	134.364	829.060				94.185			3,194.17
Minnesota	1,079	81	5	68		5			21		1,259
Mississippi											
Missouri											
Montana											
Nebraska											
Nevada											
New Hampshire			742.40	178.03		25.30					945.73
New Jersey	215.8			320.3	30.8		41.5	0.4		[4]6.9	615.7
New Mexico											
New York		1,915		301	41	233	2.49	101	28	[5]7	2,628.49
North Carolina											
North Dakota											
Ohio	46.7			786.6	7.3	151.5		66.3	444.0		1,502.4*
Oklahoma											
Oregon				6.				12.5		[6]6.25	24.75
Pennsylvania				872.19	308.70	90.40	21.15	0.31	87.33		1,380.08
Rhode Island				241	5	4					250
South Carolina											
South Dakota											
Tennessee											
Texas											
Utah	1,319.06	23.03	226.42	13.49				6.20			1,588.20
Vermont	1,053.22										
Virginia	475	1,158		876	9						2,518
Washington	3,900			271		80		0.90	0.42	[7]15.70	4,268.02
West Virginia											
Wisconsin	500	100	100	650	200	5	3	120	2	[8]90	1,770
Wyoming											
Total	12,575.42	5,019.11	2,015.82	6,981.24	1,475.88	811.30	125.09	595.82	614.58	291.10	30,505.36
Per cent	41.20	16.44	6.62	22.89	4.85	2.66	0.41	1.95	2.02	0.96	100.00

[1] Chert, 9.64; slag, 1.3. [2] Shell, 36.3. [3] With bitumen, 115.52; all others, 2.49. [4] Shell, 6.9. [5] All others, 7. [6] Asphaltic concrete, 6.25. [7] Shell (12), shale (3), 15; granite block, 0.70. [8] Shale, 90.00. *Under contract, 187.2.

resents more than one-fifth of the mileage given (22.9 per cent), notwithstanding the fact that many people are predicting that this type of road is of but little use under modern traffic conditions. It will be seen that the sand-clay and the water-bound macadam mileage is about equal and approximately one-half of the total gravel road mileage. Michigan reports 829 miles, Virginia 876 miles, Ohio 786 miles and Connecticut 527 miles, showing that the water-bound macadam is well distributed and by no means obsolete.

The writer still believes that proper bituminous treatment of the water-bound macadam road after it has been in service six months or one year will enable it to resist automobile traffic sufficiently well to give it a high place among the desirable roads under present traffic conditions.

(4) Owing to the fact that the gravel road surface is preferable to that of many other types, many roads are now built having a base of crushed stone, slag or other suitable material, with a top surfacing of gravel. Upward of 6 per cent of all of the roads reported are of this type, New Hampshire taking the lead with 742 miles, while Massachusetts reports 411 miles, Utah 226 and Michigan 134 miles.

The macadam base gives extra supporting qualities for this road, while the gravel surface affords easy maintenance by frequent use of the road drag after rains, with only the addition of enough new gravel to keep the surface free from ruts and holes. Macomb County, Michigan, has a road of this type which is well kept, and after two years the total repairs on two miles of road is reported at only $315.53, or an average of $78.88 a mile a year, the larger part of which was spent in dragging. The travel on this road ranges between 200 and 500 vehicles per day.

A few states are building a combination road, using a gravel base and a macadam top, but this type of road is not to be recommended where the automobile traffic is heavy unless some bituminous surface treatment is provided.

(5) Owing to the rapid disintegration of the water-bound macadam road under excessive automobile traffic, many forms of bituminous binders have been tried to overcome this difficulty. A bituminous macadam built by the penetration process is usually resorted to. This method of construction is well understood by road engineers. The bottom layer of the road is generaly built by an ordinary water-bound macadam, filled with stone screenings and rolled. The top layer, which may consist of stone ranging from 1 to 2 ins. in size, is then applied and given a light coating of clean ½-in. stone chips, free from dust, which are rolled into the surface. After this the road is coated with some heavy bituminous material (asphalt or refined tar) applied hot, preferably by means of a pressure distributor, using approximately 1½ bals. of bitumen to the square yard. Another coating of clean stone chips is then applied and the road again rolled. This is followed by seal or flush coat of hot bitumen at the rate of about ½ gal. per square yard, after which another coat of stone screenings ranging from ½-in. chips down to dust is applied to fill the remaining voids and take up the surplus bitumen. The road may be opened to traffic as soon after completion as the bitumen has set.

These roads constitute 2.7 per cent of the entire mileage reported. New York is credited with 233 miles of this road, Massachusetts with 181 miles and Ohio 151 miles.

Owing to the reported cost of maintenance of most of the cheaper forms of road, many communities have been seeking a type of road on which the maintenance would be very small. To many people cement concrete seems to offer the solution, and 1.95 per cent of the roads reported are of this type. Ohio reports 66.3 miles completed and 187.2 miles under contract. Michigan has 94 miles, completed for state reward, with a considerable extra mileage through villages, on which no state aid was received, and has some thirty miles under construction which will be completed this season.

While the cost of these roads, as above noted, has reached from $7,000 to about $17,000 a mile, according to width, the maintenance thus far reported has been very small, and the writer is quite well convinced that where the traffic runs above 500 vehicles a day this type of road is well worth considering. Experience in Michigan with upwards of 100 miles of these roads is on the whole gratifying.

(7) Since the bituminous macadam by the penetration method so frequently becomes disintegrated, the method of thoroughly incorporating the crushed stone with the bituminous materials in a specially designed mixer is becoming more and more common. Materials prepared in this way are designated as bituminous concrete to distinguish them from the bituminous macadam made by the penetration method.

The foundation may be cement concrete or water-bound macadam on which the bituminous mixture is spread and thoroughly rolled, after which it is treated to a surface or squeegee coat of bituminous materials, then covered with stone chips and rerolled. The road can usually be opened to traffic the second day after completion.

The advantage of this method over the penetration process is the thorough coating of all of the stones with the bituminous binder, which is seldom or never done by the other method, thus greatly increasing the strength of the bond.

Less than 1 per cent of the roads reporting are of this type. New Jersey reports 41½ miles and Connecticut 23 miles.

(8) Brick as a paving material for city and town streets has been used in this country for upwards of 40 years, but except in a few cases it has not been extensively used in road construction until within the last 15 years. Ohio reports 444 miles of brick paved roadway, New York 28 miles, Illinois 25 and Minnesota 21 miles. No other state has reported more than four miles of brick roadway. The total is about 2 per cent of all roads reported.

As already stated, the writer does not believe that there is any one road surfacing that will best meet all conditions, and in this brief paper he has simply tried to point out some of the more important materials now in use, the extent to which they are employed and some of the conditions to which they are adapted.

Every road is a local problem to be solved on the ground after all the data regarding soil, climatic and traffic conditions have been ascertained, all of which must frequently be subordinated to the ability of a given community to pay for any kind of improved road.

ACKNOWLEDGMENT.

Abstract from a paper by F. F. Rogers, State Highway Commissioner, Michigan, before the Pan-American Road Congress.

SEWERAGE AND SANITATION

Adapted Machinery and Construction Methods Employed on New Western Ave. Sewer, Chicago.—Time Studies.

Contributed by Stanley E. Bates, Assoc. Mem. W. S. E., Chicago, Ill.

A daily average of 100 ft. of 6-ft., two-ring, brick sewer, using an old 27-ton steam shovel to dig the 18-ft. trench and a drag-line for back filling, is the record being made by The Ryan Co., contractors, Chicago, Ill., on the Western Avenue Sewer between 71st and 75th Streets in Chicago. To maintain such a record, the methods and organization employed must be efficient; these are here described.

Western Avenue is a north and south section line street and carries a street car line as far south as 71st street, the north end of the sewer extension described in this article. As the city builds up south of 71st street, Western avenue will be the main business and through traffic thoroughfare of the district. It is 100 ft. wide between property lines. The sewer is located 40 ft. from the west property line and is circular in section, running on a grade of 0.12 per cent towards the north end where it connects with an old 6½-ft. brick sewer of similar construction. The total length is 2,570 ft. The plans call for 9 manholes, 26 ordinary 4-ft. internal diameter catch basins and two special 5-ft. internal diameter catch basins.

The material to be excavated consists of a blue glacial clay, in many cases quite stiff so that there is little trouble with slides. In others, however, it is only by the most expeditious work that the sides are kept from caving in before the bracing can be put in place. Practically no stones or rock are encountered.

For excavating the trench, the Ryan Co. is using a 13-year-old, 27-ton Vulcan steam shovel equipped with a ¾-cu. yd. dipper. As manufactured, the dipper stick was 20 ft. long, but to adapt it to sewer work, a 19-ft. extension was added, making it 39 ft. long—a truly remarkable length as can be seen in Fig. 1.

Being such an old style machine, it is not equipped with a boom engine but the raising and lowering of the dipper is accomplished by the reaction of the pull of the cables from the main engine controlled by a band friction drum. While the cable is taut, in digging, the tendency is for the dipper stick to push upward through the boom unless held in place by tightening the friction drum. While the cable is loose, the dipper will drop down of its own weight unless similarly held. In the process of digging and dumping the material it is necessary to let the dipper slide up and down only a few feet.

To accomplish results with such a device in deep trench work requires shovel operators of great skill and experience. The engineer and cranesman on this shovel have been with The Ryan Co. for several years and work together with great precision. Delay and false moves are unknown.

Having such a crew, Mr. T. A. Ryan, who acts as foreman on the steam shovel work, prefers the friction drum device as being cheaper in cost and operation, more speedy, and offering less chance for breakage and less charges for depreciation.

The steam shovel is mounted on a heavily trussed timber framework which spans the trench and travels on rollers. The trussed timber and rollers are shown in Fig. 2. Three transverse 10x12-in. timbers 20 ft. long trussed with four 1¼-in. hog rods, support the front or boom end of the shovel, while two timbers also trussed with four 1¼-in. rods, hold up the rear end carrying the boiler and engine. These transverse timbers rest at either end on 8x12-in. timbers which in turn are supported by the rollers. Three-inch planks are placed on the ground for the rollers to move on.

The shovel is pulled ahead by a ¾-in. wire rope cable attached to a dead man kept from 100 to 300 ft. ahead of the machine. The shovel digs slightly more than 8 ft. to a move, this being the length of the longitudinal stringers holding the trench sheathing.

Four braces—two above and two below—are put between each set of stringers. Large lumps of clay are thrown in behind the sheathing to keep it in a vertical position, providing something for the upper braces to push against, as of course it is impossible for the shovel to dig a trench with absolutely vertical sides, particularly in sections where the clay is soft. In soft clay the sheathing is placed close together, but in hard material spaces as wide as 6 ins. are left between the planks. In neither case, however, is it necessary to run the sheathing down further than to within 5 or 6 ft. of the bottom of the trench.

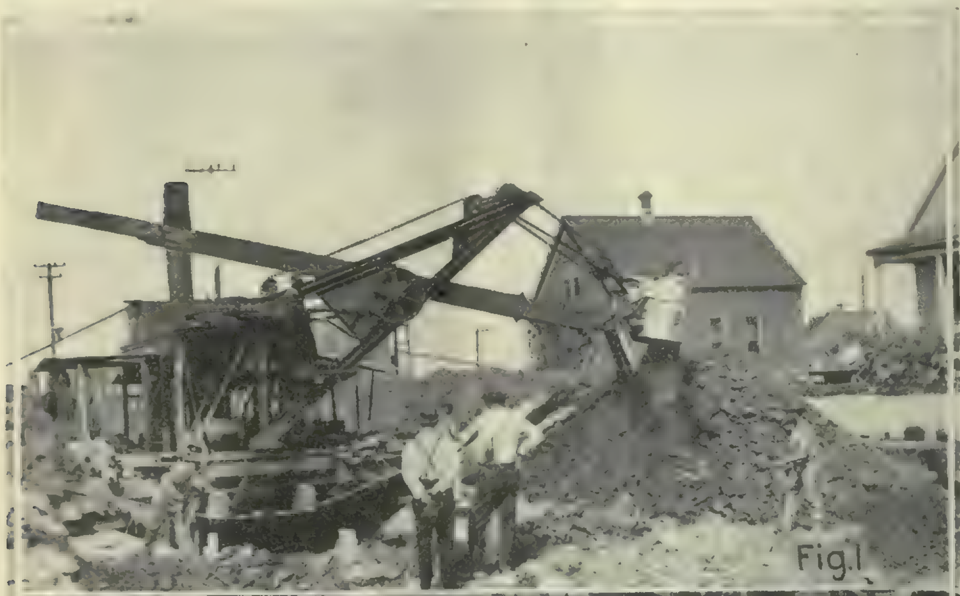


Fig.1

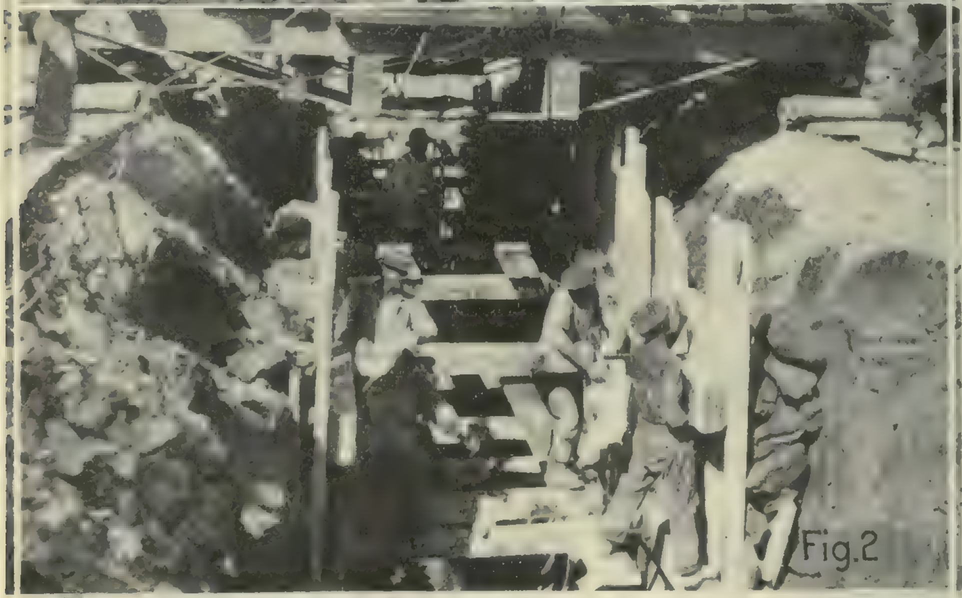
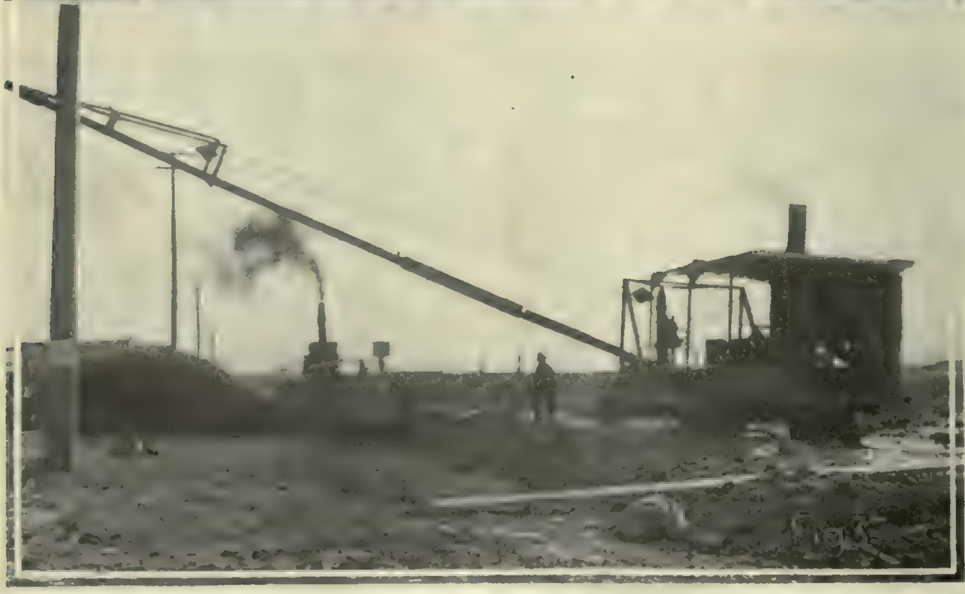


Fig.2



Views of Construction Plant Employed on New Western Avenue Sewer, Chicago.

Fig. 1—View of old Vulcan steam shovel equipped with 39-ft. dipper stick and ¾ cu. yd. dipper. Fig. 2—View of trussed platform and the rollers carrying steam shovel over the sewer trench. Fig. 3—View of the specially constructed machine used in backfilling

The sheathing consists of 2x8-in. planks from 12 to 16 ft. long. The stringers are 6x8's. The width of the trench between the sheathing is about 7 ft. 6 ins., leaving a margin of only an inch or so between the outside course of brick and the sheathing.

The time taken for bracing the trench runs between three and five minutes, depending upon the kind of material encountered. To move the shovel ahead then takes about two minutes, so the entire time lost per move is between five and seven minutes. Ordinarily there are twelve moves per day, which at 8 ft. per move makes 96 ft. daily progress. However, as there is always a space of a few inches between the ends of the 8-ft. stringers the distance is close to 100 ft. The biggest day's run so far was 14 moves, or more than 115 ft.

Measurements taken in a section dug out of hard clay show that about 45 cu. yds. of material (in place, not loose) are excavated to one move. At 12 moves per day this gives 540 cu. yds. of material.

Figuring backwards gives some interesting data. The shovel works about nine hours per day. Subtracting 6 minutes per move, multiplied by 12 moves (72 minutes), there remain 7 hours and 48 minutes (468 minutes) actual digging time. Thus 1.15 cu. yds. are excavated per minute. As the dipper holds ¾ cu. yd., it must make 1.54 trips per minute, or one trip every 39 seconds.

The sewer construction proper is done as close behind the shovel as possible, the invert brickwork being kept generally within 100 ft. of the end of the bracing. There are four brick layers and, as there are 272 bricks per lineal foot of 6-ft. two-ring sewer, 27,200 bricks are laid per day, or 6,800 per man per day. This makes 11⅓ bricks per man per minute. These figures are for the sewer only, and do not include the construction of manholes, catchbasins or connections.

For backfilling the trench a drag line is used. It is shown in Figs. 3 and 4. This machine was designed and built by the Ryan Co. especially for purposes of this kind. The frame is of steel throughout, about 11 ft. wide and 30 ft. long.

The traction wheels are of the caterpillar type, made by the Parsons Co., Newton, Iowa. The front wheels have steel plate tires 18 ins. wide.

A 20-H.P. 2-drum engine, made by the Clyde Iron Works, furnishes the power to operate the bucket, which in this case consists of an ordinary one-horse drag scraper or slip. From the forward drum of the hoist a ½-in. cable passes over a sheave at the front end of the machine and thence to the front of the slip, where it is attached by means of a bridle. From the rear drum another ½-in. cable passes over another sheave above the first, thence along the boom to a third pulley set in the end of the boom, and then back to the rear end of the slip, where it is fastened to a ring at the bottom.

The boom is 60 ft. long, made of two 8x8-in. timbers strongly spliced together in the middle. Pivoted at the forward end of the car, it is raised and lowered by a cable, one end of which is attached to a winch, the other passing through a set of blocks and fastened to the boom at a point about half way out toward the end. It will also swing horizontally through an arc of somewhat more than 180 degrees, though when once set for operation its position, horizontal and vertical, is rarely changed. A hand winch also controls the horizontal position of the boom.

For backfilling the Western avenue sewer trench the drag-line car is run along the west side of the excavation, as practically all of the material is deposited on the east side by the steam shovel. The boom is set, as shown, at about right angles to the street.

To operate the machine three men are

needed—engineer, fireman and helper, and a laborer at the slip. The latter has only to get the cutting edge of the slip started in the pile of earth. The engineer on the hoist by a proper manipulation of the two cables performs all the other operations of drawing the slip forward, dumping, and returning it to its original position.

The possible speed of operation of this machine is greater than that of the steam shovel, so it cannot be worked all day long. Less material, of course, is needed to backfill than has to be excavated, on account of the volume taken up by the sewer. This amounts to a little over 25 per cent of the total. The excess material is useful in filling up the old open ditches at the sides of the street, which had taken care of all drainage before the sewer was put in. No earth has to be hauled away.

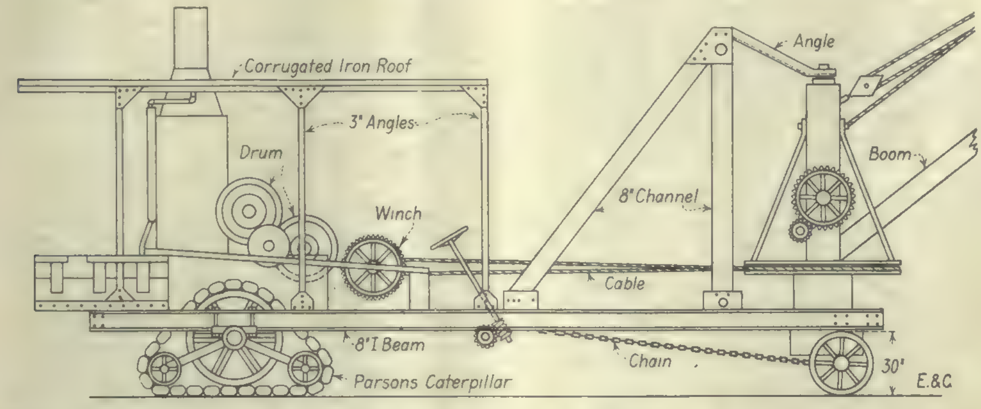


Fig. 4. Sketch of Details of Machine Employed in Backfilling on Western Avenue Sewer Construction in Chicago.

The crew necessary to carry on the entire work is as follows: One foreman for the steam shovel work, 1 foreman for sewer construction, 1 steam shovel engineer, 1 cranesman, 1 fireman on steam shovel, 1 man wheeling coal, 4 machine tenders (around steam shovel), 4 bracers, 1 straw boss, 3 men trimming trench, 1 form setter, 4 bricklayers, 2 tenders, 2 tossers, 2 passing brick to tossers, 2 men wheeling brick, 2 men carrying cement, 2 men mixing cement, 2 men removing sheathing, 1 engineer on drag line, 1 fireman and helper on drag line, 1 man at slip, 1 water boy; total, 41 men.

The above work is all done under the supervision of the Board of Local Improvements of the city of Chicago, of which C. D. Hill is chief engineer. George C. D. Lenth is assistant chief engineer in charge of sewer work.

Valuation of Railroads in Wyoming.—The Wyoming State Board of Equalization has fixed the total assessed valuation of all railroads in the state for 1915 at $55,120,350, an increase over the valuation of last year of $3,235,110.

A Handy Method of Estimating the Cost of Constructing Pipe Sewers.

Contributed by W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

Every estimate that is made of the cost of sewer construction must be based on some theory or practice that is reasonably correct in principle. Contractors or engineers who make estimates of the cost of work with which they are not familiar by a mere guess or on the basis of getting under the other bidder's prices, as some contractors do, usually come to grief sooner or later. Estimates that are worthy of consideration are usually made by one of the two following methods:

1. By estimating the amount of trench or the number of cubic yards a laborer can excavate in a day, the amount of pipe that can be laid in a day, together with cost of materials, risks, insurance, profit, etc.

2. By basing the estimate on the cost of work previously done at other places by the same or another contractor. The labor of trenching is often estimated by the cubic foot, and the price is increased as the depth increases.

The first method is cumbersome, consumes too much time, and is subject to many errors. The average amount of work that a laborer can perform in a day is often overestimated. The second method may be correct in principle so far as it goes, but the field of experience is often very limited. Perhaps a contractor has had years of experience laying 6-in. sewers 6 ft. deep, but has never laid a 24-in. sewer 16 ft. deep. How is he going to even approximate an intelligent bid on such work? The purpose of this discussion is to show a ready and reasonably correct method of making such estimates that will approximate the actual value of the work much closer than either of the above described methods. Even though the contractor wishes to get under the other fellow he should know to the best of his ability what the proper estimate should be.

For many years engineering and contracting papers have published detailed bids of the cost of vitrified pipe sewers in which the depth of the trench, the size of the pipe, and the cost in cents per foot were given. Early in my experience in engineering work the idea occurred to me that the cost, depth and size of sewers should bear some definite relationship to each other, just in the same manner as the relations found in natural and mechanical activities do. If trees grow in height and diameter, if water flows through the soil and rocks, and if electricity, which we cannot see, should follow mathematical laws, why should not the work of excavating trenches and laying pipe at least approach some law or rule which we can discover and make use of? By a careful tabulation and plotting of some 300 prices on pipe sewers of from 6 to 18 ins. in diameter and from 6 to 18 ft. deep an approximate relationship was established for each size of pipe with the depth and cost. All of these formula were of the form $D^2 = aC - b$, in which

D = depth of sewer in feet,
C = cost in cents per foot,
a and b are factors which are functions of S (size of pipe) and the character of the soil, and for any given condition are constants.

This form of equation can be arrived at mathematically by assuming that the work of excavating the trench is a function of the size of the pipe and depth of trench, and that the fixed charges, such as cost of pipe and materials, delivery on the ground, and general overhead expenses, are a function of the size of the pipe and are represented in the formula by b. None of these formulas was entirely satisfactory as they required too much time to use, and did not take into consideration sufficiently the varying character of the soil and other attending conditions, and when they did I had to use a different formula for each size of pipe which was liable to cause errors. Later I derived the following formula in which

C = the cost of sewer in cents per foot,
D = the depth of sewer in feet,
S = the diameter of sewer in inches,
X = a factor dependent upon the character of the soil and method of handling it.

$$C = X \left\{ \frac{D^2 + 10S}{53 - S} \right\}$$

Table I gives the values of the functions in the brackets for corresponding values of S and D. This is to say the cost of any sewer of size and depth chosen is equal to X times the table factor for those conditions. To estimate the cost of any sewer choose a value of X, as described later, and multiply it by the table factor. For illustration, the table factor for S equal to 8 ins. and D equal to 9 ft. is 3.5; if X is chosen at 20 the cost per foot is 3.5 × 20, or 70 cts. Those who are not familiar with the use of such a table may be materially aided by working backwards from data on previous work they have done, as follows:

TABLE I.—FOR ESTIMATING COST OF VITRIFIED PIPE SEWERS EXCLUSIVE OF APPURTENANCES.

Figures in table give values of $\frac{D^2 + 10\,S}{53 - S}$

Size of pipe in inches.	Depth of Trench in Feet																							
	4.0	4.5	5.0	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5
6	1.60	1.70	1.80	1.90	2.00	2.10	2.30	2.50	2.60	2.80	3.00	3.20	3.40	3.60	3.90	4.10	4.30	4.60	4.90	5.20	5.40	5.70	6.00	6.40
8	2.10	2.20	2.30	2.40	2.50	2.60	2.80	3.00	3.20	3.30	3.50	3.80	4.00	4.20	4.40	4.60	4.90	5.20	5.50	5.80	6.10	6.40	6.70	7.00
10	2.60	2.75	2.90	3.00	3.10	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.10	5.30	5.60	5.90	6.20	6.50	6.80	7.10	7.50	8.00
12	3.30	3.40	3.50	3.65	3.80	3.90	4.10	4.30	4.50	4.70	4.90	5.10	5.30	5.50	5.80	6.10	6.40	6.70	7.00	7.30	7.70	8.00	8.40	8.70
15	4.40	4.50	4.60	4.80	4.90	5.10	5.20	5.40	5.60	5.90	6.10	6.40	6.60	6.90	7.10	7.40	7.70	8.10	8.40	8.80	9.10	9.50	9.90	10.3
18	5.60	5.70	5.80	5.95	6.10	6.30	6.50	6.70	6.90	7.10	7.40	7.70	8.00	8.30	8.60	8.90	9.20	9.50	9.90	10.3	10.7	11.1	11.5	11.9
20	6.50	6.65	6.80	6.95	7.10	7.30	7.50	7.70	8.00	8.20	8.50	8.70	9.00	9.30	9.70	10.0	10.4	10.8	11.2	11.6	12.0	12.4	12.8	13.3

Size of pipe in inches.	Depth of Trench in Feet.																							
	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	23.5	24	24.5	25	25.5	26	26.5	27	27.5
6	6.70	7.00	7.40	7.80	8.10	8.52	8.95	9.30	9.70	10.2	10.7	11.1	11.6	12.0	12.5	13.0	13.5	14.0	14.6	15.1	15.7	16.2	16.8	17.4
8	7.40	7.70	8.20	8.50	8.90	9.30	9.80	10.2	10.6	11.1	11.6	12.0	12.5	13.0	13.5	14.0	14.6	15.1	15.6	16.2	16.8	17.4	18.0	18.6
10	8.50	8.70	9.00	9.40	9.80	10.2	10.7	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6	15.1	15.7	16.3	16.9	17.5	18.1	18.7	19.3	19.9
12	9.10	9.50	9.90	10.3	10.8	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2	15.8	16.4	17.0	17.6	18.2	18.8	19.4	20.0	20.7	21.4
15	10.7	11.1	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.1	16.7	17.3	17.9	18.5	19.1	19.7	20.4	21.1	21.8	22.4	23.1	23.9
18	12.4	12.9	13.4	13.9	14.4	14.9	15.5	16.0	16.6	17.1	17.7	18.3	18.9	19.5	20.2	20.9	21.6	22.3	23.0	23.7	24.4	25.2	26.0	26.8
20	13.8	14.3	14.8	15.3	15.8	16.4	17.0	17.6	18.2	18.8	19.4	20.0	20.7	21.4	22.1	22.8	23.5	24.2	25.0	25.8	26.6	27.4	28.2	29.0

A contractor has laid a 10-in. sewer 8 ft. deep at a cost of 65 cts. per foot, and he now wishes to bid intelligently upon a 12-in. sewer

9 ft. deep. The table factor for the 10-in. sewer 8 ft. deep is 3.8. 65 ÷ 3.8 = 18 = X. If the work on which he wishes to bid is of the same character he should use 18 as a value of X, but if the work was estimated to be 10 per cent more difficult, then he should use a value of X equal to 19.8. The table factor for a 12-in. sewer 9 ft. deep is 4.9. The estimate would then be 4.9 × 19.8 = 97 cts.

After a little experience in the use of the table and by keeping good records of the work done an engineer or contractor can make very close estimates on any proposed work. To show how closely work may be estimated the following facts are given:

At Antigo, Wis., the estimate on two miles of 24-in. intercepting sewer was $19,888, and the contract was let for $19,885. At Prairie du Chien, Wis., 25,410 ft. of 6, 8, 10 and 12-in. sewers were estimated by this method at $20,116, and the contract was let for $20,482.24. At Boscobel, Wis., 15,600 ft. of 8, 10 and 12-in. sewers were estimated to cost $15,215, and the contract was let for $15,349.90. At none of the above places was the estimate given out previous to the closing of the bids.

For Wisconsin conditions, where the excavation is made in gravelly clay with no water or quicksand, I have found that a constant of about 20 gives close results. In sandy soils and shallow trenches, when sheeting was not required, a constant as low as 15 has given an estimate equal to the contract price.

Table II shows the factors that have been computed from the cost of actual work done at the cities named.

TABLE II.—COMPUTED VALUES OF X FROM ACTUAL COSTS OF SEWERS IN WISCONSIN CITIES.

Location.	Factor. From.	Factor. To.	Character of the soil and condition.
Medford	22	26	Clay, gravel and boulders, wages high.
Richland Center	21	22	Mostly sand, deep trenches, sheeted, wages medium.
Kiel	15	20	Sandy clay, wages medium, labor conditions good.
Mauston	14	20	Sand, sandy clay, some water, labor conditions good, pipe prices medium.
Burlington	13	22	Gravelly clay, 1/10 laid in concrete.
LaFarge	17	23	Sandy clay, some water, sheeting.
Sanitorium, Wales.	..	35	Clay, 2 miles inland, have to board laborers.
Plymouth	20	27	Clay, gravel and boulders.
Lake Mills	16	19	Sand, clay and good digging.
North Milwaukee	20	24	Red clay, machine work.
West Salem	17	19	Good digging, wages medium.

From the data given in Table II the conclusions are drawn which are expressed in Table III.

This method of making estimates has not been based on the amount of work that a man can do in a day, or the price paid him, but has been arrived at by a study of a large number of bids on work where the size of the pipe, depth of the trench and other general conditions were known. The cost of manholes, lamp holes, catchbasins or other accessories has not been included. It is not based on work so large or of such a nature that steam shovels would be used, or work involving rock excavations, or in quicksand of any considerable extent, but is based on work involving the use of vitrified pipe in diameters ranging from 6 to 20 ins. in diameter, and on the ordinary run of soils as we find them in the north central states. The estimate arrived at is not the actual cost, but the price a contractor would bid for the work.

TABLE III.—VALUES OF X BASED ON SOIL AND OTHER CONDITIONS.

Character of soil and other conditions.	Value of factor X.
Sandy soil, bracing only required, no water; wages and pipe prices medium	14
Good digging in any soil, work scarce	15
Clay soil, good digging	17
Red clay, no bracing	20
Sandy clay, some water	23
Sand with some water	20
Red, sticky clay	24
Gravel and boulders, wages high	26
Clay, gravel, lots of boulders, labor scarce	27
Work inland from railroad; board of laborers and other increased expenses	35

I have found the above formula and tables very useful in my work for the past ten years. My assistants soon learn to use them readily, with a little advice from me as to choice of the factor X. By this method our estimates are made in a very short time and seldom vary over 5 per cent from the actual contract price, which cannot be said of most cost estimates on work of an engineering nature.

Extent and Cost of Use of Motor Trucks in Municipal Refuse Collection Service.

(Staff Abstract.)

The purpose of this article is to give a brief account of experience with motor trucks in municipal refuse collection service. Their use for this purpose is comparatively new, but is growing, and promises to develop further. Consequently improvements in their application may be expected.

FIELD FOR TRUCKS.

Refuse collection service as regards transportation includes two parts: (1) The house-to-house collection, and (2) the transportation of the collected material from the point of last collection to the place of final disposal. The first part constitutes a so-called start-and-stop service; the second is a straight run. The first corresponds somewhat to ice delivery service, or package delivery from a department store; the second is more similar to coal delivery. The problem as a whole includes a great number of local considerations, such as the location of the house can, the character of the alley and street pavements and grades, the cost of team haul, the available locations for loading stations, places for final disposal, etc. Considerations such as these cannot be covered in a general article such as this one, but are problems to be solved for each locality.

PRINCIPLES OF COLLECTION.

A thorough study of refuse collection involves the proper correlation of the following principal elements: 1. Unit quantities of refuse. 2. Frequency of collection. 3. Time required for one collection. 4. Length of working day. 5. Length of haul. 6. Size of wagon. 7. Number of trips per day.

The time spent actually filling a refuse wagon is called the productive time, while the time spent hauling after the wagon is full is called the unproductive time. Obviously the unproductive time should be kept as low as possible, particularly for that part of the equipment which is making the house-to-house collections. It has been found in some cities that motor trucks are less costly to operate than teams only when operated two or three shifts each day.

PRESENT USE IN VARIOUS CITIES.

A brief summary of the use made of motor trucks in a number of cities is given below. This list is a fairly complete record in indicating the field over which the use of motor vehicles extends. The populations noted are from the United States census for 1910:

New York City (4,766,883): The Department of Street Cleaning operates a number of 5-ton rear-dump gasoline trucks. The tractor-trailer system is also used. The tractor-trailer equipment includes a 7-ton garbage wagon with a low loading height, and 8-ton and 15-ton rear-dump ash wagons. The large 15-ton wagon is built for a speed of 8 miles per hour. It is fitted with steel tires for summer use. During the winter rubber tires are put on the front wheels. The bulk of the load, however, is carried on the steel tires.

Boston (670,585): The city operates two 5-ton rear-dump electric trucks for collecting ashes, rubbish and street sweepings. The trucks make house-to-house collections and deliver the material to dumps.

Detroit (465,766): Two 6-ton gasoline trucks are used for transporting a number of loaded garbage boxes from a transfer station to a point of disposal. The trucks have a flat body and are equipped with loading cranes. The city also operates two smaller gasoline trucks for removing garbage from hotels and restaurants.

Jersey City (267,779): A private collector operates one 3-ton gasoline truck for refuse collection.

Seattle (237,194): The Department of Health has operated one 5-ton gasoline truck for carrying refuse from a transfer station to the place of final disposal. The truck carries a 7-cu. yd. rear dump body.

Atlanta (154,839): The Street Cleaning Department operates several gasoline trucks for collecting mixed refuse from houses and hauling it to the city refuse incinerator.

New Bedford (96,650): A private collector operates one 3-ton gasoline truck for refuse collection.

Lawrence, Mass. (85,892): A 3-ton gasoline truck is operated by the Health Department for refuse collection.

Joliet, Ill. (34,670): The city operates a 3½-ton gasoline truck equipped with an automatic rear-dump body. It is used for house-to-house collection of garbage.

Asheville, N. C. (18,762): An electric truck is used for house-to-house collection of garbage. The body is all steel and watertight, with a number of hinged covers. The body is dumped from the rear by hand hoist.

Miami, Fla. (5,471): The city operates a 2-ton electric truck for house-to-house collection of garbage. The truck carries two flat decks, each with room for 50 cans of garbage. It starts out in the morning with a load of 50 clean cans and leaves one at each house where a full can is taken. The truck cost $3,300, and the cost of operation, exclusive of fixed charges, amounts to about $9 per day. This figure, however, includes the wages of two helpers for loading the truck.

Calgary (43,704): This city operates a number of electric trucks, covering a variety of service. The Sanitary Department has a 5-ton truck with an extra battery on the rear end. This truck is used with three trailers, each having a capacity of about 16 cu. yds. The garbage is drawn by one-horse carts to transfer stations and discharged into the trailers. A rope network is laid to cover the inside of the trailer body. The trailers are picked up by the truck at certain times each day and hauled to the incinerator. At the incinerator a traveling crane picks up the rope network and drops the garbage into a storage pit. The truck is said to have replaced six teams. This truck cost $5,050 f. o. b. Calgary, complete with battery.

TABLE I.—FIRST COST OF MOTOR TRUCKS FOR REFUSE COLLECTION.

Rated capacity, tons.	Cost of truck, complete.
1	$2,600
2	3,400
3	4,200
4	4.800
5	5,400
6	6,000
7	6,500

The city also has two combination 5-ton trucks used for ash collection in winter and street flushing in summer. These trucks are worked both day and night.

Trucks are also used at Missoula and Butte, Mont.; Dubuque, Iowa, and Springfield, Mass. There are therefore fifteen or more cities where motor trucks are in use in refuse collection service.

TYPES AND SIZES OF TRUCKS.

A variety of makes, types and sizes of trucks are in use. The majority have capacities of from three to five tons. Both gasoline and electric motive power are used. The bodies are built to unload by dumping at the rear, or with a rope network as at Calgary. With a tractor the trailers can be built for bottom dumping. The service is both house-to-house and a straight run from a transfer station to a disposal plant.

COST DATA.

First Cost.—The first cost varies with the kind of body, the general finish, the appurtenances and other items. A very general figure for the cost of different trucks is given in Table I.

Operating Costs.—The cost of operating varies considerably from one locality to another. Some general data are available. Table II gives the manufacturers' estimate of the daily cost of operation, based on a travel of 40 miles per day.

TABLE II.—COST OF OPERATING GASOLINE TRUCKS PER DAY OF 40 MILES TRAVEL.

Rated capacity, tons.	Cost per day.
1	$ 7.40
2	7.60
3	9.40
4	10.25
5	11.00
6	11.75
7	12.50

These figures, of course, are only approximate. They include all charges, both fixed and operating.

The *Electrical World* has compiled operating costs for electric motor trucks in commercial service from 50 plants taken from all parts of the United States. The costs include interest, depreciation, insurance, licenses, upkeep of tires, batteries, mechanical parts, power, supplies, garage charges drivers' wages and supervision. The daily mileage is not recorded but the total cost per day is as follows for the various sizes of trucks:

Rated capacity, tons.	Average cost per day.
0.5	$ 6.34
1.0	7.56
2.0	8.92
3.5	10.38
5.0	11.74

These are quite representative figures, and are only slightly higher than the manufacturers' cost.

A study of a number of records indicates that the daily mileage of trucks will range from 25 to 40. A mileage of 30 miles per day would give the following approximate costs per ton mile, computed from the average manufacturer's figures:

TABLE III. — TOTAL COST OF OPERATING MOTOR TRUCKS PER TON-MILE.

Rated capacity, tons.	Cost per ton-mile, including fixed charges.
1	$0.25
2	.13
3	.11
4	.09
5	.07
6	.06
7	.06

The Chicago Civil Service Commission, after an extended study, found the operating cost of a 3-ton gasoline truck to be $0.13 per ton mile. A 3-ton electric truck cost $0.11 per ton mile with current at 0.6 ct. per kilowatt-hour. This is a very low cost for electric power.

The Automobile Chamber of Commerce, after compiling a large number of cost data for commercial vehicles of various sizes, arrived at an average cost of operation, including fixed charges, of $0.11 per ton mile.

The Department of Public Works in Chicago uses a 5-ton and a 2-ton gasoline truck for delivering materials between city yards and construction jobs. The average cost of operating the 5-ton truck was 13 cts. per ton mile. The cost of operating the 2-ton truck varied from 14 to 32 cts. per ton mile. The cost by teams under contract was 26.9 cts. per ton mile. These costs were from actual service records during the last six months of 1914 and include fixed charges and all other costs.

These figures are from truck operation only and do not include the wages of helpers for loading in collection service.

COMPARISONS.

A study of the cost of operation indicates that the fixed charges amount to about 58 per cent of the total cost. The power cost is generally less than 10 per cent of the total. Consequently the choice between gasoline and electric trucks does not depend wholly upon the power item, but rather upon special local conditions.

Comparing motor vehicles with horse-drawn garbage wagons at $5.50 per day the Chicago investigation showed that with electric trucks a saving of 5.1 per cent could be made in parts of the city where the haul was considerable. This comparison is based on an 8-hour working day for both wagon and truck. Longer operation of the truck would have increased the saving.

SUMMARY.

Both gasoline and electric trucks are used in a variety of ways in refuse collection service. They are used for house-to-house collection as well as for a straight run from a transfer station. The trucks used have proved to be reliable, but no standard type has developed.

As compared with horse-drawn wagons the difference in cost is often slightly in favor of the truck, especially when the truck is operated more than one shift per day. However, the difference in cost of operation does not control, and special local considerations must be studied and weighed for each case. In considering cost data based on commercial service the cost of gathering the refuse should be added.

ACKNOWLEDGMENT.

Paper before annual meeting of American Public Health Association, Rochester, N. Y., September, 1915, by Mr. Samuel A. Greeley, 64 West Randolph street, Chicago, Ill.

BRIDGES

The Board of Engineers of the Quebec Bridge and a Lower Chord Section of the Bridge—C. N. Monsarrat, Chairman and Chief Engineer, in the Center; Ralph Modjeski on the Left; C. C. Schneider on the Right—Pin Hole Shown is 45 Ins. in Diameter.

Design of Standard Solid-Deck Reinforced Concrete Trestle in Use on Illinois Central Railroad.

(Staff Article.)

In connection with the construction of second track on its main line the Illinois Central R. R. has developed an efficient type of solid-deck concrete trestle. With the recent opening of 34 miles of second track between Gibbs and Kerrville, in Tennessee, this railroad has completed its double track work between Chicago and Memphis. In this connecting link there are about 9,500 ft. of concrete trestle, in addition to other minor bridge work. The reinforced concrete slab superstructures of these trestles rest on concrete pile bents, instead of on the solid concrete piers originally used in this type of bridge. This change has resulted in a considerable saving in the cost of the substructures. The following data apply to the standard type of reinforced concrete trestle now in use:

LOADS AND ALLOWABLE STRESSES.

Loads.—In designing the reinforced concrete trestles the following loads are used:

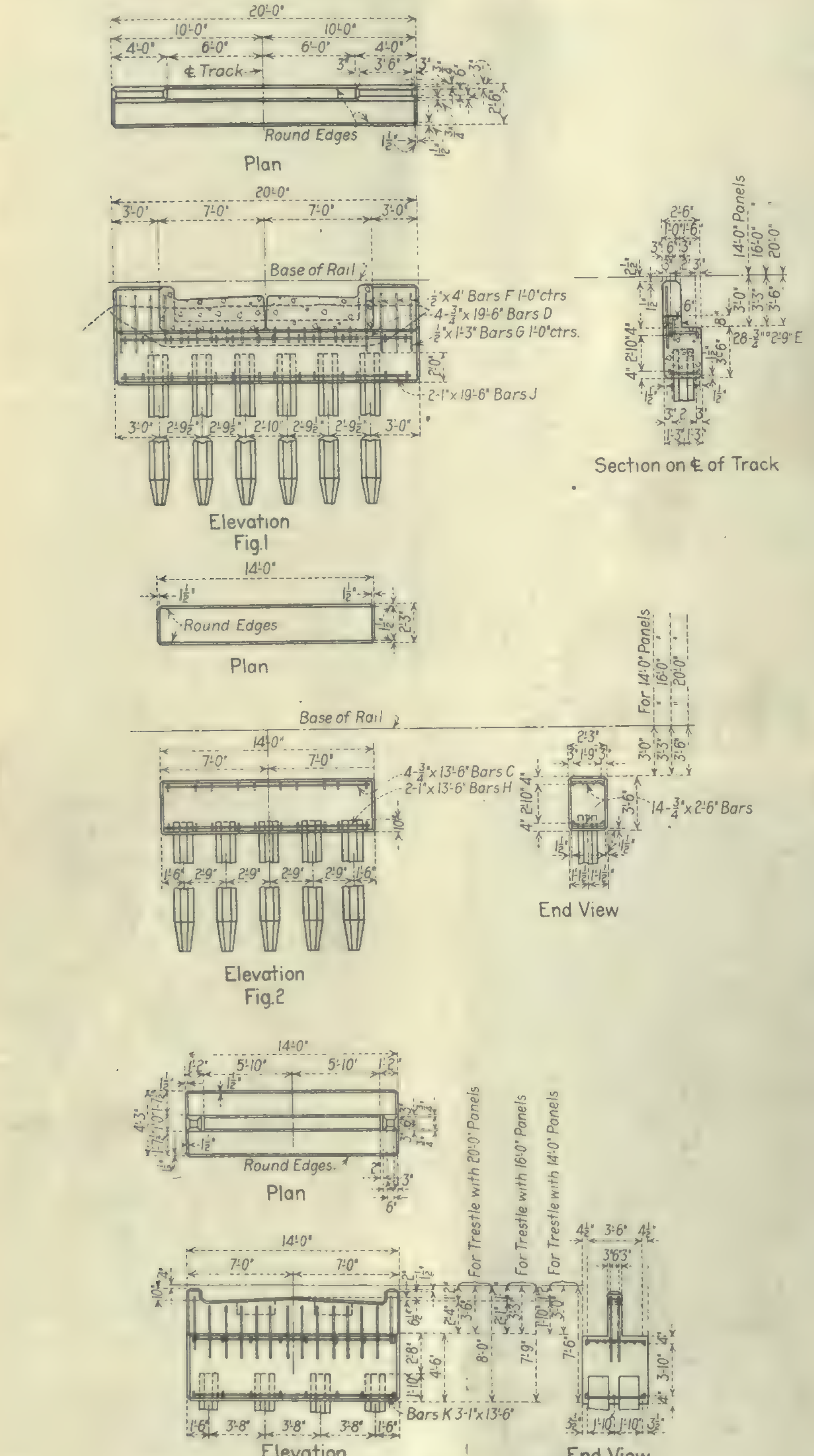
Dead load = weight of structure.
Live load = two 188.75-ton engines (practically Cooper's E-55).
Impact stress

$$= 0.5\,\frac{\text{live load stress} \times \text{live load stress}}{\text{live load stress} + \text{dead load stress}}$$

Allowable Stresses.—The allowable stresses used are as follows:

Tension in reinforcing steel, 17,000 lbs. per square inch.
Strength of concrete in tension neglected.
Tension in rods of vertical web reinforcement, 12,000 lbs. per square inch.
Compression of concrete on extreme fiber due to cross bending, 750 lbs. per square inch.
Shear on section without web reinforcement, 40 lbs. per square inch.
Shear on section with bent up rods only, 60 lbs. per square inch.
Shear on section with bent up rods and vertical stirrups, 120 lbs. per square inch.

Where web reinforcement is necessary 40 lbs. per square inch is deducted from the total shear on $j\,b\,d$, where no bent up bars are used. For figuring vertical stirrups, where bent up bars are used, 60 lbs. per square inch is deducted from the total vertical shear on $j\,b\,d$.



Figs. 1, 2 and 3. Details of End, Intermediate and Anchor Piers of Standard Solid Deck Reinforced Concrete Trestle in Use on Illinois Central R. R.

Stirrups are proportioned according to the following formulas:

Vertical stirrups, $P = \dfrac{VS}{j\,d}$.

Inclined stirrups, $P = 0.7\,\dfrac{VS}{j\,d}$.

In these formulas,
P = total stress taken by stirrup.
V = total vertical shear on section.
b = width of section of beam.
S = horizontal spacing of stirrups.
$j\,d$ = distance of centroid of compression of concrete to center of gravity of steel reinforcement.

Bond.—For plain bars the allowable bond stress is 80 lbs. per square inch, and for deformed bars 120 lbs. per square inch.

Concrete Proportions and Reinforcing Steel.—For the reinforced concrete slabs and pier caps the concrete proportions are 1 part cement, 2 parts sand, and 4 parts crushed stone. All reinforcing steel is high carbon steel conforming with the specifications of the American Railway Engineering Association.

PIERS FOR SINGLE TRACK TRESTLES.

The piers are of three types: the end, the intermediate, and the anchor. In trestles where there are ten or more spans an anchor pier is to be placed every sixth bent. Standard designs include 14-ft., 16-ft. and 20-ft. panels, the same size of pier being used for the different spans.

End Pier.—The end pier cap has a width of 20 ft., a thickness of 2 ft. 6 ins., and a depth below the slab seat of 3 ft. 6 ins. The parapet wall has a thickness of 12 ins. and a height above the slab seat of 2 ft. 8 ins. for the 14-ft. spans, 2 ft. 11 ins. for the 16-ft. spans, and 3 ft. 2 ins. for the 20 ft. spans. The pier contains six octagonal reinforced concrete piles, all piles being driven plumb. These piles have an inscribed diameter of 16 ins., and are embedded in the pier cap to a depth of 2 ft. Deducting the spaces occupied by the embedded portions of the piles each end pier cap contains 6.9 cu. yds. of concrete.

Details of a typical end pier are shown in Fig. 1. These drawings show the arrangement and give the size of the various reinforcing bars.

Intermediate Pier.—The intermediate pier cap has a width of 14 ft., a thickness of 2 ft. 3 ins., and a depth of 3 ft. 6 ins. This pier contains five reinforced concrete piles spaced 2 ft. 9 ins. on centers. These piles project 10 ins. into the pier cap. Deducting the space occupied by the tops of the piles the pier cap contains 4.0 cu. yds. of concrete.

Figure 2 shows a plan, a side elevation and a cross section of a typical intermediate pier.

Anchor Pier.—The cap of the anchor pier has a width of 14 ft., a thickness of 4 ft. 3 ins., and a depth below the slab seat of 4 ft. 6 ins. Above the slab seat, and located in the center of the cap, there projects a continuous 12-in. wall, which acts as an anchorage for the adjacent slabs. The height of this wall above the slab seat, at the curb, is 2 ft. 8 ins. for the 14-ft. spans, 2 ft. 11 ins. for the 16-ft. spans, and 3 ft. 2 ins. for the 20-ft. spans. The pier contains eight reinforced concrete piles, arranged in two rows of four piles each. These project 1 ft. 10 ins. into the pier cap. The rows are spaced 2 ft. on centers, the piles in each row being spaced 3 ft. 8 ins. on centers. Deducting the spaces occupied by the tops of the piles each anchor pier cap contains 11.3 cu. yds. of concrete.

Figure 3 shows a plan, a side elevation and a cross section of a typical anchor pier.

Reinforced Concrete Piles.—The octagonal reinforced concrete piles used in the standard piers have an inscribed diameter of 16 ins., and are made in lengths of 20, 25, 30, 35 and 40 ft. Beginning at a plane 2 ft. from the end each pile tapers, ending in an octagon having an inscribed diameter of 5 ins. The 20, 25 and 30-ft. piles are each reinforced with eight longitudinal bars and with hoops. For the 20-ft. piles the longitudinal rods are ⅝-in. round, for the 25-ft. piles ¾-in. round, and for the 30-ft. piles ⅞-in. round. The hoops are made of No. 7 B. W. G. wire, welded in the form of a circle, with an inside diameter of 14 ins. At the lower end the longitudinal rods are brought together and wrapped with No. 12 wire. To hold the longitudinal rods in place a ¼-in. spacing rod, bent to form a loop near each end, is placed every 2 ft. 3 ins. along the pile.

Figure 4 gives details of the 20, 25 and 30-ft. piles.

The 35 and 40-ft. piles are similar to those shown in Fig. 4, the only difference being in the longitudinal reinforcement.

For the 35-ft. piles the longitudinal reinforcement consists of eight ¾-in. round bars, placed as shown for the shorter piles, and eight ¾-in. x 11-ft. round bars, the latter occupying the central 11 ft. of the pile.

For the 40-ft. piles the longitudinal reinforcement consists of eight ⅞-in. round bars, placed as for the 20, 25 and 30-ft. piles, and eight ⅞-in. x 16-ft. round bars, the latter occupying the central 16 ft. of the pile.

REINFORCED CONCRETE SLAB SUPERSTRUCTURE.

For a single track line the reinforced concrete slab superstructure has a width of 14 ft., each span consisting of two slabs, each 7 ft. wide.

For the 14-ft. clear spans (16 ft. center to center of piers) each slab has a length of 16 ft., a width of 7 ft., a thickness at the center of 2 ft. 3 ins., and a thickness at the curb of 2 ft. 1 in. The curb has a thickness of 12 ins. and extends 10 ins. above the slab. The outside face of the slab has two 1½ x 5-ft. panels, these panels being recessed 1½ ins. The slabs are reinforced with transverse and longitudinal bars, and are fitted with lifting hooks. Each slab is provided with two weep holes, formed by inserting 4-in. tiles. These weep holes are fitted with malleable iron drain grates. Each 16-ft. slab contains 9½ cu. yds. of 1:2:4 concrete.

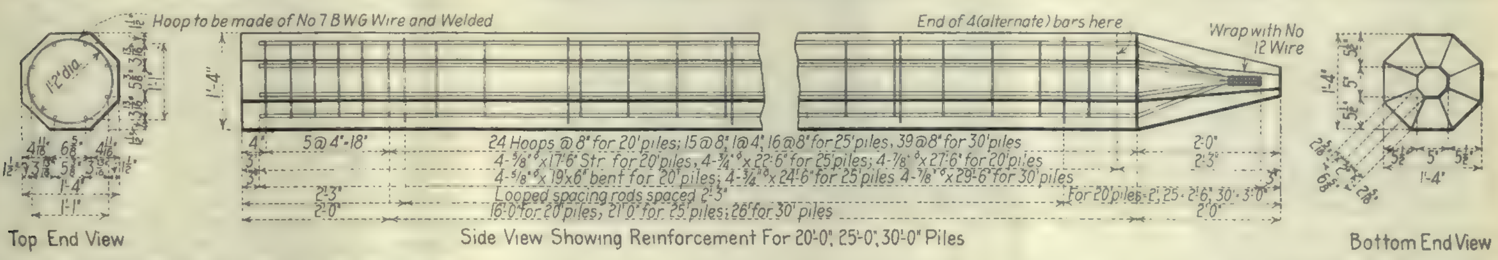

Hoop to be made of No 7 BWG Wire and Welded
1'2" dia
1'-4"
1'-1"
5@4"=18"
24 Hoops @ 8" for 20' piles; 15@8", 1@4", 16@8" for 25' piles, 39@8" for 30' piles
4-⅝"φ x 17'6" Str. for 20' piles, 4-¾"φ x 22'6" for 25' piles; 4-⅞"φ x 27'6" for 20' piles
4-⅝"φ x 19'6" bent for 20' piles; 4-¾"φ x 24'6" for 25' piles 4-⅞"φ x 29'6" for 30' piles
Looped spacing rods spaced 2'3"
16'0" for 20' piles, 21'0" for 25' piles, 26' for 30' piles
2'3"
2'0"
End of 4 (alternate) bars here
Wrap with No 12 Wire
For 20' piles 2', 25'-2'6", 30'-3'0"
Top End View
Side View Showing Reinforcement For 20'-0", 25'-0", 30'-0" Piles
Bottom End View

Fig. 4. Details of 20, 25 and 30-ft. Reinforced Concrete Piles Used in Piers of Solid Deck Reinforced Concrete Trestles on Illinois Central R. R.

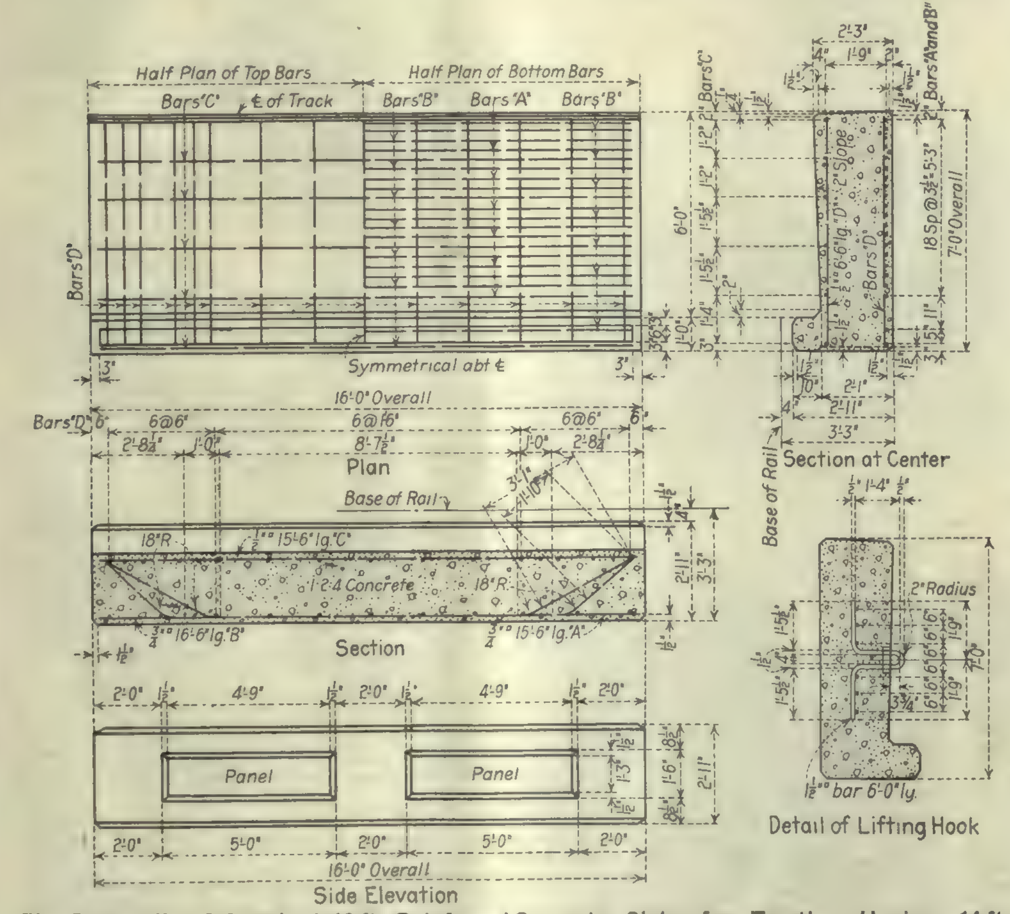


Fig. 5. Details of Standard 16-ft. Reinforced Concrete Slabs for Trestles Having 14-ft. Clear Spans, Illinois Central R. R.

Figure 5 gives details of the 16-ft. slabs used for the 14-ft. clear spans. These drawings give the size and arrangement of the various reinforcing bars, and indicate the provisions made for drainage and for lifting the slabs.

PIERS FOR DOUBLE TRACK TRESTLES.

For double track trestles separate intermediate and anchor piers, and the same type of slab, are used as for single track lines; the end pier, however, is made in one piece. This pier has a width of 34 ft. and contains eleven reinforced concrete piles. With the exception of its width this pier has the same dimensions as the end pier shown in Fig. 1.

Figure 6 (p. 290) is a view of one of the older types of reinforced concrete structure, in which solid piers and abutments are used, and Figs. 7, 8 and 9 (p. 290) are views of the new standard type of reinforced concrete trestle.

The structures described in this article were designed by the engineering department of the Illinois Central R. R., A. S. Baldwin, chief engineer.

The Construction of Wooden and Combination Highway Bridges.

(Staff Abstract.)

In this article there will be considered the general features applicable to the construction of wooden and combination highway bridges, the data being presented under the headings Organization, Equipment and Erection. The data here given supplement those contained in an article on the substructures for wooden and combination highway bridges, published in our Sept. 29, 1915, issue. The construction features are important considerations of the design, as they usually affect, and sometimes govern, the type of work to be undertaken. This is particularly true in small or isolated projects, where the desirability of using a single crew on various classes of work and the limitations of meager plant are particularly urgent.

In many projects under the Alaska Road Commission the difficulties of transportation have limited to a very considerable extent the construction plant which could be landed at the bridge site. Such conditions caused the construction of the trusses shown in Fig. 1, several of which were built by foreman Lars Holland, for the Quartermaster Department, U. S. A., in 1900, in locations where the cost of transportation on all supplies and equipment exceeded 20 cts. per pound. Three bridges, each with two truss spans, were built with no equipment except axes, saws, a 2-in. ship auger, chisels and pocket knives. Only native timber was available, no metal of any kind was used in any part of the bridges, and the bridges were built entirely without plans. These bridges were in use for periods varying from ten to thirteen years, and one at the latter age successfully carried a load of six horses drawing nine tons on two sleds in addition to a light snowload.

ORGANIZATION.

Bridge Crew.—A satisfactory crew for the construction of bridges involving one or more long span trusses of the types under consideration should have about the following personnel:

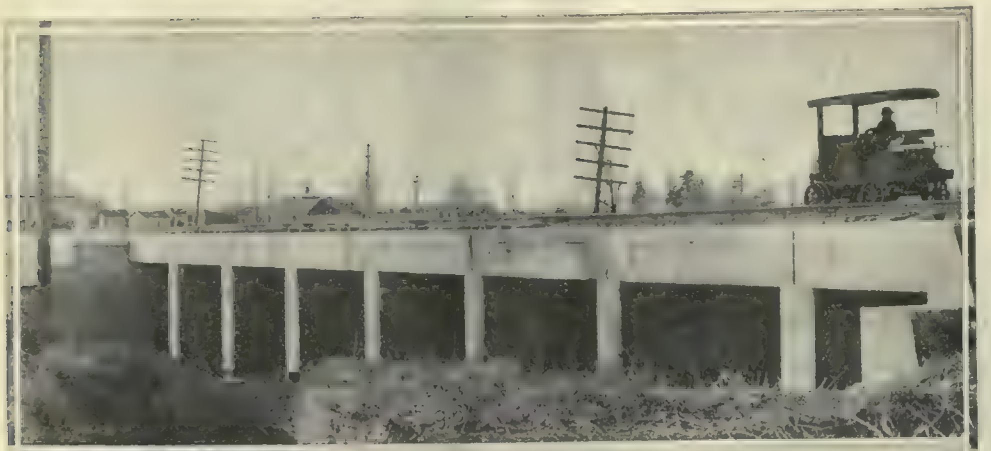
1 foreman.
1 head carpenter.
2 carpenters.
1 blacksmith.
1 engine runner.
1 teamster.
10 laborers.
1 cook.
1 cook's helper.

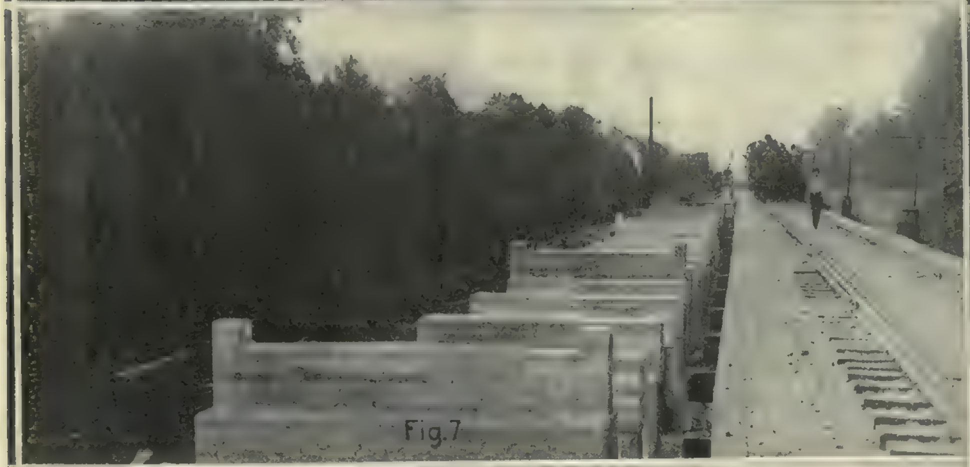
The number of teamsters actually engaged will depend upon the amount of material to be hauled. One teamster and his team will almost be necessary at the bridge, in addition to the transportation required to land materials and supplies at the bridge site. The blacksmith may not be necessary if access to shops is convenient. The engine runner is, of course, required only if a pile driving, hoisting or logging engine is to be used. Three of the laborers should be qualified carpenter's helpers, and at least one should be a broad-axeman if any round timber other than piling is to be used. If logged timber is to be used generally, all of the laborers must be axemen, and at least three should be broad-axemen.

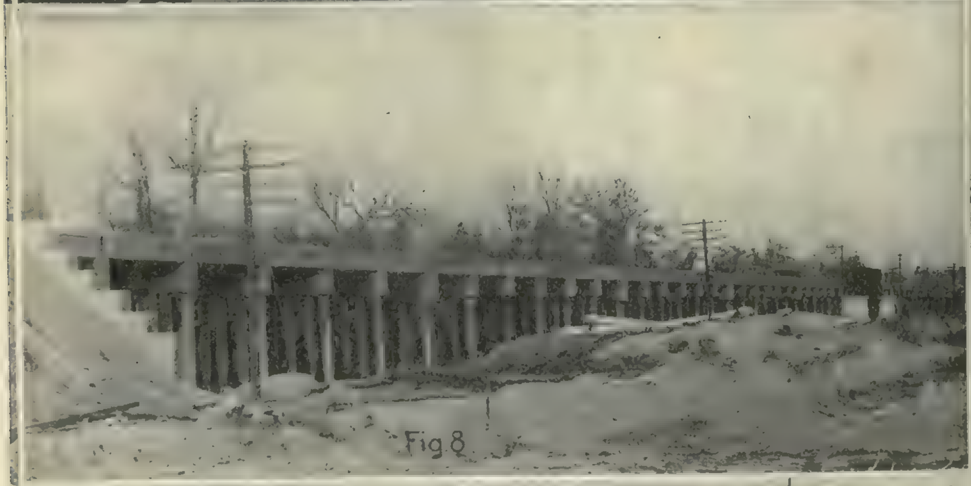
Pile Driving Crew.—A pile driving crew may be temporarily organized from the above or may be organized for work with the pile driver only. The latter method is recommended when a driver and crew can be kept continuously busy on various jobs. The following are included in the pile driving crew:

1 foreman.
1 engine runner.
1 fireman.
1 winchman.
1 leadsman.
3 groundmen.
2 pile hookers and trimmers.
1 teamster.

Logging Crew.—If all or part of the timbers are to be logged, a logging crew may be organized from the bridge crew and the







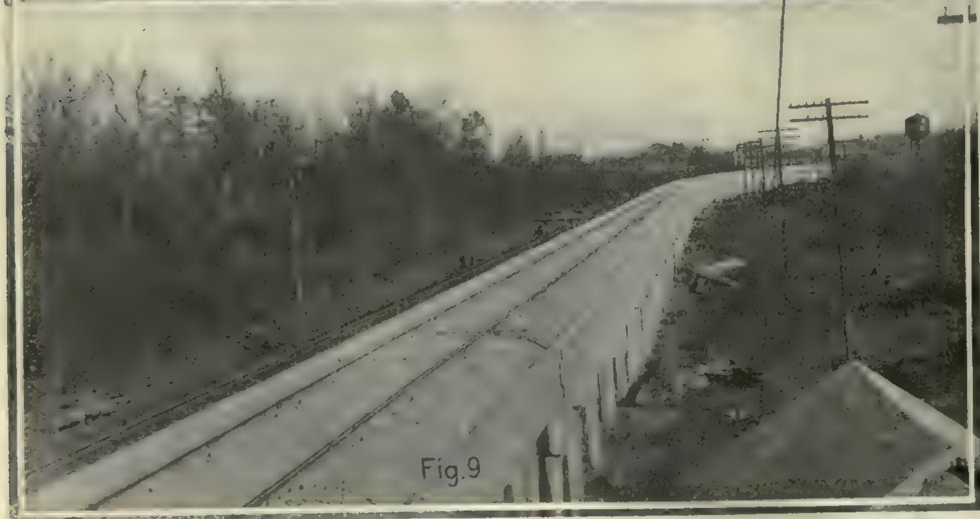


Fig. 6. Type of Solid Pier Structure Formerly Used as Standard on Illinois Central R. R.—Fig. 7. Anchor and Intermediate Piersfor New Standard Type of Reinforced Concrete Trestle—Fig. 8. Standard Type of Reinforced Concrete Trestle with Reinforced Concrete Abutments—Fig. 9. Long Reinforced Concrete Trestle of Standard Type with Ballast and Track in Place. (See page 289.)

logging completed before the work of erection begins. Generally, however, it is better to organize a small logging crew of men specially qualified to log and deliver at the site the sticks required by the foreman. The size of the logging crew will depend upon the amount and the nature of the logging required. It should be made up about as follows:

1 sub-foreman.
6 axemen.
2 teamsters.
1 cook (if camped away from the bridge crew).

Additional teamsters will be required if there is a considerable haul to the bridge site. In certain localities logging may be economically accomplished, using the pile-driver engine instead of teams for dragging out the logs.

Engineering Party.—An engineering party consisting of one instrument man and two rodmen should be available at the bridge site when needed. Frequently, in highway work, the foreman will be able to run a level, and if given the proper instruments he can give his own cut-offs, etc., using members of his crew as rodmen. Alignment can usually be secured by eye if the locations of the approaches or abutments are given.

EQUIPMENT.

The equipment of the crews depends so largely upon the circumstances of particular cases that a standard equipment list is of value chiefly as an aid to the memory and to suggest other and special needs. A well equipped crew will usually have the articles named in the list below:

Bridge Crew Equipment.—The equipment needed for the bridge crew will be about as follows:

1 pile driver complete, with additional rope, cable and wrenches.
6 snatchblocks and heavy manila rope (about 1¼ ins. diameter).
6 pile hoops—two 12 ins., two 14 ins., and two 16 ins.
1 team and wagon.
2 log chains.
1 contractor's dolly.
2 four-line blocks and falls with heavy manila rope.
1 100-ft. steel tape graduated in feet and inches.
3 carpenter's tool chest sets.
3 additional carpenter's squares.
2 carpenter's levels.
2 additional braces with assorted bits by sixteenth sizes from ½ to 1¼ ins.
2 ship augurs each size, 1 in. to 3 ins., by quarter sizes.
6 cross-cut saws (1 one-man, 5 two-man).
2 rip saws.
1 saw setting outfit.
1 set of files, assorted grades of fineness.
1 adjustable boring machine.
2 sets framing chisels, assorted sizes.
2 carpenter's slicks, about 3 ins.
2 carpenter's gouges.
4 carpenter's hammers.
6 2-ft. carpenter's rules.
Lumber, crayon, pencils, cord, etc.
1 grindstone.
2 oilstones.
12 whetstones (for axes).
1 small forge.
1 anvil.
1 set blacksmith's tools (hammers, chisels, nippers, tongs, horseshoeing equipment, etc.).
1 ratchet drill with assorted twist drills.
1 set taps and dies.
6 double-bitted swamping axes.
1 poleaxe.
2 broadaxes.
2 adzes.
2 striking hammers, about 6 and 8 lbs.
1 sledge hammer.
1 crow bar.
2 pinch bars.
1 wrench for each size of nut for bolts larger than ¾-in. required by plans.
4 monkey wrenches, two 8 ins. and two 18 ins.
2 Stillson wrenches, 18 ins. and 36 ins.
4 picks.
6 long-handled shovels.
6 peavies
2 jack screws, about 2½-in. thread.
2 plumb bobs.
1 camp equipment, complete.
1 Wye or Dumpy level } If foreman is to do his own instrument work.
1 level rod }

The logging crew will require a wagon or sled and two log chains to each team, two double-bitted axes for each man, one peavy for each man, and may require camp equipment.

The above list will be found reasonably complete for general cases, but special cases will require additional quantities and tools not mentioned above, while some articles listed may not be required.

For the pile drivers required in highway bridge construction, a double-drum, two-spool hoisting engine, using a 2,000 to 3,000-lb. hammer, will usually be most satisfactory. Leads about 30 ft. long should be provided and the frame should be long enough to give an overreach of at least 18 ft.

ERECTION.

On the arrival of the crew at the site and the completion of the camp, the logging crew should be organized and started upon its work. A framing yard as near the bridge as practicable, and convenient thereto and to the delivery point of the materials, should be cleared. The bridge site should also be prepared. All framing other than the simplest of right angle notching should be done by the carpenters, and usually in this yard. Helpers should be assigned to the framing yard to move timbers, to assist in sawing, boring and similar rough work. Carpenters should not be required to move timber, etc., except when absolutely necessary. The pile driver crew should be organized, the driver set up, and moved to position. Laborers not otherwise employed should be engaged in clearing the bridge site or drawn from other work for the purpose if necessary.

Framed trestles may usually be framed at the point of erection. If the members are too large to be raised by hand, a small gin-pole at one end of the sill can be erected to raise them. If many bents are to be erected, a small force should be assigned to complete all of this work. Framing and erecting bents and placing sway and longitudinal bracing can be performed by laborers, one of whom should be a carpenter's helper.

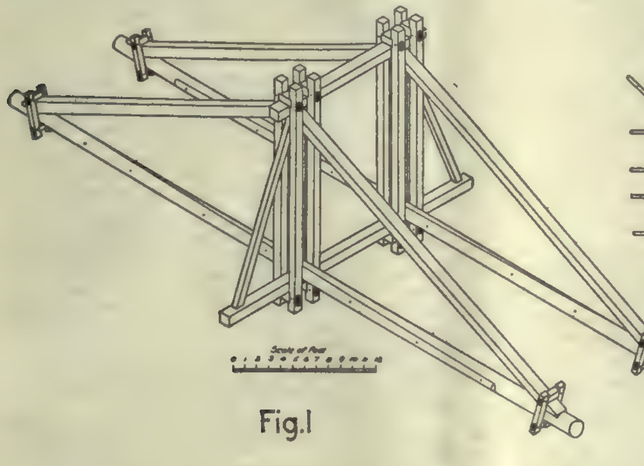


Fig. 1

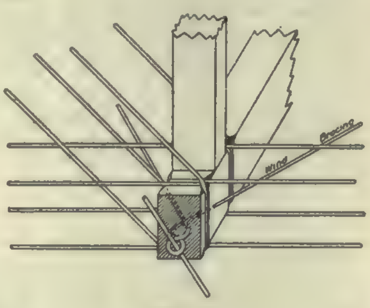


Fig. 3

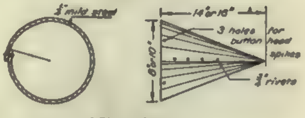


Fig. 2

Fig. 1. Type of Wooden Bridge Erected in Alaska Where Cost of Transporting Materials Was Excessively High—Fig. 2. Detail of Shoe for Wooden Pile—Fig. 3. Detail Showing Manner of Tightening Wind Bracing Cables of Combination Bridge.

Piles may be successfully driven in almost all soils except solid rock, quicksand, and large boulders. In quicksand they can frequently be jetted, or jetted and driven into place. In boulder formations, unless the boulders are large and close together, the piles can be driven, but not to accurate position. In driving in boulders or gravel the piles should be shod with a conical shoe of ⅜-in. sheet steel. Many types of shoes are used with varying degrees of satisfaction, but the writer has found the shoe shown in Fig. 2 the most satisfactory of several types used.

In practically all driving the piles should be hooped. The butt of the pile should be "dubbed" or beveled to receive the hoop, the hoop used being the next size smaller than the diameter of the butt of the pile. A good pile hoop can be made from ⅝-in. or ¾-in. Norway iron, 3 ins. wide, bent to a circular form and welded.

The conditions of driving determine the methods to be employed, and they are too varied to be considered here. The work may require simply the operation of the driver, or it may include the operation of a considerable floating plant. In most cases, however, the driving will be from the ground, from bents already driven, or from false bents driven for the purpose of supporting the driver.

If frozen ground is encountered it must be thawed by driving thawing points of the proper length into the ground before attempting to drive the piles. A thawing point consists of a hollow iron bar, usually 6 to 9 ft. long with a wedge-shaped point. The interior cavity opens through the point and has a steam hose connection near the base. The point is driven into the ground as far as possible by hand, and steam at boiler pressure is forced through it. As the ground below the point thaws, the point is driven deeper, until the penetration desired for the pile is obtained. The point is then withdrawn and the pile driven. Care should be taken to see that the point remains in the ground long enough to thaw a radial distance of 2 ft. or more around it, or the pressure of the frozen walls will not permit the displacement of the interior thawed material by the pile. This condition may be indicated in ordinary driving by the springing of the pile as in driving in quicksand.

There are few points of difficulty in the erection of crib or pile and crib piers that belong to general cases. In the construction of piers with piling, the latter should all be driven before any portion of the bracing is placed, as the spacing actually secured for the piles may slightly modify the exact location of the bracing or cribs. If the conditions of driving are such that the piles can not be accurately placed, the wall piles of a pile and crib pier should be driven well inside the wall line and the wall may be made to bear against them by blocks when necessary.

Trestles do not require falsework in their erection. Frequently king-post trusses can be erected without falsework below the chord line by using the chords as beams to support the trusses during erection. Falsework from the ground may frequently be desirable, but if at a great height the trusses may be erected from a temporary single lock bridge (military type) between the abutments.

Larger bridges usually require falsework built from the ground. This falsework consists of a series of two-story trestles with the caps of the upper and lower stories 2 or 3 ins. below the positions to be occupied by the upper and lower chords, respectively, in the unloaded bridge. These bents are ordinarily two-post bents. They are usually placed at the panel points of the truss, or near them if such location would interfere with framing. They must be provided with sway bracing and longitudinal bracing. In the interests of economy, the falsework may be of second-hand lumber. If from timber cut from the forest, it may well be dry timber such as can frequently be cut from burned areas. These remarks are not to be understood, however, as advocating the use of *defective* timber in falsework.

The vertical posts of the false bents may be piles, or false piles (i. e., piles set by hand, like posts), or simply posts with or without a mud sill. If the driver must be moved along the bridge site on false bents, these bents should be so driven that they can be used in the falsework. The chords are raised to positions on this falsework and are blocked to accurate position and completed throughout. The blocking permits adjustments which are necessary from time to time because of the settlement of the falsework; it also facilitates the removal of the falsework after the bridge is completed. In light bridges the chord members can usually be raised by hand. In heavy structures a gin-pole may be erected with and supported by the falsework near the center of the span for use in raising heavy pieces. In Howe trusses the diagonals are next placed and then the verticals, the nuts on the latter being tightened to their positions. The wind bracing is next placed and tightened. The falsework should be removed, commencing at the center of the span and working both ways. The floor is then completed, and after its completion the nuts of the verticals and wind bracing should be retightened.

The order of the placing of the members of combination bridges depends upon the arrangement of the members upon the pins, but the method of procedure is similar. In the erection of the cable type of combination truss, the verticals and top struts take the place of the upper story of the falsework and the roadway bearers are the caps of the lower stories. In construction, the roadway bearers should be placed about 1 in. below their positions in the unloaded bridge; they should not be spiked to the falsework bents. In place of spiked caps these bents may be cross braced at their tops by waling pieces. The diagonals are tightened with blocks and tackle and fastened with cable clips. When the diagonals are properly tightened the bridge clears the falsework. The cables in the wind bracing are continuous through consecutive panels, and they are tightened by twisting a rack stick through loops at the panel points, as shown in Fig. 3.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Capt. Glen Edgar Edgerton, Corps of Engineers, U. S. A., in *Professional Memoirs* for July-August, 1915.

Closing 977½-ft. Hell Gate Arch.—On Thursday, Sept. 30, 1915, the American Bridge Co. placed the closing section of the Hell Gate arch of the New York Connecting R. R., New York City, and on the next day the backstays were slacked off and the two half spans, which had been erected as cantilevers, were made to act as an arch. By means of a system of telephones, placed at the arch center, at each backstay jack, at each counterweight, and at the office, the work was synchronized and all operations successfully completed. The erection of the backstay on the Ward's Island end was started about Feb. 1, the shoes were set about June 1, and the erection of the arch progressed rapidly until its closure. The total weight of the arch as now erected is about 13,000 tons, and there are about 23,000 tons in the backstays and anchorages. For riveting, an electrically driven air compressor plant was set up on each side of the river, the air being piped to the riveters through an air union run along the top chord of each half of the arch. The travelers were also electrically operated, the current being carried across Ward's Island in a submarine cable. The arch was designed and is being erected under the direction of Gustav Lindenthal, chief engineer, New York Connecting R. R. It was fabricated and is being erected by the American Bridge Co.

The Arrowrock Dam across the Boise River just above Boise, Idaho, the highest dam in the world, was officially dedicated on Oct. 4, with appropriate ceremonies.

WATER WORKS

Choosing a First-Class Water Works Superintendent in Massachusetts.

(Staff Article.)

A few months ago a vacancy occurred in the office of water works superintendent at Fall River, Mass. Fall River is a first-class city. Its population in 1910, as given by the federal census for that year, was 119,295. The qualifications of the applicants for the position were tested by means of a written examination formulated and conducted by the Civil Service Commission of Massachusetts. We are advised by the chief examiner of the commission, Mr. Joseph J. Reilly, that the questions "were framed to meet the requirements of a high-class place. If a position of the same caliber were again vacant an examination of equal difficulty and of the same general character would be held. It is not often that such a vacancy occurs."

We have heretofore expressed the conviction that water superintendents should be selected because of their special qualifications for the position. This belief appears to be growing. The practical method of applying this belief is, of course, through civil service regulation of appointments. With all its faults the merit system of selecting city employes is gradually growing in favor. Probably at some date, still far in the future, all water superintendents will be so chosen. In the meantime it is interesting occasionally to study the scope of the examinations set where the merit system, so called, is in vogue. We believe most active-minded men find mental pleasure in testing their own qualifications. The Fall River questions, here given, serve this purpose admirably. This is admittedly a difficult examination, taken as a whole, and the average superintendent would appear to have no reason to be disappointed in himself if he can't answer all of these questions. The editor isn't. The questions do tend to show the importance of reading and study to the water works superintendent.

SUBJECTS AND WEIGHTS.

The examination covered seven subjects and to each subject a weight was assigned. The subjects are here enumerated and the weight assigned to each subject is indicated by the figures in parenthesis: Education and Experience (11), Handwriting (1), Accuracy (1), Report (2), Mathematics (3), Water System (8), and Care and Operation of Plant (4). It is not our purpose to comment on these weights further than to call attention to the fact that practical knowledge and experience is fully appreciated, as indicated by giving 11 points out of a total of 30 to education and experience. In arriving at the applicants' general average standing his grade on each subject was multiplied by the weight for that subject, and all of these products of weights and grades were summed up and divided by 30, the total of the weights.

EDUCATION AND EXPERIENCE.

The following ten questions were formulated to cover education and experience. The applicant was required to make oath as to the truth of his answers to these questions before taking the balance of the examination. The questions follow:

1. What is the date of your birth?
2. What has been your education?
3. What has been your occupation during the last ten or more years? State in detail in relation to each year, giving name of employer, if any, and specify fully the nature of your duties.
4. State what experience you have had in machine-shop practice, specifying the exact nature of your work.
5. Have you ever had the handling or supervision of men? If so, state how many and in what kind of work.
6. Have you a license as a stationary or marine engineer? If so, state the class and date of issue.
7. What experience have you had in purchasing supplies, advertising for contracts or in making out specifications for the same?
8. What experience have you had in the construction and maintenance of water works in all its branches?
9. State in detail your experience in the operation and repair of steam engines, steam pumps, electric pumps and boilers.
10. State any other facts which may help the examiners to judge of your training and experience.

HANDWRITING AND ACCURACY.

Under this heading the applicant was required to copy accurately in his best handwriting two typewritten paragraphs containing a total of 90 numbers and words. These are here omitted to economize space.

REPORT.

Under the heading of "Report" a choice was granted the applicant between writing a report of 300 words or a letter of equal length. The "specifications" follow:

The Watuppa Water Board requests you, the new superintendent, to carefully go over the entire water works situation of Fall River and to submit to them a comprehensive report on the same at the next monthly meeting. Suppose that you have examined into Fall River water works matters thoroughly for the period of three weeks. Embody your supposed findings in a report to the board of not less than 300 words.

Or write a letter of not less than 300 words, addressed to the Civil Service Commission, in which you describe the training and qualifications required in the superintendent of the Fall River water works or similar plants.

MATHEMATICS.

The ten questions on mathematics follow:

1. Carry out the operations indicated in the following and express the result as a decimal:

$$\frac{\frac{1}{\sqrt{64}}+\frac{1}{.2}+1\frac{3}{7}-\frac{13}{6}-\frac{1}{\sqrt[3]{64}}}{2\,(1000)\,\frac{1}{3}}=?$$

2. A train moving at a uniform speed of 40 miles per hour passes a certain station at 2 p. m. At 2:30 p. m., or 30 minutes later, a second train moving in the same direction at the uniform speed of 50 miles per hour passes this same station. At what time will the trains collide and at how many miles from the given station?
3. What will be the total pressure of water on one side of a tank 10 ft. x 10 ft. x 10 ft., the tank being full and water at the temperature in the tank weighing 62.4 lbs. per cu. ft.
4. The foundation of an engine is built of concrete and measures 25x10 ft. at the bottom and 20x8 ft. at the top, the four sides sloping from the bottom to the top. The distance from the bottom to the top is 10 ft. How many cubic yards of concrete in this foundation?
5. Solve the following by logarithms:

$$\frac{.93\times(1.35)^{1/3}\times .095\times 1.13}{1.11\times 903\times(.3)^{7}}=?$$

6. Heat received from a burning body varies inversely as the square of the distance from it. A thermometer held 7 ft. from a fire rises 28° F.; how many degrees F. will it rise if it is held 4 ft. 6 ins. from the fire?
7. How much will it cost to develop 275.75 boiler hp. for 9½ hours if the boiler uses 4.3 lbs. of coal per hp. per hour and the coal costs $4.65 per long ton? (1 long ton = 2,240 lbs.)
8. A horizontal return tubular boiler is 18 ft. long, 72 ins. in diameter and the water line is 30 ins. from the top of the shell. What is the approximate volume of steam space in cubic feet?
9. A pulley 30⅜ ins. in diameter runs 657 R. P. M. What is the rim speed in feet per minute?
10. How many pipes 1¼ ins. in diameter are required to equal in area one 8-in. pipe?

WATER SYSTEM (WEIGHT 8).

The examination on the subject "Water System," which was given a weight of 8 points out of the total of 30, contained the following 26 questions:

1. Name two qualities that sand suitable for cement mortar should possess.
2. In what proportions should the materials be mixed to make very strong Portland cement concrete?
3. In mixing concrete and placing it in position, what are the most important things to be looked after to insure good results?
4. What should be done to make a safe foundation for a water pipe under the following conditions: (a) With peat or soft mud 12 ft. deep below bottom of trench? (b) with solid rock 1 ft. above bottom of trench?
5. How should a trench dug in clay be refilled with the same material so as to prevent future settlement as far as possible?
6. How should a trench dug in mixed gravel and sand be refilled with the same material so as to prevent future settlements as far as possible?
7. (a) In bracing a trench 12 ft. deep and 6 ft. wide, dug in loose sand, what should be the size of (1) Rangers? (2) Braces? (3) Sheeting? (b) How far apart should the braces be placed? (c) How far apart should the rangers be placed?
8. If a service pipe is broken and leaking between the main and the curb, how would you repair it?
9. (a) How many ordinary lead joints should one man caulk, under favorable conditions, in a line of 12-in. water pipe in 8 hours? (b) Describe the method of making a joint of ordinary lead in a 30-in. water pipe.
10. (a) What different materials are used in making joints in water pipes? State briefly how each is used. (b) Describe the method of cutting a 30-in. water pipe in two pieces, on the work. State the tools and the number of men required to do the work efficiently.
11. What stock would be required to lay a ⅝-in. lead service-pipe from a 12-in. main, 15 ft. out from the street line? Mention everything needed to complete the work.
12. (a) When is an air-cock used? (b) Where is it located? (c) When is a blow-off used? (d) With what is a blow-off usually connected?
13. In laying a 16-in. main, 15 ft. from the curb, what stock would be needed to establish a post hydrant? Mention everything needed to complete the work.
14. State the uses of the following-named castings: (a) Blow-off branch; (b) Four-way branch; (c) Hydrant pot; (d) Offset; (e) Cap.
15. How is the actual water pressure found at any point?
16. Give an estimate of the cost of laying 500 ft. of 12-in. pipe in a suburban street of this city, including one hydrant and one gate. Give details of labor and of stock.
17. Give the most common causes of leaks in main water pipes, and in services laid in the street by the Water Department.
18. (a) What are the most common defects in new cast-iron water pipes? (b) What defects develop in cast-iron pipes that have been long in use?
19. How are the effects of electrolysis manifested and where are such effects usually found?
20. Name one means that is effective in lessening the action of electrolysis.
21. How many feet in height would water rise in a vertical pipe connected with a water main that is under pressure of 87 lbs. per square inch?
22. Describe briefly two different methods of thawing out a frozen service pipe in the street.
23. How deep should water pipes be laid to prevent freezing?
24. State briefly: (a) how fire hydrants should be taken care of; (b) how gate-valves should be taken care of.
25. (a) If water is flowing into a cellar fronting on the street, how would you determine whether or not it is coming from a main pipe or service pipe? (b) If it is determined that the leak is from the water pipe system how would you proceed to locate it, if it did not show on the surface?
26. (a) What is a reasonable average consumption of water for one person in one day? Give answer in gallons. (b) What are the most common ways in which water is wasted?

CARE AND OPERATION OF PLANT (WEIGHT, 4).

Under the heading "Care and Operation of Plant" the following 50 questions were asked:

1. What does the term "pump duty" mean?
2. What is meant by the M.E.P. in a steam-engine cylinder and how is it obtained?
3. Write the usual formula for computing the I.H.P. of a steam engine and, using the formula, figure the I.H.P. of an engine, using your own data.
4. Could a boiler be supplied with water by an injector using steam of a pressure lower than the pressure in the boiler being supplied? Explain fully.
5. What is a steam-engine indicator generally used for?
6. Name the places where an indicator may be advantageously attached and state what information you would expect to obtain from diagrams taken from the places you have named.
7. What is meant by absolute zero of temperature and how many degrees below zero on the Fahrenheit scale is it?
8. The temperature of steam supplied to an engine is 331.169° F., the temperature of the exhaust from this engine is 219.452° F., what is the thermal efficiency of the engine?
9. If a condenser is added to the above engine so that the temperature of the exhaust steam is lowered to 153.122° F., what change if any will there be in the thermal efficiency, the temperature of the steam supplied remaining the same?
10. What is meant by: (a) Net hp. of an engine? (b) Actual hp. of an engine? (c) I.H.P. of an engine?
11. Explain the difference between the real and apparent cut-off of an engine and show by figures how the real cut-off may be found

when the apparent cut-off and clearance are known. Furnish your own data.

12. With reference to steam, what is meant by total heat of vaporization?

13. What is the difference between saturated and superheated steam?

14. Which will a pump lift the better, hot water or cold water? Why?

15. Theoretically, how high will a pump lift water by suction and what limits the theoretical lift?

16. What is considered a good suction-lift in practice?

17. What is meant by priming in a boiler? Would the temperature of steam at a given pressure vary with different degrees of priming?

18. About how many B. T. U.'s are required to change 1 lb. of ice at 0° F. into steam at atmospheric pressure?

19. A pump of a given size would deliver 78,341 gals. of water in 24 hours if there was no slip. It is found that its actual delivery is only 56,377 gals. What is (a) the efficiency of the pump and (b) the percentage of slip?

20. If a pump does not work properly, where would you look for the trouble?

21. Which is usually given, the inside or the outside diameter of pipes and boiler tubes?

22. What is the most accurate way of ascertaining the steam consumption of a steam engine per I.H.P. per hour and how may the steam accounted for by the indicator be calculated? What is the value of such a determination?

23. What source of waste in the steam-engine cylinder is increased as the difference in the temperature of the steam entering and leaving the cylinder is increased and how may this waste be partly avoided?

24. All other conditions remaining the same, which is the more economical, a condensing or a non-condensing engine? Why?

25. Why is a compound engine more economical than a simple engine, both working under the same steam pressure and ratio of expansion?

26. If the barometer reads 30 ins. and the vacuum in the condenser is 26 ins., what is the absolute pressure in the condenser?

27. The I.H.P. of an engine is 363.74 and the actual hp. is 484.15; what is the mechanical efficiency of the engine?

28. Sketch a section of the rim of a pulley showing what is meant by crowning and explain why pulleys are crowned.

29. In belting from one pulley to another, should the belt run to or from the bottom of the driving pulley? Why?

30. Make sketches of a section of a gear wheel: (a) with epicycloidal teeth; (b) with involute teeth; and state what advantage the involute teeth has over the epicycloidal tooth, if any.

31. What is meant by the pitch of the teeth of a gear?

32. Show by figures how you would compute the length of belt required, if you knew the diameter of the two pulleys and the distance between the centers of the shafts.

33. What is the difference between mitre gears and bevel gears?

34. A counter shaft makes 376 R.P.M.; the main shaft driving it makes 162 R.P.M. What is the velocity ratio between the main shaft and the counter shaft? Neglect slipping and stretching of belts.

35. The water cylinders of a double acting duplex pump are 24 ins. in diameter and the stroke is 36 ins. long. If the pump makes 30 strokes per minute and the slip is 20 per cent, what is the capacity of the pump in gallons in 24 hours?

36. If a steam gage reads 127 lbs. and there is a column of water 5 ft. 6 ins. high above the gage in the connecting pipe, what is the correct steam pressure in the boiler? Show how you arrive at the result.

37. Explain the use of: (a) A boring bar. (b) A counterbore.

38. (a) What is the difference between a bulge and a blister on a boiler and (b) when are they dangerous?

39. How would you test molten babbitt metal to tell whether or not it was of the right heat to pour properly?

40. Explain the difference between a jet condenser and a surface condenser.

41. Show by figures what height column of water will be balanced by a pressure of 14.7 lbs. per square inch.

42. Show by figures how high a 3-in. flat-seated globe-valve must rise from its seat to give an opening equal to its area, also how high if the seat is beveled 45°.

43. Explain the action of an air chamber on the delivery side of a pump. Is there any advantage in having an air chamber on the suction side?

44. With reference to steam engines, what is meant by: (a) inside lap? (b) outside lap? (c) angle of advance? (d) lead? (e) clearance?

45. What instrument is used to get the M. E. P. as shown by an indicator diagram?

46. What is the difference between a single-acting and a double-acting pump?

47. In large engines, what advantage has a piston valve over a plain slide valve, if any?

48. What care must be taken when grinding a twist drill so that it will cut equally on both sides?

49. A single leather belt 6 ins. wide is running 2,750 ft. per minute. What hp. will the belt safely transmit?

50. What would be the hp. safely transmitted if the above belt were double instead of single?

ACKNOWLEDGMENT.

For a copy of the questions used in this examination we are indebted to Mr. Joseph J. Reilly, chief examiner, Massachusetts Civil Service Commission, State House, Boston.

The Utility of Pump Slip Tests in Maintaining Efficiency of Pumping Engines.

(Staff Abstract.)

Unless there are definite outward indications that something is wrong in the water end of a pumping engine the seeker after efficiency in pumping engine maintenance usually concentrates his efforts on the steam end. This is unfortunate for in many cases the greatest gain in economy of operation is attained by studying the condition of the water end and by correcting the faults disclosed by such study.

The water end of a large pumping unit is the vital end, from the water works engineering viewpoint, for while the steam end may be working with the highest degree of fuel economy, slippage in the water end will entirely nullify or seriously impair the efficiency of the unit. Pumps in our stations contain as high as 480 small valves in the water end, any one of which is liable to accidental damage or wear resulting in sudden and unobserved development of slippage.

It is necessary to know frequently the quantity of water the pump will displace per revolution, to make up an honest daily log sheet from which the efficiency of the unit and the actual amount of water delivered for consumption may be calculated.

In the New York City water works regular quarterly pump slip tests are made with a pitometer to attain two very important ends, the first being to determine the condition of the water end of the pump, and the second to determine for record the amount the actual discharge differs from the theoretical so as to know the net gallons per revolution delivered.

It is seldom when these slip tests are made that we do not find a number of the pumps slipping from 10 to 15 per cent and very observing operating engineers when told the amount can hardly believe it, due to the absence of any blowing, pounding, or other outward indications of inward disturbances. However, when he opens up the water end of the pump he invariably locates the trouble and the slip is cut down often as low as 2 to 4 per cent.

To illustrate by an actual instance the value of the first determination by slip test (that of the condition of the water end), I give below the results obtained in a recent case before and after the slip determinations and repairs:

Cost of pumping.......	5 cts. per million-gallon feet.
Theoretical displacement	10,000,000 gals. per day.
Discharge pressure.....	50 lbs. (115 ft.).
Total daily work performed	10 ×115 = 1,150 million-gallon-feet.
Slip of pump first test..	13 per cent.
Loss per day of energy due to slippage.......	1,150 × .13 = 149.50 million-gallon-feet.
Loss per day in fuel consumption and other operating expenses.	149.50 × .05 = $7.47.
Slip of pump after repairs	3 per cent.
Net saving in slippage due to repairs........	10 per cent.
Saving per day in energy	1,150 × .10 = 115 million-gallon feet.
Saving per day in fuel consumption and other operating expenses.	115 × .05 = $5.75.

In the above case after the slip test revealed a faulty condition, the water end of the pump was opened up and examined. It was found that there were six springs broken and a piece was out of one valve, which had been renewed only a few days before. This condition was not apparent from the working of the pump and had it not been for the slip test, would not have been known.

To obtain the most value from the slip test when trouble in the water end is indicated, the pump should be tested again as soon as repairs are made to determine the amount of saving and to know that the trouble has actually been corrected. It often happens that the engineer when overhauling the pump will locate some small trouble with the valves or springs and repair them and believing that that was the whole difficulty close the pump up again and not search further although the greatest trouble may have been overlooked.

The necessity of the second determination by the slip test (that of the actual gallons displaced per revolution) is of decided importance as affecting the accuracy of the records of output and needs no discussion.

ACKNOWLEDGMENT.

From paper by H. D. Havill, Assistant Engineer, Department of Water Supply, Gas and Electricity of New York City, before New England Water Works Association.

Prescribed Water Works Operation Methods in Missouri.

(Staff Abstract.)

The Public Service Commission of the State of Missouri recently promulgated a set of rules regulating gas, electric and water service. These rules became effective Oct. 1, 1915, and are here presented in substance, insofar as they pertain to water utilities. The rules apply to all utilities regardless of whether ownership is private or public. In what follows is given the gist of the general rules pertaining to water utilities and the special rules for water utilities.

GENERAL RULES PERTAINING TO WATER UTILITIES.

A record must be kept, alphabetically arranged, of the names and addresses of all consumers furnished with metered service with the identification number of meter or meters in use by each consumer.

A record shall be kept, numerically arranged, in accordance with the utility's system of numbering its meters, indicating for each service meter owned or used a proper description, date of purchase (the approximate time of purchase if the exact date is not known), record of the use, repairs, adjustments and tests to which the meter has been subjected, and its present location.

When a service meter is tested the original test record shall be preserved for a period of at least two years. This record shall include the information necessary for identifying the meter, date and place of test, name of person conducting the test, reason for making test, method of test, reading before being disturbed, and the result of the test, together with all data taken at the time of the test so as to permit of the convenient checking of the methods employed and calculations in connection therewith.

The allowance of certain variations from correctness on meters as hereinafter specified does not mean that meters may deliberately be set in error by the amount of the tolerance. This tolerance is specified to allow for the necessary irregularities in meter tests and maintenance conducted on a commercial scale.

Each service meter shall be suited to the particular installation to which it is assigned and chosen with a view of obtaining the best adaptation to local conditions and to the load.

It is suggested that those utilities not required to maintain certain testing equipment as hereinafter specified arrange to perform the tests set forth by making use of the testing equipment of some nearby utility required to maintain same.

Reasonable efforts shall be made to eliminate interruptions of service, and when such interruptions occur, service should be re-established with the shortest possible delay. When service is interrupted for the purpose of working on any portion of the system, such interruption should occur at a time which will cause the least inconvenience to the consumer, and those seriously affected by such interruptions should, if possible, be notified in advance.

A record shall be kept of all interruptions of service on the entire system or major divisions thereof, including the time duration and cause of each interruption. These records shall be filed and preserved for a period of at least one year.

Each utility shall keep a record of the time of starting up and shutting down all important items of equipment. A record shall be kept of the indications of the principal switchboard instruments, station meters, gages, etc., readings being taken at sufficiently frequent intervals to show the characteristics of the load. (Graphic recording instruments should be used for this purpose in accordance with the best modern practice when feasible.)

These records or charts, suitably identified and dated, shall be filed available for inspection and preserved for a period of at least two years.

Each utility shall, upon written request of any consumer, cause the meter-reader reading the meter installed upon the premises of such consumer to leave upon such meter a card or slip showing the date and time such reading was taken, and either the total reading expressed in cubic feet, or gallons, or showing the position of the hands upon the dial of such meter at the time the reading is taken.

All bills rendered to consumers for metered service furnished shall show the reading of meter at beginning and end of period for which bill is rendered and shall give dates of reading, number of units of service supplied and the basis of charge or reference thereto. In general, these bills shall be made out in such a manner as to be readily understood by the consumer and so that the amount of bill can be checked from the information appearing upon the bill. This rule may be waived for any consumer by special written consent of such consumer.

Utilities shall, upon request, use their best efforts to inform consumers as to the conditions under which efficient service may be secured from their system.

No utility shall discontinue the service of any consumer for violation of any rule of such utility except on written notice of at least 48 hours, advising the consumer in what particular such rule has been violated for which service will be discontinued. It is recommended that such notice be served in the following manner for the reasons set forth:

First: By enclosing in a registered letter addressed to the consumer a copy of the notice to be served; and the return registry receipt of any such registered letter shall be prima facie evidence of the service of any such notice; and the utility shall preserve a copy of said notice to which shall be attached such return registry receipt, which at all times and in any proceeding resulting from or growing out of said notice, or anything complained of, and contained or set out in said notice, shall be prima facie evidence of service of any such notice.

Second: A delivery of a copy of any such notice to the consumer or by leaving a copy at his usual place of abode with some member of his family over 15 years of age shall be deemed and, for the purposes of these rules, is hereby made sufficient service of any notice required to be served under this rule. Any such notice may be served by any agent, employe or servant of the utility and the person serving the same shall make return showing the kind of service had, and the return shall be preserved the same as above set out in case of service by registered letter.

This rule may be waived where a by-pass is discovered on a consumer's service meter or in the event of discovery of dangerous leakage on a consumer's premises, or in the case of a consumer utilizing the service in such a manner as to make it dangerous for occupants of the premises, thus making the immediate discontinuance of service to the premises imperative. In the event of discontinuance of service for any of these reasons, the consumer should be notified of such discontinuance immediately with a statement concerning reason for discontinuance.

Each utility may require, at any time, a cash deposit or a personal guaranty of a responsible person, at its option, from any consumer before metered service is furnished; provided that the amount so required to be deposited or guaranteed shall not exceed an estimated bill covering one billing period plus 30 days from such consumer.

Interest at the rate of 6 per cent per annum, payable annually or upon the return of any deposit covering the time of the deposit, shall be paid by the utility to the consumer upon every cash deposit so required; provided said cash deposit remains for a period of at least six months; provided, further, that the rate of interest of such cash deposit shall be only 3 per cent per annum if the utility keeps such cash deposit in a separate and distinct trust fund and deposited as such in some bank or trust company and not used by the utility in the conduct of its business; and provided, further, that this rule shall not be construed so as to conflict with the charter provisions of any city.

Instead of the annual payment of interest on cash deposits as stipulated above, any other interval between payments agreed to in writing by consumer will be satisfactory to the Commission.

SPECIAL RULES FOR WATER UTILITIES.

All water furnished by any utility for human consumption and general household purposes should be free from disease-producing organisms, injurious chemical or physical substances, and agreeable to sight and smell.

Water which rarely shows the presence of members of the B. Coli group and which has a reasonably low bacterial count under the usual standard test methods will ordinarily be considered safe from the standpoint of disease-producing organisms.

Note (a): Filtration by approved methods is strongly recommended where doubt exists as to the quality of the water furnished at any time. Filtration of water drawn from surface supplies is, in fact, nearly always advisable. Although artificial sedimentation by the use of coagulants such as sulphate of iron and lime or alumina sulphate is frequently sufficient to produce a good quality of water, yet a carefully conducted filter plant is generally conceded to be the most efficient and reliable means of removing bacteria, suspended matter and color from the majority of water supplies.

Note (b):—Sterilization treatment by hypochlorite of lime, chlorine gas or other approved sterilizing agent, is generally advisable for all water furnished, even as an adjunct to sedimentation and filtration methods of purification. The expense of proper sterilization treatment is comparatively small, and if hypochlorite of lime or chlorine gas is employed the quantity usually necessary for adequate results does not appreciably affect the potability of the water. Proper sterilization insures the death of the vast majority of the bacteria in the water before reaching the consumer.

Bacteriological analyses should be periodically made upon water furnished for public service by any chemist or bacteriologist of recognized standing.

Samples for test should be carefully drawn under the directions of the person making the test. Taps should be allowed to run freely at least five minutes before collecting samples from same.

Utilities furnishing water for public service are recommended to employ chemists or bacteriologists in a consulting capacity under whose supervision tests should be made as frequently as deemed advisable. When this is not feasible, tests shall be made at least twice yearly, preferably in the late spring and early fall.

The results of all tests made must be recorded and kept on file available for public inspection for a period of at least two years, and also filed with the Commission by each utility monthly until further advised. These records must indicate when, where and by whom each test was made. The standard methods of water analysis by the American Public Health Association should be followed as regards chemical, physical and bacteriological examinations and collection of samples and any departure therefrom should be specifically stated.

"Dead Ends" in the distributing mains should be avoided as far as possible. Where such "Dead Ends" exist they should be frequently flushed. To insure compliance with this requirement, it is suggested that all "Dead Ends" be equipped with hydrants.

Every effort must be made to maintain a steady pressure which will at no time fall below the fixed minimum suitable for domestic service.

In addition to furnishing commercial service, each utility furnishing fire hydrant service must be able, at any time within reasonable notice, to supply adequate fire service in accordance with the best standard practice covering service to local fire fighting equipment and facilities.

When the foregoing pressure requirements are outlined in a reasonable manner by the ordinance under which the utility operates, they should be complied with as set forth therein.

Each utility furnishing water service in cities of 2,500 inhabitants or over shall maintain a graphic recording pressure gage at its plant, downtown office, or at some central point in the distributing system or each subdivision thereof, where continuous records shall be made of the pressure in the mains at that point. Utilities operating in cities of 5,000 or more inhabitants shall equip themselves with one or more graphic recording pressure gages in addition to the foregoing, and shall make frequent records, each covering intervals of at least 24 hours' duration, of the water pressure at various points on the system. All records or charts made by these meters shall be identified, dated and kept on file for inspection for a period of at least two years.

No water service meter shall be allowed in service which has an incorrect gear ratio or dial train or is in any way mechanically defective or shows an error in measurement in excess of 5 per cent when registering water at stream flows equivalent to approximately one-tenth, one-half and full normal rating under the average service pressure. When adjustment is necessary such adjustment should be made as accurately as practical for average rate of flow under actual conditions of installation. Tests for accuracy shall be made with a suitable testing device in accordance with the best modern water meter practice.

Unless otherwise ordered by the Commission, each water service meter installed shall be periodically removed, inspected and tested in accordance with the following schedule, or as much oftener as the results obtained may warrant to insure compliance with the provisions of the preceding paragraph.

⅝-in. meter 10 years or 100,000 cu. ft.
¾-in. meter 8 years or 150,000 cu. ft.
1-in. meter 6 years or 300,000 cu. ft.
All meters about 1-in., 4 years.

The usual request test is provided for in the rules and regulations.

Each utility furnishing metered water service in cities of 3,000 or more inhabitants shall maintain one or more suitable water meter testers and keep same in proper adjustment so as to accurately register the condition of meters tested at all times.

Each water meter tester must be accompanied by a certificate of calibration indicating that the volumes or weighing devices used have been referred to proper standards certified by the National Bureau of Standards, or some testing laboratory or other authority of recognized standing.

Meter tests must be located in a large, comfortable working space, easily accessible and equipped with all necessary facilities and accessories.

San Francisco's Auxiliary Water Supply System for Fire Protection.

When the great fire at San Francisco swept four square miles off of the city's map the citizens got together and voted $5,000,000 for the construction of an auxiliary water supply system for fire protection. This system, as far as engineering skill can provide, will make another such disaster impossible.

Contrary to general belief, the auxiliary water supply system is not a salt water system. Fresh water is used under ordinary conditions, because, if salt water were allowed to stand continuously in the pipes, its corrosive effect on the cast iron would soon necessitate the renewal of the entire pipe system.

Moreover, in small fires, the destructive effect of salt water on perishable goods is much greater than that of fresh water.

As at present constructed, the fire protection system comprises two distinct units. One is a high pressure pipe distribution supply with its appurtenant reservoirs and two separate pumping stations on solid bed rock. The second is a series of independent cisterns specially designed to withstand severe earthquake shocks. There are in addition two fireboats for the protection of the water front and shipping interests.

Eight square miles are protected by the high pressure system. There is an upper and a lower zone, each supplied from a separate distributing reservoir at an elevation which gives a pressure of 150 lbs. per square inch at the hydrant. When necessary to operate the system at a pressure higher than 150 lbs. both zones can be connected to the main supply reservoir, with a capacity of 10,000,000 gals., located near the summit of Twin Peaks at an elevation of 760 ft. This gives a pressure of 325 lbs. at the lowest hydrant in the lower zone.

There are 72 miles of cast iron pipe in the distribution system. This pipe is specially designed to allow the maximum lateral motion without leakage. The whole system is laid out as a gridiron, and a notable feature is its division into independent units by a series of gate valves. This allows the cutting out of any block in which a break occurs and isolating that section without impairing the efficiency of the remainder of the system.

Beside the pipe distribution system, the auxiliary water supply includes 135 underground cisterns, from which water can be pumped in case high pressure mains are ever disabled. Numerous brick cisterns existed at the time of the 1906 disaster but they had not been maintained and their location was unknown to the fire department. Had they been in condition and full of water, the fire could have been confined to a very much smaller area. Fifty of the old cisterns have been repaired since 1906 and are now in first class condition, and 85 new cisterns of reinforced concrete have been constructed. These are built beneath the surface of street crossings, and their position is indicated bv a distinctive type of pavement around their rim. The average capacity of each cistern is 75,000 gals. They are built in monolithic units to roll like a boat at sea, without injury.

ACKNOWLEDGMENT.

From a paper by M. M. O'Shaughnessy, City Engineer of San Francisco, before the League of California Municipalities.

Simple Tests for Identifying Steel and Wrought Iron Pipe.

(Staff Abstract.)

When the Committee on Standard Specifications for Wrought Iron Pipe began its labors, a few years ago, it sought a simple test whereby the buyer of pipe could satisfy himself as to whether he was getting steel or wrought pipe. The need for such a test was well defined, for many water works superintendents stated their inability to differentiate between the two kinds of pipe and stated the belief that they were sometimes supplied with steel pipe when they ordered wrought iron. Accordingly the committee sought to bring out such a test but was unsuccessful in their efforts along that line until the latest annual meeting of the Association when the tests here outlined were brought out in the discussion of the progress report submitted.

Sulphuric Acid Test.—W. R. Conard of Burlington, New Jersey, described the sulphuric acid test as follows: "Anyone who is using wrought iron or steel pipe can make a very simple test to determine whether they are getting wrought iron or steel pipe. Take one part of sulphuric acid to three parts water and immerse a short section of the pipe in the solution for six or eight hours. This will demonstrate very quickly whether it is iron, or steel, not positively always, but generally speaking, and quite conclusively. When the short section of pipe is taken from the bath the pitting of the metal will show a more or less granular structure if it is steel; if it is wrought iron it will show a fibrous appearance. It does not take so very long to make the test, and one can demonstrate to his own satisfaction in that length of time just whether he has iron or steel."

Hammer and Chisel Test.—Again referring to the structure of the materials, W. J. Haddow said: "You may profit by the experience of the machinist and arrive at the same conclusion in about two minutes with a hammer and chisel. The grain of the iron is arranged longitudinally; steel, as the previous speaker has said, shows little granular particles."

Cutting and Thread Tests.—Mr. C. W. Wiles, Superintendent of Water Works, Delaware, Ohio, spoke of the cutting and threading of steel and wrought iron pipe as follows: "Any man who cuts pipe or goes into a shop and puts a piece of pipe into the cutter can tell very quick whether he has steel or iron. Another method of test is by the use of a threading machine on a piece of pipe; the wrought iron will take a sharp, smooth thread. Wrought iron cuts and threads more easily than steel, and wears the cutting and threading tools less."

Emery Wheel Test.—The emery wheel test was described by A. A. Reimer, Superintendent of the East Orange, N. J., water department and chairman of the committee, as follows: "Another interesting test can be made by those who have machine shops. You can make it very easily: take a pieec of steel pipe and then get a piece of wrought iron pipe, and make sure that it is wrought iron pipe. Put the pipes on an emery wheel and you can see the difference in the sparks that are produced in the case of wrought iron as compared with the steel. You will be surprised at the difference you get in those sparks. That is about the simplest test that you can work with for a quick test. You will never be fooled, because low carbon steel cannot possibly make the same kind of sparks that the wrought iron pipe will. That is one of the most positive tests that have been found up to the present time. In our committee work, this is one of the points that we brought up in connection with wrought iron and steel, and after you have seen the sparks once you can never be fooled."

It will be noted that Mr. Reimer directs the experimenter to make sure that he has a piece of genuine wrought iron pipe for use in this comparative test. Believing that this point might prove troublesome to some experimenters since this is the very thing to be brought out by the test, the editor feels justified in stating that genuine wrought pipe can be obtained of the A. M. Byers Co. of Pittsburgh, Pa.

Fall Meeting Illinois Section of American Water Works Association.—The fall meeting of the Illinois Section of the American Water Works Association will be held at Hotel Sherman, Chicago, Oct. 19, 1915. An interesting and highly instructive program is being arranged. There will be an inspection trip during the day, with the new municipal shops, the Wilson Ave. tunnel construction, the Lake View and the Chicago Ave. pumping stations as the principal objective points. A descent into the new tunnel will be made to view the construction plant and methods employed on the job. The manufacture of valves, hydrants and possibly meters will be seen at the new shops. At the Lake View pumping station the boiler room is a special attraction. At the Chicago Ave. station the new chlorination plant installed by the Electro-Bleaching Gas Co. will be inspected. There will be a dinner at night at the hotel and following this two papers will be read. Mr. Samuel A. Greeley will read a paper on "Water Softening" and Mr. John Ericson City Engineer of Chicago, will describe the new Wilson Ave. water supply and pumping works. The new Wilson Ave. crib, unique in design, will be described. This talk will be accompanied by lantern slide views of the design and construction features of the works.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A Precise Measuring Barrow for Concrete Work.

(Contributed.)

Municipal and county authorities are becoming more and more stringent in the rules surrounding the proportioning of aggregates in concrete for road, bridge, sidewalk, and other pubic work. In order to supply contractors with ready means of meeting these requirements the Sterling Wheelbarrow Co., of Milwaukee, has perfected a measuring wheelbarrow in two sizes—2 cu. ft. and 3 cu. ft. The bodies of these barrows are guaranteed as to the accuracy of measure, when filled and scraped off.

These barrows are made of steel throughout, the body being blue annealed steel, the handles steel pipe and the legs and braces steel channels and bars. A unique feature is the method of joining the legs to the handles by clamps at the point of great stress. Another interesting fact is that the wheel has self-lubricating bearings—this feature consisting of an oil-impregnated fiber bushing in both bearings. This bushing it is claimed, not only outwears brass or babbitt but it becomes glassy smooth under use.

Precise Measuring Barrow for Concrete Work.

The New Thew Combination Boom Shovel.

(Contributed.)

The Thew Automatic Shovel Co., of Lorain, Ohio, has just placed a new machine on the market known as the Thew Combination Boom Shovel, Fig. 1. In this new machine, the Thew horizontal crowding motion, a feature of Thew shovels for more than 15 years, is combined with shipper shaft mechanism of new design. The two crowding mechanisms are independent and non-interfering. Both are operated from the same crowding engine, which is simply changed in position. When using the horizontal crowd the long dipper handle must be removed and when the shipper shaft crowd is in use, the short dipper arm is chained to the boom structure after removing the dipper. All changes necessary can be made in less than three hours. The same dipper can be used with either crowding mechanism but a special sewer trench dipper will be furnished, if desired.

The trussed and reinforced boom of the Thew shovel, and the manner in which it is attached to the turntable by wide hinge castings, provide unusual strength and rigidity, and add to the operating efficiency and durability of the machine.

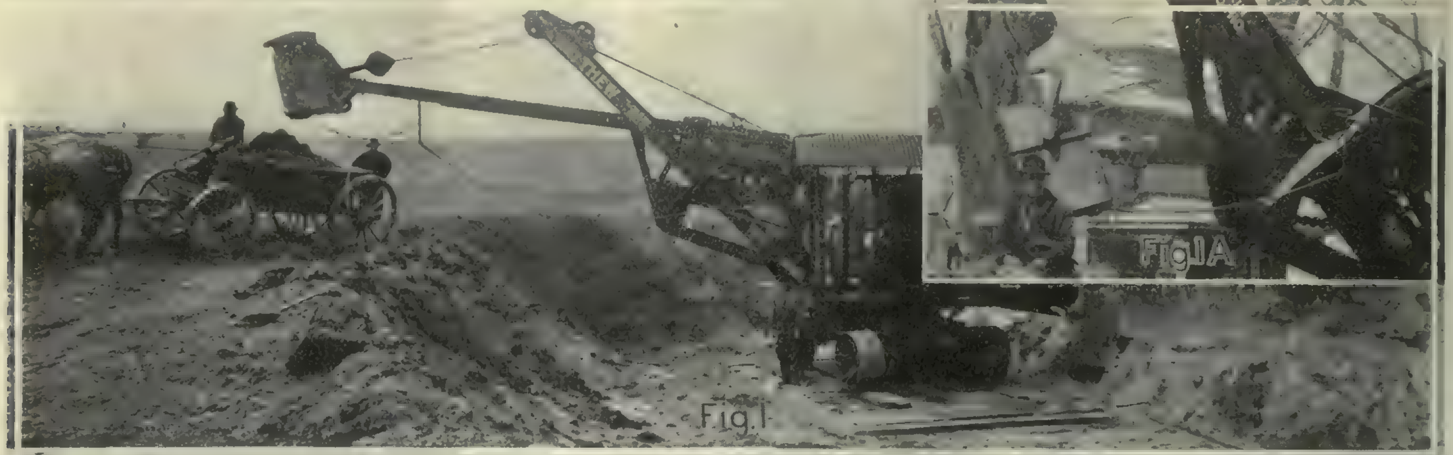


Fig. 1 Fig. 1A

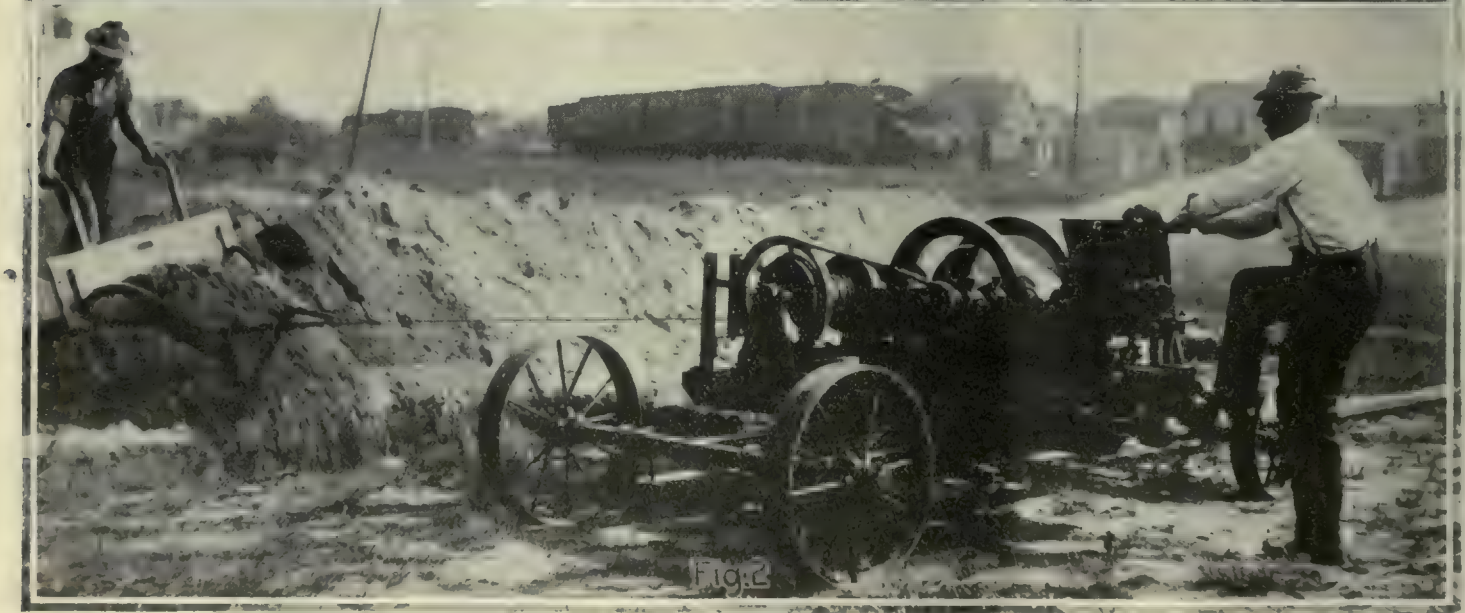


Fig. 2

Two New Earth-Handling Machines for Contractors.
Fig. 1—Thew Combination Boom Shovel. Fig. 2—Power-operated Trench Backfilling Machine.

The long dipper handle used in connection with the jack shaft crowding mechanism combines lightness and strength. It is made of a single piece of wood, 8 ins. square, armored with steel plates and equipped on the under side with steel racks. These dipper arms can be had in numerous lengths to suit requirements of different kinds of work, depending upon the depth of trench, extent of dumping radius, or height of clearance lift desired. A dipper with 27-ft. stick can dig a trench 16 ft. below the ground on which the shovel stands. A stick of this size makes it possible to dump material in a radius of 31 ft. and with a clearance of 14 ft.

The single dipper stick, in connection with the design of the boom, affords a combination of unusual strength and effectiveness. The single stick is of the simplest possible construction, is less liable to get out of alignment, or bow out of shape, than if it were constructed in two parts as has been customary; and, is also lighter and stiffer.

When the dipper is lowered into a trench, the dipper stick passes down between the side members or dipper arm guides of the combination boom, thus distributing any side thrust or undue strain encountered. It is obvious that this construction affords far greater strength than if it were necessary for this lateral strain to be borne solely by the shaft upon which the dipper stick is mounted.

This combination boom Thew shovel gives the contractor a machine with which he can handle practically any kind of work encountered. It is of particular interest also because the contractor can have either kind of crowding motion incorporated when the machine is purchased, and the other mechanism can be purchased and added at a later date, when the occasion requires.

A number of these machines have been in use for several months, and they have performed their work satisfactorily under the most trying conditions.

A General Utility Gasoline Power Unit for Backfilling, Simple Hoisting, Etc.

The "Double-Quick" gasoline power unit, here illustrated in Fig. 2, is used in backfilling trenches; for light hoisting operations, hauling overground materials such as heavy timbers; loading, unloading and placing heavy pipe, valves, etc., in trenches; for cleaning sewers, and for pulling aerial and underground cables. The machine probably finds its greatest field of usefulness in the backfilling of trenches. It has done this work at a cost as low as 2 cts. per cubic yard.

The essential elements of the machine are an engine and a winding drum; these are mounted on a turn-table. This table swings easily and can be locked in any one of four positions to permit the use of the winding drum from the front, rear or sides of the machine. At each setting of the turntable the scraper is readily operated through an arc of 90°. A dead-man is furnished with the machine and so also are 300 ft. of ⅝-in. manilla rope and a sheave. The machine moves along the trench under its own power by means of the rope attached to the end of the tongue and passing through the sheave on the dead-man and back to the winding drum. A ditching scraper also comes with the outfit. With the scraper is supplied 50 ft. of ⅜-in. steel cable which passes to the winding drum. The trucks are standard wagon gage and the wheels have wide tires. The total shipping weight is 2,630 lbs. A 4½ hp. gasoline engine furnishes the power. The speed can be varied by a change of sprockets on the crankshaft of the engine. These are furnished with the outfit. The scraper moves 150 ft. per minute in common soil and 100 ft. per minute in clay soil. Two men are required to operate the machine when backfilling; one holds the scraper and the other the single controlling lever.

The machine in operation possesses two incidental advantages of importance. It can be set on lawns or parking without damaging them when backfilling dirt piled on the side of the trench nearest the center of the street. In such cases teams cannot be used for it is not permissible to drive them over the grass. The hoisting ability of the machine is utilized, also, in pulling out trench bracing which otherwise would have to be left in the trench.

The machine is built and sold by the Waterloo Cement Machinery Corporation of Waterloo, Ia.

Knox Tractors Doing Heavy Hauling.

(Contributed.)

The largest contracting concern in the city of Philadelphia, the Henderson Company, recently received a contract from the city to move a 33-ton boiler from a power plant in Holmsburg, Pa., to the City Power Plant, at Fairmont Park. As the wagon upon which to mount the boiler weighed 8 tons, the gross load to be hauled was 41 tons. A little figuring showed that it would take 28 horses to haul this enormous load and 10 extra horses with block and falls to start the load. About the time it was ready to start operations, a representative of the Knox Motors Associates put in an appearance, and made the statement that the Knox Tractor, although rated as having from 5 to 15 ton capacity, could easily perform the stunt of pulling this enormous load. Mr. Henderson was skeptical, but was willing to be shown. The tractor was brought on the scene and was hitched to the load, as shown in Fig. 3. The start was made without difficulty, and the "Gasoline Horse" hauled this unusual 41 ton load to its destination without mishap.

Figure 4 shows seven oil tank wagons, with a total gross weight of 97,710 lbs.—considerably more than 48 tons, gross weight—being pulled by the Knox four-wheel tractor.

Mr. Frank C. Feller, president of the Knox Auto & Tractor Co., of Cleveland, Ohio, who supplied the photograph, states that the running time from Cleveland, to Cook Road, Lorain County, a distance of 30 miles, was six hours, including the time for coupling and uncoupling. This is an interesting example of what can be done in the way of getting maximum results from a single power plant. It is worth observing, too, that this 48-ton load is spread out over 14 axles and that only the forward end of the first trailer is supported on rubber tires, 26 of the wheels being steel tired.

A Worm Drive Truck for Contractor's Hauling.

(Contributed.)

A 3-ton truck for general contractor's hauling is illustrated by Fig. 5. The truck is equipped with a special flare-top dump body which is operated by a Wood hydraulic hoist. Though the owner carries all sorts of loads on his new vehicle, as shown in the illustration, he finds it of the greatest efficient and economical utility in the transportation of capacity loads of building material, such as crushed stone, sand or gravel, and ashes. The truck was built by the Packard Motor Car Co., Detroit, Mich.

A New Gasoline Tractor Truck.

(Contributed.)

The Transport Tractor Co. Inc., of Long Island City, N. Y., has placed on the market a gasoline tractor, Figs. 6 and 7, designed and built to haul five tons either by attaching vehicles by means of a patented device furnished with the tractor or on specially built trailers. The advantages claimed for it are small initial investment, and economy in gas, tires and repairs, resulting in exceptionally low operating costs. The builders claim that the tractor can be used economically to move a load as small as two tons. A 25 hp. engine is used working through a specially designed worm driven axle having exceptionally large gear reduction. The final ratio on low gear is 45.8:1 which insures ample power for all road conditions. It has been the aim of the builders to make a simple, powerful machine of rugged design with large road clearance having all working parts protected from mud and water and one that is easily handled and easily cared for.

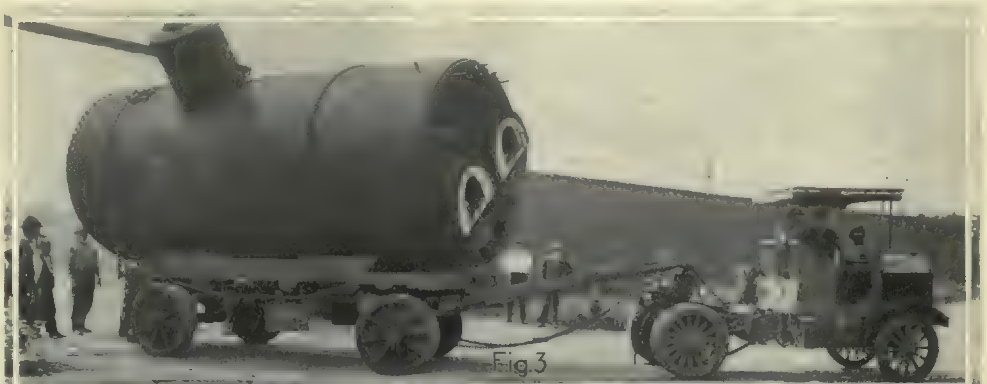


Fig.3

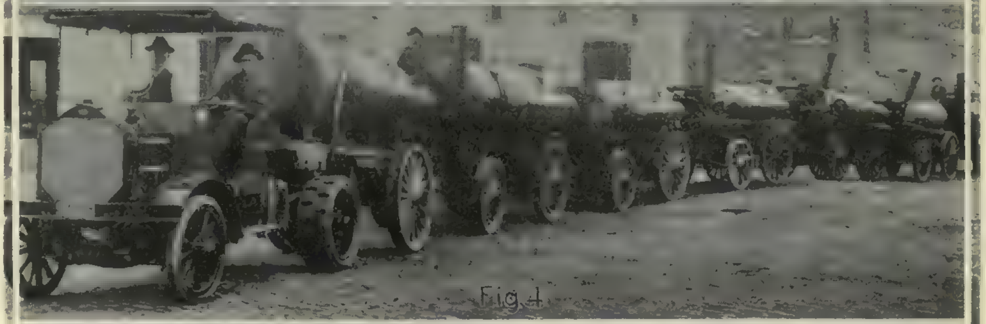


Fig.4

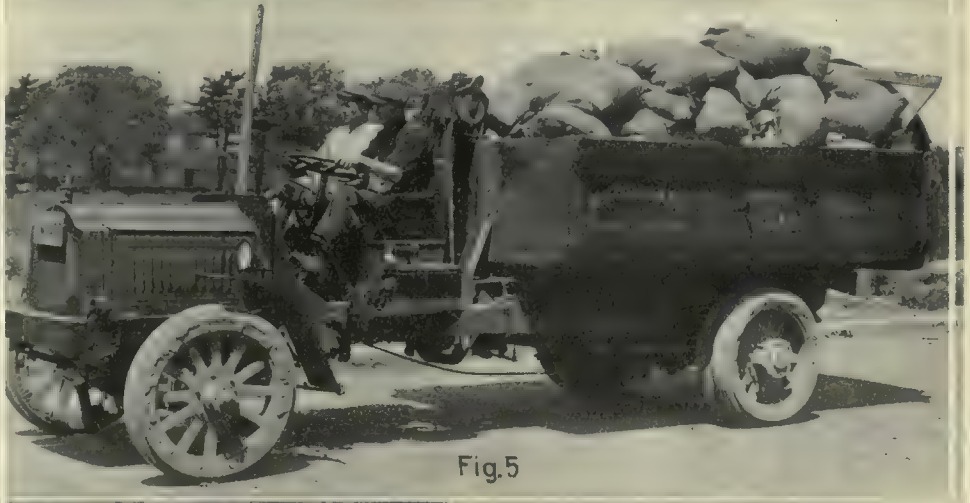


Fig.5

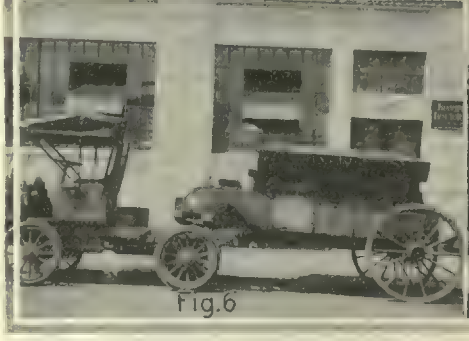


Fig.6

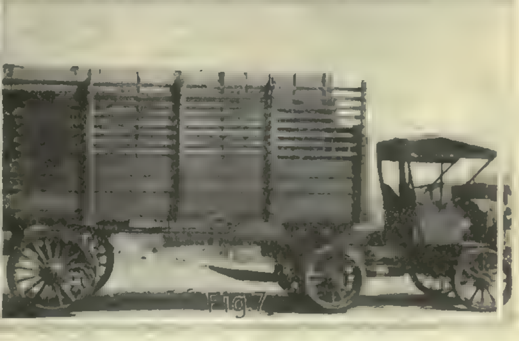


Fig.7

Tractors and Trucks for Contractors' Handling Operations.

Fig. 3—Knox Tractor Hauling 33-Ton Boiler on 8-Ton Truck. Fig. 4—Knox Tractor Hauling Seven Oil Tank Wagons Weighing Over 48 Tons. Fig. 5—Packard 3-Ton Contractors' Truck. Figs. 6 and 7—Two Applications of Transport Tractors.

The Simplate Valve—Its Construction and Operation.

(Contributed.)

During the past decade, a number of designs of flat plate compressor valves have been presented and discarded because of inefficiency and impracticability. These designs were all remarkably similar, varying only in minor details. The Simplate is unique and distinctive in both design and construction. Its chief advantages are that it is simple; that its plates are independent in action, one of another; that each plate has its individual springs; that the tension of the spring on the inlet and discharge valves differs according to the density of the air handled; and lastly that it is applicable to all positions and conditions.

In Fig. I is shown a discharge valve. The valve seat (A) is cast from a special composition possessing toughness and high tensile strength, and it also has circular ports as shown in the figure. It is machined so that the raised portion of the seat, or the points on which the plates rest forming the joint, is very narrow, thus reducing the unbalanced area to a minimum. The keeper (B) is of the same material and is provided with suitable ports for the free passage of air through it. It also furnishes the guides for the valve plates, and affords, as well, satisfactory pockets for the valve springs.

The valves (C) are simple concentric steel plates of uniform section, with a separate and independent plate over each port. Each plate is also independently governed by its own springs, hence the action or opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily need to move, unless the speed conditions should demand it. Here is seen the great advantage of having the plates independent of one another, rather than for the series of plates to be made from one sheet with openings cut through to allow the air to flow from the different ports.

The springs (D) are of the Volute type and are made of special alloy steel, heat treated and carefully tempered. They have the proper tension for the discharge and inlet valves, so as to effect the most perfect valve action. The parts making up a complete valve are assembled and held together by the nickel steel stud (E) and castle nut (F), and when this nut is securely tightened in place, it is firmly held so by cotter pin (H).

Figure 2 shows the inlet valve, the construction of which, as can be seen, is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as it does in the discharge valve; the keeper is thinner, and the springs are of lighter tension. On account of the difference in the thickness of these valves, they cannot be reversed; that is, the inlet cannot be put in where the discharge should be, nor the discharge where the inlet belongs—this precautionary measure is deemed to be highly necessary. The spring tension on the inlet valves is made very light so as to get the full benefit of the varied opening of the different plates when the piston speed is changed. For instance, with an inlet valve of the size here shown, the spring tension is so calibrated that the outer plate opens with a pressure of but ¼ oz. per square inch, and 1 oz. will open the intermediate plate, while it requires 2½ ozs. to open the inner one. This illustrates the true meaning of the varied opening.

Simplate valves are efficient in the highest degree because they are light and durable, always remain tight, are opened with little work, and are noiseless in operation. They have suitable spring tensions inasmuch as the inlet and the discharge spring tensions differ according to the difference in the density of the air handled, their opening is varied in proportion to the increase or decrease in the piston speed; their location in the cylinder is convenient for examinations or repairs and allows the air to enter the cylinder through cool and unrestricted passages; and finally, the power required to expel the air from a cylinder is a minimum. The valves described are the product of the Chicago Pneumatic Tool Co., Chicago, Ill.

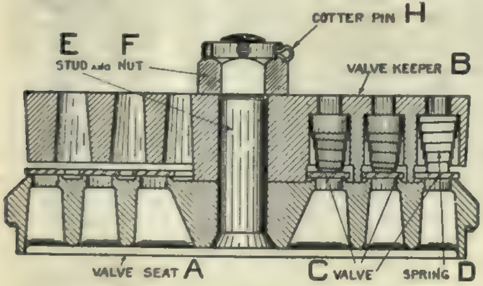


Fig. 1—Simplate Discharge Valve

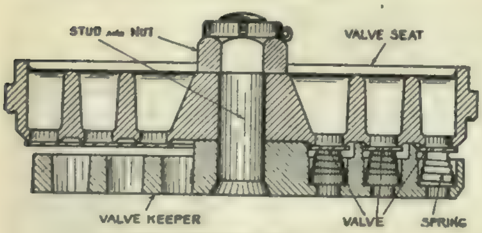


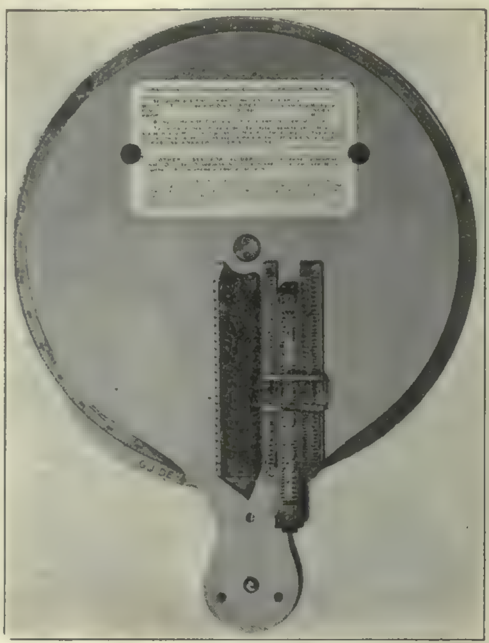
Fig. 2—Simplate Inlet Valve.

New Type of Flat Plate Compressor Valve.

A New Type of Computer Giving Results Accurate to Five Places.

A new computer has recently been placed on the market, which gives results correct to five significant figures. In this new type of computer the system of graduation is uniform throughout, the length of scale being 120 times as great as the scales on an ordinary 10-in. slide rule.

The new device, which is known as the "Ross Precision Computer," consists of a finely graduated dial, rotating between a movable guide and a fixed, slotted cover, and a self-reading slide mounted at the right of the slot. The cover is extended to form a handle. For approximate calculations the slide is sufficient, but for precise results the dial is used in conjunction with the slide to check the result, to point out the answer under the slot-line, and to locate the decimal point in the answer. By referring to the illustration it will be noted that concise directions are given on a card attached to the cover of the computer.



Ross Precision Computer.

To multiply and divide any series of numbers, it is only necessary to set each number in succession under the slot-line. After the last number has been set the answer will appear, also under the slot-line. To locate this answer requires a setting of the mounted slide. The slide may be used for computations where an accuracy of three significant figures is sufficient, while the dial gives accurate results to five significant figures—the first three figures as printed on the dial, the fourth by noting the sub-divisions, and the fifth by estimating tenths of divisions.

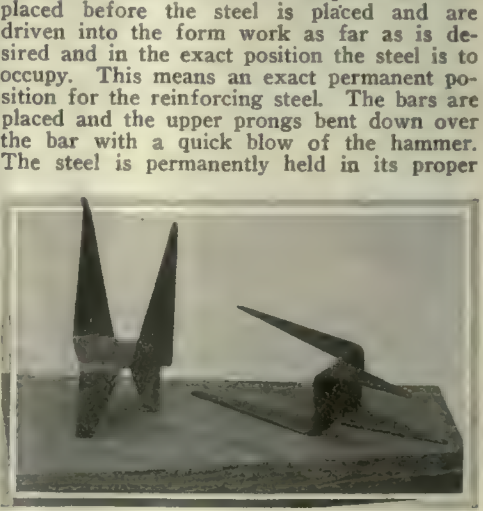
The computer is made of metal throughout, the graduations being engraved on silvered metal surfaces. It is slightly over 8 ins. in diameter, weighs less than a pound, and is packed in a flexible leather case. It is the invention of Louis Ross, and is manufactured by the Computer Manufacturing Co., 25 California St., San Francisco, Cal.

A New Reinforcing Bar Chair.

(Contributed.)

A chair for holding reinforcing bars in place has recently been developed along lines radically different from previous efforts. Heretofore the various chairs on the market have been developed so that under weight their feet would not dig into the wooden form.

As shown in the accompanying illustration, a new principle has been followed in making Staple-Chairs. This chair is made from extra stiff sheet steel, cut and bent to develop two pairs of pointed prongs projecting in opposite directions. Staple-Chairs are placed before the steel is placed and are driven into the form work as far as is desired and in the exact position the steel is to occupy. This means an exact permanent position for the reinforcing steel. The bars are placed and the upper prongs bent down over the bar with a quick blow of the hammer. The steel is permanently held in its proper position and in a proper elevation above the form.



Staple Chair for Reinforcing Bars.

In early work there was some apprehension lest the driven-in points might make centering removal difficult. In rather extensive work around in Cleveland there has been no trouble on this point. The clip has been developed by The Shop-Fabricated Reinforcement Co., Cleveland, Ohio.

Engineering and Contracting

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The Lighter Side of Engineering and Contracting

Dry Land Fishing.

ANDY Koenig, the St. Louis labor king, is a devoted disciple of Isaac Walton. As an earnest fisherman he has few equals and no superiors. Last summer Koenig and some friends went after bullheads. Now the bulkhead is a peculiar kind of fish and has several interesting points, two of which are just back of its gills. It lives in sluggish water, likes a muddy bottom and bites best at night. Andy's party included a lieutenant of police and two contractors. One of the latter had made various boasts as to the number and size of the fish he was going to catch. The crowd got into a boat and pushed off. It was a dark night and the mosquitoes were particularly active. For some time there was no action, so the boat was moved from place to place. Finally the fish began to bite. Everybody was catching them except the boastful contractor, who was seated in one end of the boat. Not a nibble did he get. He baited and rebaited his hook; he spit on the bait; he cast it over his left shoulder, but never a fish came his way. He put on a heavier sinker; he let out more line, but nothing changed his luck. And all the time Koenig and his friends were cheerfully hauling in bullheads. After about three hours of this Andy suggested that it was time to go home. They reeled in their lines, but made no move to start rowing. "What you waiting for?" said the unlucky fisherman, somewhat peeved. "Think this old raft's got a gas engine?" Koenig pulled out a pocket flash light, and said sweetly: "Oh, no, Micky, we're just waiting for you to step ashore so we can follow." He opened up the light and Micky discovered that his end of the boat was snug to the bank and all the evening he had been fishing for bullheads in the tall grass. Andy, in making the various moves of the boat earlier in the evening had pushed his friend's end up against the shore.

Wool Gathering Transit Man.

ON a tunnel job carried on some years ago in a southern city the labor was largely Senegambian, as our friend Koenig would say. The tunnel was a small one, perhaps 5½ ft. high. At one point a pocket of water and sand was struck unexpectedly and the inrush caught and smothered two or three muckers. The occurrence made a deep impression on the 'darkies and thereafter it took only a trickle of water from the "face" to raise a wild yell and a stampede of husky colored gentlemen toward the portal. As "leaks" were frequent, a considerable amount of time was consumed in these foot races, but it remained for the transit man to peak the spire of complaints. He complained that the speed of his work "giving line" was retarded by the necessity of going over the line pegs in the roof rock at frequent intervals "to clean off the nigger wool."

A Sad Reality.

BY A. SUBB.

Said the architect to the builder,
With a large and chesty sigh,
"I'd like to give this job to you,
But, Holy Gee, you're high."

"Oh, never mind," the builder said,
"I'll take it anyway;
I'll just cut off ten thousand bucks
And make the SUCKERS pay."

The SUBS came flocking 'round the job
Like flies around a pie,
But all the builder said to them
Was "Holy Gee, you're high."

He took their hide, he picked their bones
And scraped their carcass dry,
They found the money, brains and skill.
He found the air and sky.

And when they got all through the job,
They owed him 10 per cent
For hauling rubbish, watchman's fees
And SU PER IN TEN DENT.

Considerable Come Back, This.

THE manager of the Peoria Water Co. was discussing with a water consumer the condition of the latter's water meter. How hard water acted on the brass in the meter, causing slow running and in some cases complete stoppage of the meter was explained to show the necessity of removing it for testing and repairs. Said the consumer: "Well, if your water has that effect on brass, what effect will it have on my stomach?" The water works man was stumped for a moment, at this query, and then replied: "Well, your brass is not in your stomach."

Ignorance Is Bliss.

RECENTLY a large electric street railway company appointed a new engineer of maintenance of way. The new official upon making an inspection of the properties observed the lax methods of one of the company's track oilers. He severely took the employe to task, threatening to discharge him if the track did not show a decided improvement upon the next inspection. Two weeks passed, when the new official upon making an inspection observed the oiler was performing excellent work. He, upon return to the office, wrote the employe, highly commending him for his efforts. The employe, who could neither read or write, upon receiving the letter did not open the communication. Placing the envelope in his coat pocket he turned to the laborers and remarked, "Well, that's just what I expected."

C. A. E., Los Angeles, Cal.

No Wonder He Died.

TIL Huston, of the Huston Construction Co., of Havana, also is part owner of the New York baseball team of the American league. This latter fact has nothing to do with the story; it merely indicates the contractor's bravery. During the Spanish-American war Huston was an officer in a volunteer regiment. Now the army mule is a pretty tough specimen, and it takes a mighty hardy man to handle it. The mule drivers during this country's little unpleasantness with Spain were a particularly tough lot. In fact, they were tougher than the mules themselves. One day Huston was talking with the surgeon in charge of the hospital camp when a driver rode up and dismounted. "Say, Doc," said the man, "give me some arnica. I don't feel just right. Me and me pardner were lying under a wagon drinkin' whiskey. We made a mistake an' got hold of a quart bottle of carbolic acid we used for bathing sores on the mules. We drunk it all up before we noticed." The doctor tried to make the man lie down, but he said he was all right, and after getting some medicine started away. In about 15 minutes the driver came tearing back as fast as his horse would carry him. "Turn down a bed, doc; turn down a bed," he yelled. "I guess I'll lie down. When I got back to the wagon I found my pardner deader'n hell. But that guy always did have a weak constitution."

Name Your Poison.

THE late R. S. Hunt, secretary of the Spence & Howe Construction Co., at one time was in charge of the erection of a power plant in West Virginia. While on the work he stopped at a small country hotel. One night a drummer came in and walked up to the desk. "Where shall I autograph?" he inquired of the clerk. "Hey!" said the clerk, "autograph?" "Yes, sign my name, you know." "Oh!" said the clerk, and produced the register. A few minutes later a native advanced to the desk. "Will you autograph?" asked the clerk with a beaming smile. "Sure," said the native, his face also beaming. "Mine's rye."

Skinner Mulvey says: The slipholder says to me, I brag to the foreman, the foreman brags to the boss, the boss brags to the engineer 'bout all that dirt we moved last month. But the mules don't brag to anyone. Pretty much the way of the world, ain't it?

CURRENT NEWS

The Doings of the Week.

Broader activity in business was a feature of the week. Bank clearings exceeded those of the corresponding week of last year, indicating increasing operations in finance and investment. Railroad buying last week again was encouraging, and export sales continued active. A development of the week was the strength displayed by railroad securities on the stock market throughout the violent, reaction in the industrials. In the construction field a better showing as regards advertised work was made. This was due in a measure to the readvertisement of numerous jobs. No particularly large undertakings reached the call for bids stage during the past week. Building prospects show an expansion over previous week. Reports from 140 cities for September show a gain of 15 per cent in number of permits and 30 per cent in value over the figures for the corresponding month of last year. In the metropolitan district of New York reports show a total of 9,403 buildings with an estimated value of $126,502,000. In the same month last year an estimated value of the 9,163 buildings projected was $89,486,000. This indicates the general trend of Eastern building construction. Money for building work is now obtainable in the East at much lower premiums, and as a result it is possible there will be a larger percentage of new building plan filings during the winter than in a corresponding period in many years. In the iron and steel market activities were well sustained. Domestic rail orders aggregated 108,500 tons, most in small orders. The Union Pacific bought 10,000 tons, Chicago Great Western 8,000 tons, Nashville, Chattanooga & St. Louis 8,000 tons, Southern Ry. 12,000 tons, and Seaboard Air Line 12,000 tons. This latter tonnage will be used for the Charleston Southern Ry. now under construction. Structural steel contracts for September amounted to about 137,000 tons—9,000 tons less than in August. A large amount of new business, however, is in sight for October, and already bids have been closed for 60,000 tons. The American Bridge Co. was low bidder for furnishing this amount of steel for the Municipal Ry. Corp. of New York. Pig iron production for September was 2,852,561 tons, with 268 furnaces in blast on Oct. 1. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Oct. 6 were as follows:

Finished Iron and Steel.	Oct. 6.	Sept. 29.
Per lb. to large buyers:	Cts.	Cts.
Bess. rails, heavy, at mill...	1.25	1.25
Iron bars, Philadelphia......	1.509	1.509
Iron bars, Pittsburgh........	1.40	1.35
Iron bars, Chicago	1.35	1.35
Steel bars, Pittsburgh.......	1.40	1.35
Steel bars, New York........	1.569	1.569
Tank plates, Pittsburgh......	1.40	1.35
Tank plates, New York......	1.569	1.569
Beams, etc., Pittsburgh......	1.40	1.35
Beams, etc., New York......	1.569	1.569
Skelp, grooved steel, P'gh....	1.40	1.35
Skelp, sheared steel, P'gh...	1.45	1.40
Steel hoops, Pittsburgh......	1.40	1.40
Sheets, Nails and Wire.		
Per lb. to large buyers:		
Sheets, black, No. 28, P'gh...	2.00	1.90
Galv. sheets, No. 28, P'gh....	3.50	3.50
Wire nails, Pittsburgh	1.75	1.75
Cut nails, Pittsburgh	1.70	1.60
Fence wire, base, P'gh......	1.60	1.60
Barb wire, galv., P'gh.......	2.60	2.60

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees 3 in. and over, 1.40 cts.

Railways.—No developments looking to the immediate undertaking of any large railroad construction jobs occurred during the past week. Numerous small projects are now approaching the customary winter conversation stage. Some of these may develop later on into real jobs. An encouraging feature of the week was the well sustained strength of railroad securities in the stock market. Wall Street is beginning to believe that a new era is opening for the railroads and is manifesting its belief by its actions.

Roads and Streets.—California, Pennsylvania, Massachusetts and New York are advertising lettings. The work for the last mentioned state involves 29 contracts covering about 115 miles of road. Street paving, as is to be expected, shows a falling off in the number of jobs advertised. The contracts let include two road contracts amounting to about $58,000 for East Liverpool Township, Ohio; 20,000 sq. yds. of brick paving for Pawnee, Okla.; a $37,000 road contract at Jacksboro, Tenn., and a $40,000 paving job for Garrett, Kan.

Bridges.—No particularly large bridge undertakings appear to have been advertised during the past week. The County Commissioners at Boise, Idaho, are asking bids on a 454-ft. steel highway bridge; the State Superintendent of Public Works, Albany, N. Y., opens proposals Oct. 19 on a $59,000 bridge job at Lyons Falls, N. Y.; St. Louis, Mo., is calling for bids for the reinforced concrete viaduct on Chouteau Ave. Five bids were received for the Kaw River reinforced concrete bridge at Lawrence, Kan., the Missouri Valley Bridge Co., Leavenworth, Kan., at $199,910 being low bidder. Robert Grace Contracting Co., Pittsburgh, Pa., at $103,000, was awarded the contract for foundations and approaches for Union Ave. grade crossing work at Cleveland, O.

Drainage and Irrigation.—The U. S. Reclamation Service is calling for bids on about 340,000 cu. yds. of canal excavation near Loma and Mock, Colo. Bids will be opened Oct. 22 at Rensselaer, Ind., on a drainage ditch requiring 477,811 cu. yds. excavation. The Jackson County Drainage District No. 8, of Edna, Tex., is asking proposals on about 317,000 cu. yds. of excavation. Burt-Washington Drainage District of Tekamah, Neb., awarded contracts amounting to about $112,000 to J. L. Mullen, Lincoln, Neb., E. D. Barr, Pocahontas, Ia., and J. W. Boyle, Dubuque, Ia. Edgar Chapman, Plant City, Fla., was awarded $113,000 contract for construction of Gamble Creek drain at Palmetto, Fla., the work calling for 23 miles of ditches requiring 1,340,000 cu. yds. of excavation. H. B. Whitney, Emmettsburg, Ia., secured a 217,921 cu. yd. contract for Osceola County, Ia.

Water Works.—A considerable number of water-works jobs are now being advertised. Peapack, N. J., is asking bids on 8 miles of 4-in., 6-in. and 8-in. pipe line; Cleveland, O., open proposals Oct. 20 for laying two 60-in. mains; Cincinnati, O., is calling for bids for the Kennedy Heights stand pipe. Bureau of Yards and Docks opens proposals Oct. 30 for $250,000 steel water tank and tower for Indian Head Naval Proving Ground.

Sewerage.—A fair amount of sewerage construction is being advertised. District Commissioners, Washington, D. C., ask bids for 11,000 ft. 11-in. to 24-in. pipe sewers; Algoma, Ia., is asking proposals on 14,000 ft. 8-in. to 18-in. sewer; Elliott, Ia., opens bids Oct. 19 on 11,750 ft. of 6-in. to 15-in sewers; Seaside Park, N. J., is asking proposals for 8,000 ft. 8-in. to 12-in. sewer and disposal plant; Verona, N. J., opens bids Oct. 21 for 17 miles of 8-in. to 20-in sewers and sewage disposal works; Kaufman, Tex., is calling for proposals on sanitary sewers and disposal plant. Jas. Ferry & Sons, Inc., Baltimore, Md., at $125,922, was low bidder for storm water drains for Atlantic City, N. J. Contracts let include the following: Public Service Construction Co., Omaha, Neb., sewers and disposal plant for Brooklyn, Ia., at $32,469; Moreno, Brooks & Burkham, St. Louis, Mo., sewer system for Fayette, Mo., at $35,847; W. C. Elliott, Portland, Ore., at $58,448, for sanitary sewers for Forest Grove, Ore.; Sullivan, Long & Hagerty, Bessemer, Ala., at $34,000, for sewer system for North Chattanooga, Tenn.

Buildings.—Building construction appears to be beginning to pick up. There is a considerable amount of public and educational structures ready for figuring. Many large private undertakings, office buildings and the like, also will be placed under contract soon. Work advertised during the past week by the Supervising Architect, U. S. Treasury Department, includes the following: Extensive remodeling, etc., of post office at Boise, Idaho; enlargement of vault, etc., at post office, Buffalo, N. Y.; extension, remodeling, etc., of post office and court house at Huntington, W. Va. Bids will be opened about Nov. 1 for a $1,000,000 office building at Omaha, Neb.

Rivers and Harbors.—Beaumont, Tex., is calling for bids on second unit of its harbor development, work including 500 ft. of quays, 400-ft. steel shed, and gantry jib cranes. Eastover Construction Co., Inc., Utica, N. Y., at $38,543, was awarded contract for improving Canisteo River for New York state. Arthur McMullen, New York, was awarded contract for new $1,000,000 dock at Canton, Baltimore, Md., for Pennsylvania R. R. Montague & O'Reilly, Portland, Ore., were awarded contract, at $98,000, for 17 miles of dike in Wahkiakum County, Wash.

Why Contractors Fail.

The epitaph of many contractors who have fallen by the wayside should contain the warning: "He was too optimistic." Optimism is a mighty fine thing, but so is good, hard common sense. If some contractors would use more of the latter there would be fewer jobs finished by the bonding companies. It is a common occurrence for a contractor to bid on contracts about 10 sizes too big for him. He knows he has insufficient capital and inadequate plant to swing the work; yet his optimism is so great that he thinks he can 'pull through some way.' Sometimes he does, more often he doesn't. In any case, he is seriously handicapped even before he signs the papers. Lack of capital causes more failures than the old standby, too low or reckless bids. An analysis made by the National Surety Co. of recent claims aggregating over $500,000 paid under contract bonds, showed that over 65 per cent of the losses were due to conditions existing prior to the signing of the bond. Of this percentage inadequate capital accounted for 12.8 per cent, while low or reckless bids were responsible for 12 per cent. Insufficiency of plant was blamed for 4.1 per cent of the losses, and errors in bids or calculations for 5.1 per cent.

Jurisdictional Union Disputes.

There was a time when a contractor who employed union men was reasonably safe from labor troubles. But nowadays there are so many overlapping unions that an employer is in continual hot water. No sooner is a job started than a jurisdictional dispute arises among the unions themselves. The contractor is neutral, but so was Belgium, and the result is the same: The warring factions walk over him and his work is tied up while they fight it out. Even in municipal day labor construction jurisdictional disputes between the unions are of frequent occurrence. Just at present St. Louis is a storm center. The city is constructing the approaches to a bridge over the Mississippi River by day labor, union men only being engaged in the work. Several strikes have resulted from the jurisdictional disputes among the various unions, and the carrying out of the improvement as a consequence has been seriously delayed. Seemingly the employment of union men is no longer a safeguard against labor troubles.

A $1,419,000 IRRIGATION PROJECT.

Proposed for 18,000 Acres of Land Near Lindsay, Cal..

High Head Pumping with Supply from Wells.

An extensive high head pumping project is proposed for the irrigation of lands near Lindsay in Tulare County, California. A preliminary report on this development has been submitted by Stephen E. Kieffer, consulting engineer, Mechanic's Institute Bldg., San Francisco. Following this report the necessary proceedings have been taken and an election will be held on October 16 for the formation of a district to be known as the Lindsay-Strathmore Irrigation District.

The district will include the territory lying between the Southern Pacific R. R. on the west and the hills on the east and extending about three miles north of the city of Lindsay to the town of Strathmore on the south. The total area of the district is about 18,000 acres, and the greatest distance from north to south is 8 miles and from east to west 5 miles. The topography is that of a gently and uniformly sloping plain extending westward from sharply rising hills. Elevations range from 384 ft. at Lindsay to 700 ft. on the slope of the eastern hills. About 8,000 acres of the district are now planted to citrus fruits. It is probable that by far the greater portion of the land will be devoted to these crops and to olive culture. The principal city in the district is Lindsay, which has a population of about 2,500. Strathmore is a small town. Both of these places are on the east side branch of the Southern Pacific R. R. The Santa Fe System also has recently completed a line into Lindsay.

The water supply is to be derived by pumping from the underground storage waters of the Kaweah Delta. Provision will be made for a net amount of 1.75 acre feet of water per season. The plant will consist of a system of wells, pumping plants, canals and pipe lines. The water will be collected from widely distributed wells and delivered through a system of conduits to the sump of a central pumping station. This station will deliver the water to a boosting station at the toe of the hills, where it will be lifted to a high level ditch upon the hills. From this ditch a distributing pipe system will be directly supplied to irrigate about 16,200 acres. A second boosting station will lift water to a second high level ditch for the irrigation of the remaining 1,800 acres in the district.

The plant will be designed upon the basis of a maximum yearly requirement (including losses) of 29,100 acre feet, and an irrigating period of 200 days. The well pumping equipment will be installed with a normal full-load capacity of 133 per cent of the average load, and the main pumping plant with 116 per cent of the average.

It is assumed that 37 wells 12 ins. in diameter and about 100 ft. deep will be required for the full supply. These wells will have a minimum spacing of ¼ mile. Each well will be electrically pumped, and equipped with an 8-in. centrifugal pump direct connected to a 15-H. P. motor set in a reinforced concrete pump pit and suitably and substantially housed. The water from the wells will be collected and conducted to the central pumping station sump through steel and cement pipe lines and open cement-lined ditches. The average total lift from wells to sump, including depths of normal water plane, pump draw down and friction, is estimated to be 30 ft.

The main pump station will be located centrally to the wells at some point near the Kaweah River. All of the water from the wells will be delivered to the concrete-lined sump at this station. The total estimated lift (including friction) from this sump to the sump of boosting station No. 1 at Merryman is 65 ft. A pump capacity will be provided for a uniform flow of 85.5 cu. ft. per second, or 38,500 gals. per minute, divided into three equal units. The pumps will be 20-in., horizontal, single-stage, centrifugal. The motive power may be either electric motors direct connected to the pumps, or Diesel engines connected through increasing gears. Each engine or motor will have a rated capacity of not less than 240 brake H. P. The plant will be housed in a concrete building with provision for air cooling.

The water will be delivered from the main pump station to boosting station No. 1 through three 48-in. pipes, each of which will be about 3½ miles long. Station No. 1 will be located at the foot of the hill near Merryman. The lift to the ditch upon the hill will be 165 ft., this including friction. Four 500-B. H. P. Diesel engines or motors and four 18-in. horizontal, single-stage, centrifugal pumps will be used. The discharge pipes from the station will consist of three lines of 36-in. riveted steel pipe ½ mile in length.

The main ditch will start above Merryman and follow southward along the western slope of the hills just above the existing orange groves. This ditch will be divided into two sections. Section 1 will have a length of about 7 miles and will carry all of the water to the north line of the district. Section 2 will have a length of about 6 miles and will terminate on the point of the hills due east of Lindsay. Section 1 will have a bottom width of 5 ft., side slopes of ½ to 1, water depth 4 ft., grade 3 ft. per mile. Section 2 will supply water direct to the distributing pipes throughout its length, and will vary in bottom width from 5 ft. to 3 ft. and will have a grade of 5 ft. per mile. The entire ditch will be lined with cement mortar placed by the cement gun over reinforcing wire.

Beginning in the main ditch on the line between Sections 9 and 10 two main pipe lines will be carried through the district. Pipe line No. 1 will run due south and east and will vary in size from 36 ins. to 12 ins. Pipe line No. 2 will run east and south to boosting station No. 2, and thence to the balancing and relief reservoir and will be 30 ins. to 24 ins. in diameter. These pipe lines will carry a static head below the hydraulic gradient of from 20 to 145 ft. Main No. 3 will begin at the extension of the main ditch in Section 3-20-27, will be 16 ins. and 14 ins. in diameter, and will be carried to boosting station No. 3.

Boosting station No. 2 will be located under a balancing reservoir head of 25 ft., with an effective elevation of 540 ft. It will boost 3,800 gals. per minute to the 700-ft. level under a lift, including friction, of 165 ft. The discharge pipe will be 2,300 ft. long and 20 ins. in diameter. The equipment will consist of one 240-B. H. P. engine and 12-in., horizontal, single stage, centrifugal pump.

High level ditch No. 2 will follow the eastern boundary of the district along the western slope of the El Mirador hills. It will be cement lined throughout with a length of about 12,000 ft., 2 to 1.5-ft. bottom, side slopes ½ to 1, and grade of 4 ft. per mile.

The water will be distributed to the land through a system of distributing pipes. This will consist (in addition to the main pipe lines already referred to) of a system of pressure pipe lines reaching some point opposite every tract of land in the district. From these pipe lines water will be distributed to the private lines of each irrigator. The system will contain approximately 93 miles of reinforced concrete pipe from 6 ins. to 16 ins. in diameter.

The total estimated cash cost of the work is approximately $1,419,000 for 18,000 acres, or $78.83 per acre.

A graduate fellowship, to be known as the R. D. Chapin fellowship in highway engineering, has been given the University of Michigan by Roy D. Chapin, president of the Hudson Motor Car Company. The money is to be used entirely for the benefit of Michigan highways. In the experimental work, materials found locally will be used.

IRRIGATION PROJECT IN TETON COUNTY, MONTANA.

Main Supply to Be Had From Teton River.

Works to Be Carried Out for Teton Co-Operative Reservoir Company.

The Teton Co-operative Reservoir Co. of Helena, Mont., is planning an extensive irrigation system in Teton County, Montana.

The water supply will be taken from the flood waters of the Teton River and from those of the Black Leaf and Muddy Creeks. As the latter are comparatively small streams the main supply will come from the Teton River, the catchment area of which is approximately 170 square miles, and the estimated available run-off, other than that required for the water rights of prior appropriators, is estimated at about 70,000 acre feet as a minimum. This water, other than that required by individual holders, may be applied on Carey act lands situated near Brady, Mont., lying about 35 miles east of the impounding reservoir, 40,000 acres of which have been applied for.

The Teton River is subject to heavy floods which last but a short time, the heaviest of record being 1,680 second feet. The diversion from the river will be by means of a low concrete dam about 600 ft. long and which will have a wasteway 470 ft. long to pass any inordinate floods.

The head works will be of concrete and they will be so arranged as to pass the amount of water decreed to the prior appropriators, amounting to some 400 second feet, and also to pass into the diversion canal of the company 800 second feet at the same time. As the floods usually occur in May or June, when there is generally not very much irrigating done, it is unlikely that the full amount of 400 second feet will be needed below for any great length of time. The diversion canal extends for about 4 miles over a gravelly bench and then is dropped into the impounding reservoir, which is formed by an earth dam 52.5 ft. high and about 2,500 ft. long, with upper slopes of 3 to 1 and lower slopes approximately 2 to 1. The outlet pipe is concrete, 5.25 ft. internal diameter, and is controlled by a single gate Chapman valve. The upper face is covered with stone to a depth of about 3 ft.

The work at the dam was practically completed several years ago. The work on the Teton River and the completion of that at the reservoir will not be let by contract, and it is the intention to finish it this season by day labor.

The water from the reservoir will flow down Alkali Creek to its confluence with Muddy Creek, thence down this stream for about 8 miles, where it will be diverted to the canal, which will carry it to the irrigable lands below.

This canal will be 14 ft. wide on the bottom, side slopes of 1½ to 1, and will carry a maximum of 6 ft. of water. As from all indications the soil will be found firm and gravelly, the canal has been given a gradient of 0.05 per cent, and it will therefore carry upward of 400 second ft. This canal has been located for 13.25 miles, which distance it is proposed to build next year and which will require the excavation of 250,000 cu. yds. of earth, the building of 700 lin. ft. of reinforced concrete syphon 7 ft. internal diameter, one steel flume of 12 ft. diameter, and concrete headworks.

As conditions to be overcome at Muddy creek are very similar to those found at the Teton River, the same general plan will be followed in each, *i. e.*, a diversion weir of concast iron head gates operated by bevel gears, and sluice gates for passing water to prior rights and for cleaning out sand and gravel accumulations.

A. K. Prescott of Helena is president of the company and Charles W. Helmick, Helena, is the engineer.

$10,473,000 for U. S. Reclamation Projects.

The U. S. Reclamation Service has completed its apportionment of the funds appropriated by Congress for the present fiscal year. The sum of $10,473,350 was allotted to primary projects for the year ending June 30, 1916. The allotments are as follows:

Arizona:	
Salt River Project, Arizona	$ 537,000
Yuma Project, Arizona-Cal.	659,600
California:	
Orland Project, Cal	70,200
Colorado:	
Grand Valley Project, Colo	561,300
Uncompahgre Project, Colo	375,400
Idaho:	
Boise Project, Idaho	1,040,000
Minidoka Project, Idaho	328,300
Jackson Lake Enlargement, Idaho-Wyo.	475,700
Kansas:	
Garden City Project, Kan	1,600
Montana:	
Huntley Project, Mont	120,000
Milk River Project, Mont	422,300
St. Mary Storage Project, Mont	473,900
Sun River Project, Mont	720,000
Lower-Yellowstone Project, Mont.-N. Dak.	47,000
Nebraska:	
North Platte Project, Neb.-Wyo	272,000
Fort Laramie Unit, Neb.-Wyo	644,200
Nevada:	
Truckee Carson Project, Nev	190,000
New Mexico:	
Carlsbad Project, N. Mex	102,400
Elephant Butte Storage, N. Mex	607,400
Hondo Project, N. Mex	4,000
Rio Grande Project, N. Mex	404,600
North Dakota:	
North Dakota Pumping Project, N. Dak.	20,000
Oklahoma:	
Lawton Project, Okla	40,000
Oregon:	
Umatilla Project, Ore	294,800
Klamath Project, Ore.-Cal	164,900
South Dakota:	
Belle Fourche Project, S. Dak	144,000
Utah:	
Strawberry Valley Project, Utah	393,000
Washington:	
Okanogan Project, Wash	51,000
Tieton Unit, Wash.	52,000
Yakima Storage, Wash.	559,800
Yakima-Sunnyside Unit, Wash	278,000
Wyoming:	
Shoshone Project, Wyo	419,300

The allotments for preliminary investigations for secondary projects were as follows: Colorado River Basin, Ariz.-Cal., $25,000; Iron Canyon Co-operation, Cal., $25; Pitts River co-operative work, Cal., $25; Shasta County co-operative work, Cal., $100; Lassen County co-operative work, Cal., $50; General, investigations, Cal., $5,000; Walker River Investigations, Nev., $50; Columbia River co-operation, Ore., $7,500; Pecos River Investigation, Tex., $900; unallotted to specific investigations, $11,325.

State Water Supply Project in South New Jersey.

Several important water conservation projects are under consideration by the State Water Supply Commission of New Jersey. One of these provides for the acquisition by the state of the so-called Wharton tract in south New Jersey. At the election November 2 the citizens will vote on issuing $1,000,000 of bonds for purchasing these lands. The tract contains approximately 170 square miles, most of which is uninhabited wild land, nearly all wooded.

The property controls the water rights of the Batsto, the Atsion and the Wading Rivers, which are estimated to be capable of the development of 400,000,000 gals. daily supply. Estimates for special developments have not yet been made. Studies completed so far, however, show that it is possible to construct an impounding reservoir at Batsto at elevation 30 which would hold 21,000,000,000 gals. and also that a 25,000,000,000-gal. reservoir could be built on the higher portions of the Mullica River watershed.

It is stated that the probable first utilization for potable water supply purposes could be very cheaply inaugurated by using water power on the several streams to pump directly from the streams without the immediate necessity for the construction of storage reservoirs. It is believed such an arrangement will make available a supply of from 20,000,000 gals. to 60,000,000 gals. per day, depending upon how many branches of the Mullica River were used. From this development it is stated that an additional 10,000,000 gals. per day for Atlantic City, if desired, could be furnished at an initial cost under $250,000.

Bids Asked on 23 Miles of California State Roads.

The State Highway Commission of California is advertising its first letting of the fall. Bids are asked on three contracts as follows: Nine miles of concrete road in Placer County, grading 4.2 miles of highway in Sonoma County and 10 miles of highway in Mariposa County. The latter contract calls for 53,000 cu. yds. of earth excavation, 1,700 cu. yds. solid rock excavation, 810 cu. yds. Class B concrete in culverts and monuments, 2,324 lin. ft. of guard rail, and the placing of 1,896 lin. ft. of 12-in. to 30-in. corrugated metal pipe. The section extends from westerly boundary of county to Cathay-White Rock road.

The work in Sonoma County involves 43,500 cu. yds. excavation without classification, 14M B. M. Oregon pine lumber and 19M B. M. redwood lumber in place, 185 cu. yds. Class B concrete for culverts and monuments, 4,200 lin. ft. new board and wire property fences and 32,400 lin. ft. new woven wire property fences. The section extends from Reclamation to Fairville.

The 9 miles of concrete road in Placer County will extend from Lincoln to the northerly boundary of the county. The contract calls for 45,000 cu. yds. excavation without classification, 235 cu. yds. Class B concrete for culverts and monuments, and 8,760 cu. yds. class B concrete for pavement, 3,120 lin. ft. guard rail and placing 980 lin. ft. 12-in., 18-in. and 24-in. corrugated metal pipe.

Bids will be received until 2 p. m., October 18, by the California Highway Commission, 515 Forum Bldg., Sacramento, Cal.

A 115-Mile Highway Letting.

The largest highway letting so far this fall is now being advertised by the New York State Commission of Highways. This work involves 29 contracts, calling for the construction of over 115 miles of road. The roads location and mileage of the various contracts are as follows:

Road No.	County and Name.	Mileage.
1279	Albany, Dunnsville-Altamont	3.41
5532	Allegany & Steuben, Arkport-Van Scoters Corners	5.25
1327	Cayuga, Fleming-Scipio, Part 2	6.06
5594	Clinton, Plattsburg-Ingraham	3.79
1331	Columbia, Claverack-Chatham, Part 1	4.27
1332	Columbia, Claverack-Chatham, Part 2	7.77
5595	Cortland, Broome Co. Line-Marathon Village	4.00
1333	Erie, Collins Center-Springville	9.14
1334	Erie, Transit, Part 4	4.30
1335	Erie, East Eden-Hamburg	4.50
1336	Erie, West River Road	5.19
5582	Genesee, Leroy-Pavilion, Part 2	4.53
5593	Livingston, Caledonia-Mt. Morris, Part 1	7.69
1110	Madison, Oneida-South Bay, Part 1	3.05
1326	Madison, De Ruyter Village; Albany Street	0.18
1328	Monroe, Winton Road North	0.73
1337	Monroe, East Rochester-Penfield	2.91
5547	Oneida, Whitesboro-Carey Corners	0.70
5274-A	Onondaga, Phoenix-Syracuse	0.18
448	Orange, Port Jervis-Sullivan Co. Line, Part 2	3.64
449	Orange, Burnside-Washingtonville	3.17
1329	Orange, Goshen Village: Church, W. Main & Main Sts. and Greenwich Avenue	3.70
5591	Orange, Newburg-Cornwall	0.38
5545	Schenectady, Schenectady-Duanesburg, Part 2	5.62
5589	Seneca, Lodi-Interlaken	5.01
5510-A	Sullivan, Bloomingburg-Monticello, Part 1	0.43
1079	Tioga, Spencer-Candor, Part 2	4.07
1330	Tompkins, Ithaca-Esty Glen	2.48
603	Ulster, Napanoch-Montela	10.24

Bids on the above work will be received at the office of the commission, 55 Lancaster St., Albany, N. Y., until 1 p. m., Oct. 26.

Canadian Northern Pacific Ry. Terminals at Vaucouver.

The Canadian Northern Pacific Ry. has construction under way on its extensive terminal developments at Vancouver, B. C. This work includes the reclamation of 164 acres at the head of False Creek, which has been reserved for the purposes of this company. To date 2,000,000 yds. out of a total of 3,250,000 cu. yds. have been filled in and operations are being continued.

Tenders were opened on Oct. 5 for a reinforced concrete sea wall for the purpose of closing the head of the creek from tide water. This involves the following quantities:

Foundation excavation (wet), cu. yds	450
Concrete, cu. yds	4,950
Reinforcing steel, lbs	305,000
Concrete piles, lin. ft	15,900
Creosoted fir piles, lin. ft	12,200
Asphalt, sq. yds	2,820
Rock fill, cu. yds	15,500
Square timber, No. 1 common, ft. B. M.	19,500
Iron in timber, including U bolts, lbs	5,500
Spring coils, No	255

The contract will be let immediately and the construction started. T. H. White, Vancouver, B. C., is Chief Engineer Canadian Northern Pacific Ry.

16 New Submarines for U. S. Navy.—The U. S. Navy Department opened bids last week for constructing 16 submarines. The Union Iron Works, San Francisco, and the Electric Torpedo Boat Co. of Quincy, Mass., submitted the lowest offers for the Pacific and Atlantic coasts, respectively. The San Francisco concern bid for five or more at $510,000 each, the first to be completed in 12 months and two each month thereafter. The Massachusetts company bid for eight or more at $523,000, the first to be completed within 17 months. The Newport News Shipbuilding Co., Newport News, Va., and the New York Shipbuilding Co., Camden, N. J., which have built many large ships for the navy, make their first appearance as bidders for submarines. The submersibles are to be of the coast defense type, displacing from 450 to 500 tons each. They will be less than 200 ft. long and will have a speed of 14 knots on the surface and 11 knots submerged. Each will carry a 3-in. gun of the disappearing type recently perfected at the naval gun factory.

Rating Batch Concrete Mixers.—The National Association of Mixer Manufacturers at its August meeting adopted a resolution providing for the uniform rating of batch mixers. This resolution provided that the members of the association in future catalogues shall specify the capacity of their mixers as "size of wet, mixed batch," and not otherwise. The resolution further provides that the dry unmixed capacity of a mixer may be approximated at one and one-half times the wet mixed batch, assuming the use of cement, sand and 1½-in, crushed stone, with 1¾ gals. of water per cubic foot of mixed concrete. The members of the association further agreed not to use the dry batch rating in their correspondence, advertising, etc., unless the standard wet batch rating were used also and with equal prominence.

Civil Engineering Society at Rensselaer.—The students at Rensselaer Polytechnic Institute, under the leadership of J. F. Matthews, a senior in the civil engineering department, are organizing a civil engineering society for the purpose of discussing current events in the engineering world and to have lectures delivered before them by the engineers of the country. Correspondence is being held with other engineering schools and an effort will be made to have the American Society of Civil Engineers sanction a junior branch at the institute similar to the junior branches of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

PERSONALS

Mr. Alexander J. Taylor has resigned as city engineer for Wilminngton, Del., to enter the employ of the E. I. du Pont de Nemours Company.

Mr. Charles W. Petit has been appointed chief engineer for the Ventura County, California, Highway Commission. The county is planning construction covering 104 miles of road to be paved with concrete or bituminous macadam, for which a bond issue has been voted of $1,000,000. Mr. Petit is also county surveyor for Ventura County. For four years he was bridge engineer of the county, having charge of construction amounting to $400,000.

Mr. J. L. Jacobs, formerly engineer in charge of the Municipal Efficiency Division of Chicago, announces that he is prepared to give counsel and undertake supervision or conduct of expert investigations connected with service and efficiency surveys, management, appraisals and cost accounting, either for industrial or public institutions. Mr. Jacobs is an associate member of the American Society of Civil Engineers and a member of the Efficiency Society. His offices are in the Monadnock Block, Chicago.

Mr. Frederick Knight Bennett, who was recently appointed valuation engineer of the Minneapolis & St. Louis Railroad Company, with offices at Minneapolis, entered railroad service with the Lehigh Valley Railroad as rodman in the spring of 1895. He was in continuous service with this company until March, 1909, as assistant engineer on maintenance; assistant engineer, engineering department; assistant engineer in charge of office and accounts; supervisor of tracks and division engineer. From that time until June, 1911, he was engineer in charge of reconstruction on the Missouri Pacific Railway. The following year he was assistant engineer, maintenance of way, on the Missouri Pacific at Kansas City, and from June, 1912, to June, 1913, was assistant to the chief engineer of that road at St. Louis. For the following year he was division engineer of the Missouri, Kansas & Texas, and since that time has been assistant engineer on valuation for the Great Northern at St. Paul and Spokane, and latterly division supervisor of the Minneapolis & St. Louis eastern division.

Mr. Arthur R. Hirst has been appointed to the position of chief engineer of the Wisconsin Highway Commission, with the title of State Highway Engineer, by Chief Engineer Mack of the newly organized State Department of Engineering. Mr. Hirst has held that position under the old régime since 1912, and prior to that was Acting State Highway Engineer for one year. Mr. Hirst is a graduate of the Maryland Agricultural College, class of 1902. He entered the service of the Pennsylvania Railroad as rodman, remaining one year. He was then appointed as surveyor and chief of party for the highway division, Maryland Geological Survey. In 1905 he became engineer of surveys for the Maryland Road Commission, leaving in 1907 to accept the office of engineer of construction for the Illinois Highway Commission. Later in the same year he went to Wisconsin as highway engineer under the State Geological Survey. He held that position until 1911, when he became Acting State Highway Engineer. Mr. Hirst will now have administrative charge of all construction of roads and bridges built under the plans of the State Highway Commission. This involves about $4,000,000 in road construction and about $800,000 in bridges per annum. This includes "state aid" construction, amounting to about $4,300,000, and road and bridge work other than state aid, about $500,000.

Mr. Edwin M. Capps, the civil engineer Mayor of San Diego, Cal., has had a varied experience in engineering and political fields. Back in 1888 he was appointed chief engineer of the Lower California Mining & Development Co., and had charge of the developing of 120 sq. miles of mineral lands. In 1890 he left that company to take the position of chief engineer for the San Miguel Land & Water Co., a large irrigation project in the vicinity of San Diego. He remained there until 1893, also holding the position of chief engineer for the Jamadia Irrigation District, in that same neighborhood. From 1893 to 1899 he was engaged as city engineer for the city of San Diego, Cal., which at that time had a population of 20,000. From 1899 to 1901 he served as Mayor of that city. In 1902 he was made chief engineer for the Tejunga Water Co., operating in general engineering work in Los Angeles. From 1904 to 1909 he was engaged in general engineering work in Los Angeles, Seattle and other points along the Pacific Coast. From 1909 to 1912 he was again city engineer for the city of San Diego, which in the meantime had grown to about 60,000. In January, 1912, he was appointed harbor engineer for the Port of San Diego, and during his term in that office he designed and built harbor improvements aggregating about $1,400,000. He was again selected as Mayor of San Diego last May, at which time the population of that growing city was estimated at 100,000. Mr. Capps is a member of the American Society of Civil Engineers.

OBITUARIES

Henry C. Shaw, vice-president of the A. Garrison Foundry Company, died suddenly Sept. 27, aged 61. Mr. Shaw was a graduate in civil engineering of the Rensselaer Polytechnic Institute of Troy, N. Y. Before entering the A. Garrison Foundry Company he was connected with the Lewis Foundry and Machine Company.

Adam Kauffman, aged 35, a well-known sewer contractor of Scranton, Pa., was killed by a cave-in of a trench in Duryea Borough, Wilkesbarre. Mr. Kauffman had gone into the trench to direct the work, and was the only one caught in the debris, the workmen making a narrow escape. Mr. Kauffman was formerly a draftsman at the International Correspondence School in Scranton.

Gurdon H. Williams, president of the G. H. Williams Company of Erie, Pa., was killed Sunday, Sept. 24, when a Nickel Plate train struck the automobile which he was driving. Mr. Williams was widely known among contractors as the manufacturer of the Williams clam shell buckets and derricks. He had been the active head of the company for many years. He was 63 years of age and made his home in Cleveland.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces examinations for the following positions with the Interstate Commerce Commission, to be held Nov. 2: Senior electrical, senior mechanical, senior signal, senior civil, senior telegraph and telephone and senior structural engineers, and senior architect. The salary in each case is from $1,800 to $2,700 per annum.

NEW CATALOGUES

Grader and Backfiller.—Paper, folder. Oshkosh Manufacturing Co., Oshkosh, Wis.

The new Oshkosh portable grader and backfiiller is described, with general specifications, and several views of the machine and its operation.

Bubbling Fountains.—Paper, 6x9 ins., 4 pp. Manufacturing Equipment and Engineering Co., 209 Washington street, Boston, Mass.

Describes sanitary bubbling fountains with ice-cooled water supply, with cuts showing various types and attachments.

Revolving Steam Shovels.—Paper, 8½x11 ins., 8 pp. American Steel Dredge Co., Fort Wayne, Ind.

Bulletin No. 10, describing "Single-Line" revolving steam shovels, their special features and advantages in operation. Shows a number of views of the shovels at work, and gives specifications.

Blue Print Filing Cabinet.—Paper, 5¼x7¾ ins., 16 pp. Yawman & Erbe Mfg. Co., Rochester, N. Y.

Describes the "Y and E" Mammoth vertical file for blue prints, and illustrates with duotone cuts. The cabinets are said to hold from 700 to 1,000 prints, maps, etc., indexed for ready reference, in compact, dustproof and convenient style.

Centrifugal Pumps.—Paper, 6x9 ins., 8 pp. De Laval Steam Turbine Co., Trenton, N. J.

"The Cost of Pumping Water" is the title of this pamphlet, which gives some interesting data and cost curves. Reproductions of the De Laval diagram and steam scale are given, with detailed instructions as to their use in determining steam consumption. A few views of De Laval turbine-driven centrifugal pumps are shown.

Sanitary Plumbing Devices.—Paper, 9¼x12 ins., 54 pp. James B. Clow & Sons, Chicago, Ill.

"Wasting a Million a Day and How to Save It" is the suggestive title of the new Clow catalogue, an attractive and well-illustrated publication showing the various sanitary plumbing devices of the company. Also gives some data as to saving accomplished by Clow types of hydrants, showers, closets, hot water heaters, etc.

CATALOGUE REVIEWS

Kahn Mesh.—Paper, 5½x7¾ ins., 34 pp. Trussed Concrete Steel Co., Youngstown, Ohio.

Kahn mesh for reinforcing concrete floors, roofs, roads and pavements, sewers and conduits, culverts, bridges, etc., is discussed in a publication just received which will interest both engineers and contractors. This material is an improved form of expanded metal manufactured by a cold drawn process. Its use for the numerous purposes mentioned is described in brief and illustrated with sectional diagrams and photographs. Slab tables for gravel, stone or cinder concrete, giving safe live loads for various sizes of slabs in pounds per square foot, reports of fire tests, cold bend tests, beam tests, etc., data as to quantities required, and other information of the kind is included with the text.

Concrete in the Country.—Paper, 6x9 ins., 112 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

"Concrete in the Country" is the title of Bulletin No. 26, published by the Association of American Portland Cement Manufacturers and distributed by the Sandusky company. The many ways in which concrete may be advantageously used in rural districts are quite fully explained, with specifications, quantities of materials, explicit directions for placing, and numerous photographs and drawings. Methods of mixing and proportioning concrete, tools necessary, methods of placing, forms and reinforcement are taken up in an elementary way which will best meet the requirements of the layman. Many farm structures, bridges, culverts, drain tile outlets, walks, etc., are shown.

INDUSTRIAL NOTES

Gold Williams, sales manager of the Marquette Cement Co., was killed Oct. 10 in an automobile accident near Aurora, Ill.

The Bucyrus Co. has recently opened an office at 900 Hibernian Bldg., Los Angeles, Cal., in charge of Mr. G. H. Hutchinson. Mr. Hutchinson is well known among contractors in his district of the country, having handled contractors' equipment for 15 years.

The Burd High Compression Ring Co., Rockford, Ill., has appointed Mr. Robert Allan as district branch manager for northern California. Mr. Allan was formerly attached to the Dallas, Tex., office. His headquarters will be at San Francisco, where he has taken offices and will carry a complete stock at 847 Phelan Bldg.

RAILWAYS

BIDS ASKED.

Georgia:

Macon, Ga.—Bids will be received Oct. 20 by C. K. Lawrence, chief engineer, Macon Terminal Co., for concrete subway to carry Pine St. under railroad track. Substructure will consist of plain concrete 1-3-6 and will require 2,310 cu. yds. The abutments will be continuous and will also act as retaining walls. Footings will be 10½ ft. by 3 ft. 5 in. Body of wall 7 ft. 6 in. at base and about 15 ft. high. Superstructure will consist of built-up steel beams with 140-ft. reinforced concrete floor slab and a 96-ft. arch. The width of roadway will be 21 ft. in subway and 30 ft. in north approach. Sidewalks to be 4 ft. and 5 ft. Total width over all 25 ft. and 35 ft.

PROSPECTIVE WORK.

Arkansas:

Star City, Ark.—Gould Southwestern Ry. is reported to be considering extending its line west to Rison or Fordyce and north to Pine Bluff.

California:

Taylorsville, Cal.—Engels Copper Co. is reported to have preliminary surveys under way for narrow gauge railroad from its mine down to Indian Valley and Indian Creek canyon to connection with Western Pacific Ry. at or below Keddie.

Illinois:

Alton, Ill.—Illinois Terminal R. R. Co., operating line between Alton and Edwardsville, is reported to contemplate extending its tracks from the latter place to East Carondelet.

Minnesota:

St. Paul, Minn.—It is reported that the Great Northern Ry. is considering reviving project for cut-off from Hutchinson, Minn., to Redwood Falls, Wabasso, Tracey, Currie, Slayton and Hardwick to Garretson, S. Dak.

Onamia, Minn.—The Great Northern Ry. is reported to be contemplating extending its line from Milaca northeast along the west side of Mille Lacs Lake to Hill City.

St. Paul, Minn.—Union Depot Co. is reported to be planning to ask bids soon on its channel improvement work for its new Union Depot here. Proposals on this work were asked early this summer but were rejected. W. C. Armstrong is chief engineer.

Mississippi:

Biloxi, Miss.—Gulfport & Mississippi Coast Traction Co., whose line was recently badly damaged by hurricane, will rebuild its roadbed between Biloxi and Pass Christian, 30 miles. W. F. Gorenflo, Manager.

New York:

New York, N. Y.—Public Service Commission of the First District has approved contract and plan submitted by N. Y. Municipal Ry. Corporation, for construction of foundation and structures for Jamaica elevated extension. This comprises 2.2 miles of 2-tracked elevated railroad running from Walnut St. along Jamaica Ave. to Cliffside Ave. Commission also approved form of contract for erection of steel for additional track on Myrtle Ave. line, as well as for certain additional work on Lutheran Cemetery line.

New York, N. Y.—Public Service Commission for First District has approved form of contract and plan for reconstruction of Brighton Beach elevated line in Brooklyn, submitted by N. Y. Municipal Ry. Corp. This contract involves reconstruction of line from Church Ave. northward to Malbone St. and widening of this portion from 2 to 4 tracks. Estimated cost of the work is $750,000 to $1,000,000.

North Carolina:

Rutherford, N. C.—Rutherford Interurban Ry. Co. has been incorporated with capital stock of $500,000 and will take over assets of North Carolina Interurban R. R. Co. Incorporators include W. A. Harrill and J. C. Mills.

Benson, N. C.—Surveys are about completed for Atlantic & Western R. R. and it is reported that construction will be started this month on the line from Benson, both east and west.

North Dakota:

Fargo, N. D.—Great Northern R. R. is reported to have completed plans for establishment of large freight terminal at this city.

Ohio:

Cleveland, O.—Cleveland Rapid Transit Co. is reported to be planning to start work this year on its subway. W. R. Hopkins is president.

Youngstown, O.—Local steel interests in connection with Lake Erie & Eastern Ry. are reported to contemplate rehabilitating old Vienna branch of Erie and Lake Shore & Michigan Southern to relieve conjection in lower yards of Youngstown.

Oregon:

Newport, Ore.—Citizens have offered bonus of $100,000 to Portland & West Coast R. R. & Navigation Co. as an inducement to construct first 10 miles of proposed line from Newport to Portland.

South Carolina:

Anderson, S. C.—Blue Ridge Ry. Co. has been making some preliminary surveys and getting estimates for extension from West Union to Stumphouse Mountain. No decision has been reached as yet regarding construction. J. R. Anderson, Anderson, S. C., is superintendent.

South Dakota:

Yankton, S. D.—South Dakota & Western Ry. Co. has been incorporated with capital stock of $1,000,000 and proposes railroad from Mitchell to Brule P. O., by way of Platte. Incorporators include W. L. Bruce, W. E. Heaton and J. J. Dorr.

Texas:

Marlin, Tex.—Plans are under consideration for formation of Interurban Construction Co. for building railway between Temple and Marlin. Marlin Commercial Club is interested.

Virginia:

Chester, Va.—Chester & City Point Electric Ry. Co. proposes to construct a line from Chester to City Point and Hopewell, about 9 miles. Route will be over nearly level country. There will be a bridge over Appomattox River. Final estimates are not yet submitted. A. C. Buchanan, secretary; J. G. Donley, Chester, engineer in charge.

Washington:

Lyle, Wash.—Klickitat Northern R. R. has resumed construction and hopes to have line in operation early next spring. Road will tap big timber belt at Mount Adams and connect with Spokane, Portland & Seattle branch line at Klickitat. F. A. Bennett, manager.

West Virginia:

Madison, W. Va.—Pond Fork Ry. Co., recently incorporated, proposes line 10 or 12 miles in length to extend up Pond Fork Coal River. This company is subsidiary to Chesapeake & Ohio Ry., of which F. J. Cabell, Richmond, Va., is chief engineer.

BIDS OPENED; CONTRACTS LET

Maryland:

Baltimore, Md.—Baltimore & Ohio R. R. has let contracts for 62,500 tons of rail for immediate delivery. Practically all of this rail will be used for replacement in the company's main line. It is of heavy type, weighing 100 lbs.

Michigan:

Ontonagon, Mich.—Smith-Byers-Sparks Co. has been awarded contract by White Pine Mining Co. for 2 miles of spur track from mine to connection with St. Paul R. R.

Virginia:

Roanoke, Va.—Norfolk & Western R. R. is second tracking 11 miles of its line, along New River, 9 miles of this is being done with company forces; the remainder has been let to J. J. Boxley & Son, Roanoke.

ROADS STREETS

BIDS ASKED.

Alabama:

Camden, Ala.—Until Nov. 1, by Blair Hughes, Road Supervisor, for 10 miles of sand-clay or clay and gravel road.

California:

Sacramento, Cal.—Until 2 p. m., Oct. 18, by State Highway Commission, W. R. Ellis, Secretary, for state highway, as follows: 9 miles of concrete in Placer County, 4 2/10 miles of graded road in Sonoma County, 10 miles of graded road in Mariposa County.

Santa Barbara, Cal.—Until Nov. 1, by County Supervisors, for improvement of Booths Point Road. Estimated cost about $18,000.

Idaho:

Boise, Idaho.—Until Oct. 15 by State Highway Commission for 58 miles of road in Caffia County and 7½ miles in Washington County; to cost about $89,000.

Illinois:

Chicago, Ill.—Until 11 a. m., Oct. 18, by Board of Local Improvements, for 22 contracts for street improvements.

Indiana:

Columbia City, Ind.—Until 2:30 p. m., Nov. 5, by T. A. McLaughlin, County Auditor, for three highways in Smith township.

Indianapolis, Ind.—Until 10 a. m., Nov. 3, by W. T. Patten, County Auditor, for grading road in Warren township.

Newport, Ind.—Until 10 a. m., Nov. 1, by Roy Slater, County Auditor, for gravel road in Helt and Clinton townships.

Williamsport, Ind.—Until 2 p. m., Nov. 1, by D. H. Moffitt, County Auditor, for three miles of gravel road in Jordan and Pike township.

Evansville, Ind.—Until 10 a. m., Oct. 18, by C. P. Beard, County Auditor, for resurfacing with asphalt on Vine St. and on Fifth St.

Indianapolis, Ind.—Until 10 a. m., Oct. 15, by Board of Public Works, for grading and graveling on Winthrop Ave.

Kansas:

Independence, Kan.—Until Oct. 21 (readvertisement), by City Clerk, for 13,661 sq. yds. brick pavement, 7,136 ft. concrete curb and gutter, and 5,990 cu. yds. of earth excavation.

Independence, Kan.—Until Oct. 21 (readvertisement), by City Clerk, for grading and paving South Fourth St. Work including 4,827 sq. yds. of brick pavement, 2,394 cu. yds. of earth excavation and 2,820 ft. concrete curb and gutter. Geo. Weaver, City Engineer.

Maryland:

Annapolis, Md.—Until 11:30 a. m., Oct. 14, by E. T. Hayman, County Road Engineer, for 1.3 miles of state-aid highway.

Massachusetts:

Grafton, Mass.—Until noon, Oct. 19, by State Highway Commission, 15 Ashburton Pl., Boston, for 22,300 ft. of highway in towns of Grafton and Upton.

Wareham, Mass.—Until 10:30 a. m., Oct. 23, by County Commissioners, care of Massachusetts Highway Commission, Ashburton Pl., Boston, for 8,750 ft. of highway, in Wareham, Mass.

Michigan:

Port Huron, Mich.—Until noon, Oct. 21, by County Road Commissioners, for grading about 14,000 ft. of the Port Huron and Yale trunk line highway.

Minnesota:

Thief River Falls, Minn.—Until 2 p. m., Oct. 18, by County Auditor, for graveling state road No. 1.

Missouri:

Kansas City, Mo.—Until 2 p. m., Oct. 15, by Thos. F. Callahan, Secy. Board of Public Works, for vertical fiber vitrified brick block pavement on 14th St.

Kansas City, Mo.—Until 2 p. m., Oct. 15, by Thos. F. Callahan, Secy. Board of Public Works, for grading on Brooklyn Ave., Spruce Ave., Garfield Ave.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

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Leagues of Municipalities Helpful to Engineers.

One of the strongest agencies now effective in popularizing engineering is the state league of municipalities. These leagues have already done much for engineers and engineering and only a beginning has been made. The oldest organization of this kind is only about 15 years old and many are much younger. The strongest state leagues of municipalities are those of California, Iowa, Kansas and Minnesota. The last named league is holding its third annual meeting during the present month. Although so young 107 Minnesota cities hold membership in the league. The plan of having cities hold membership instead of the city officials is an excellent one for, while officials come and go, the town keeps on going. When a man is elected to office in one of the membership cities that membership at once prods him into an active interest in municipal affairs which he would be long in acquiring otherwise, if he ever acquired it at all.

The League of Minnesota Municipalities may be profitably considered for a moment as typical of the highest development of this form of organization. Briefly, it is described as a voluntary co-operative association of towns of all sizes, having for its chief objects mutual benefit and assistance, for the scientific investigation and study of problems of municipal government and administration, for the promotion of good will, solidarity and uniform action among membership cities, for the dissemination of reliable information and statistics relating to all departments of municipal business, and for the advocacy of good, non-partisan municipal legislation. The league seeks to better the conditions of its membership cities by an application of terrestrial means and knowledge now at hand without endeavoring to extract panaceas from the circumambient ether. The league is affiliated, or rather associated, with the State University, more intimately, with the General Extension Division of the University. This relationship possesses several advantages; it enables the league to have without expense to itself a central office and an executive officer who looks after the business of the league throughout the year, gets new members and keeps things moving. As a part of the extension services of the university a Municipal Reference Bureau has been established in the General Extension Division. This bureau secures information for city officials, compiles statistics, makes researches, issues bulletins and reports, etc. This work is performed by the university faculty without charge to the cities as a part of the policy of being useful to those citizens of the state who are not in attendance at the university. Thus the league, while entirely independent of the university, makes use of the university's faculty, library and laboratories.

So much for the aims and activities of the league in general. Coming now to the help given engineers by the league we find it to be of two kinds: indirect and direct. The indirect help comes from a discussion of problems in municipal engineering at the annual conventions. This shows the new city official the engineer's place in the scheme of things. The direct help extended engineers comes from the newly formed Bureau of Engineering Co-operation. This bureau was formed for the purpose of advising cities to avail themselves of the services of good engineers. Many cities, particularly the small ones, occasionally need the services of an engineer, but don't know it. Moreover, they won't believe it when told as much—if an engineer does the telling. But if advised to get an engineer by the league they are at once impressed by the logic of the proposal. Thus many jobs, heretofore muddled through without engineering supervision, will now have the benefit of such supervision. When municipal officers write in for advice about public works the league officials point out that it is the poorest kind of economy to try to save an engineer's fee.

As we have said, the League of Minnesota Municipalities, with its State University connections, is a model of its kind. Such leagues afford municipal engineers a character of backing and co-operation of which they should hasten to avail themselves throughout the country.

Shrinkage and Time Effects in Concrete.

The prevention of cracks in concrete is a problem with which engineers and contractors have long contended, with varying degrees of success. Experimenters have not given the problem the attention which its importance merits, with the result that we have few authoritative data upon which to base definite conclusions. The use of steel reinforcement has greatly aided in controlling the size and position of cracks, but our lack of knowledge of the action of concrete under the varying conditions met in practice has prevented definite progress. A number of experiments have been made to determine the temperature range in concrete, but the shrinkage and time effects are little understood. In this issue we are publishing the results of some tests to determine the shrinkage and time effects in reinforced concrete. Although the tests are not of sufficient scope to warrant definite conclusion, the results are interesting and emphasize the need for a thorough investigation of the subject.

Based upon the results of these tests it was concluded that from one-half to two-thirds of the shrinkage may be expected within 40 to 60 days after exposure to dry air, although shrinkage does not entirely cease within a year. The effect of thorough wetting in the early curing stage apparently has no effect in reducing the total shrinkage, the only effect being to retard the beginning of the action; this regardless of the fact that the strength of the concrete is materially increased by such treatment. It was found that slight changes in the moisture content of the air greatly retarded the shrinkage, and under certain conditions even caused a swelling.

The time effect, which is a term used to designate the gradual yielding which takes place with time in concrete subjected to a loading, a change distinct from that due to shrinkage in hardening, was shown by these tests to continue for a long period of time. The yielding of the concrete under compressive stress with time, a phenomenon similar to the yielding of metals when stressed beyond the yield point, was found to be greater as the unit stress is increased, and it seemed to continue almost indefinitely. In these tests the deformation due to yielding was found to be from three to five times that produced immediately upon the application of the load. On the tension side of a beam or slab the effect of time was found to cause a gradual increase in the steel stresses either from the breaking down of the concrete in tension or from the failure of the bond. The combination of the extension at the bottom and a shortening at the top thus produces in beams and slabs a continuously increasing deflection.

From the results of these tests it was concluded that the gradual yielding in the upper fibres of a beam, coupled with the gradual breaking down of the concrete in tension, may result in a progressive destruction of the bond from the center toward the supports, this being assisted by the drying out incident to the large shrinkage movement. These movements also may cause high stresses in the longitudinal steel of compression members, especially in columns in which the hooping has been assumed to carry a considerable part of the load. As has been noted, these tests are not of sufficient scope to warrant definite conclusions, but they point to more pronounced movements than have generally been anticipated and emphasize the need for a thorough investigation of the subject, under the varying conditions met in practice.

Growing Appreciation of the Rights of Contractors.

Even in the presence of such discouraging conditions as scarcity of work and low contract prices the contractor must find considerable consolation in the evident fact that his rights are becoming better appreciated. The way engineers and engineering journals have been speaking up for the contractor in the last few months must make that long-suffering and good-natured citizen recall the old-time revival meetings wherein penitent sinners clamored for the floor long enough to confess their sins of omission and commission. Verily, the contractor appears to be having his inning. As an old friend of his we extend our congratulations. For ten years we have bespoken a fair deal for the contractor and have urged the recognition of his rights when that subject was less popular than it seems to be at the present time. Allies are welcome, of course, no matter how tardy their arrival.

The point at which the contractor has so far made his greatest gain is in the greater reasonableness and liberality in the interpretation of engineers' specifications which is now apparent. Only the "younger" engineers now err in the slavish adherence to the letter of specifications when such adherence works a hardship to the contractor without promoting the interest of the engineer's client. The polite term "younger," as here employed, includes those young in years, those young in experience, and those with imperfectly formed conceptions of the fitness of things generally. They are being lambasted into line by their "elders." At this point substantial relief has been experienced.

However, the irresponsible low bidder is still with us. Such bidders are born every minute and while their careers are short, as individuals, their ranks are always recruited up to full strength. Such bidders flourish, for their brief moment, because city officials think it smart to award the contract to the lowest bidder, regardless of how low his bid and how modest his demonstrated abilities. It is at this point that the engineer can be of the greatest service to the contractor. While it is not the engineer's function to serve the contractor, he certainly should do so when by so doing he also serves his client. As long as contracts are awarded to irresponsible low bidders responsible bids will be forced down to a dangerously low point. That this matter is better ordered abroad is shown by the following quotation from a recent address by a British engineer who has been engaged in engineering work in this country for the past five years:

> As business conditions settle down in the west I hope to see the engineers grading contractors according to their records. To be a good contractor does not mean that a man must be a big contractor. There are jobs for all grades, the usual rough line of division being that of financial ability to carry out works of a certain size. I am more familiar with British practice in this respect, and it is quite the usual thing for an engineer to keep lists of reliable contractors, graded according to the size of job they can handle. The small men are not asked to tender on big jobs, nor are the big men asked to bid on small jobs. I should like to see engineers here in a position strong enough to enable them to say, when a tender which is obviously too low is submitted by a man or firm of consistently bad reputation, that his bid should not be considered. Unfortunately, in the rather peculiar state of business morality here such action by an engineer would almost certainly lead to his being accused of wanting the work to go to some favorite of his own.

The lack of strength mentioned comes only from a lack of unity of purpose. Let engineers agree to discourage the awarding of contracts to irresponsible bidders and the much needed reform in this particular will speedily be effected. Engineers know, if city officials do not, that it is anything but good business to award a contract at a price which makes a legitimate profit to the contractor an impossibility. Possessed of this knowledge engineers are not justified in remaining merely silent and sympathetic observers while the stage is being set for such a failure.

Akron Business Men Appreciate Good Engineering.

The Chamber of Commerce of Akron, Ohio, had much to do with the securing of the new water supply for that city. This commercial body has kept its collective eye on the development of this new supply for over six years, during which period city officials came in and went out on the political whirligig. The works are elaborate and extensive, comprising a new aeration and filtration plant, a new pumping station and two new reservoirs. The new works cost about $4,500,000, thereby justifying a live interest on the part of the business men of the city.

When this commercial body first interested itself in the city's water problem water was being supplied by a private corporation. The supply was insufficient and impure. Politicians, for years, had gone into office on the strength of their threats against the water company but nothing was accomplished. The Chamber of Commerce took the matter up, at length, as a purely business proposition.

Many people favored driving the private water company out by building a competing, municipally owned, plant. An election was actually called to vote $750,000 in bonds for this purpose. The vote was adverse to this procedure, due to an informed public opinion. The Chamber of Commerce had argued convincingly against the injustice and unwisdom of this procedure, particularly as the suggested municipal plant had not been designed by engineers and its cost had not been studied and estimated. The private plant was purchased, finally, as the result of another election.

Then, on the recommendation of the Chamber of Commerce, the city employed expert engineers to prepare plans and specifications to govern the construction of the present new plant. Before the source of the new supply recommended by the engineers was made public, the Chamber of Commerce advanced funds with which to purchase options on over 1,000 acres of land required in the valley of the Cuyahoga River. This land was wanted for a reservoir basin. It was purchased at its value as farm land, thus effecting a saving of over $50,000 less than would have been demanded had the details of the project been known. The bond elections all carried with large majorities, with the Chamber of Commerce again taking the lead.

This kind of co-operation between city officials and commercial organizations is certainly commendable. It is especially gratifying to note that the Akron business men protected the city against the folly of building a competing water system and against the tendency to get away on the wrong foot by failing to secure proper engineering advice. Engineers will do well to seek and to promote such cooperation when the opportunity offers.

$2,000 Per Capita Wealth.

The national wealth of the United States was at least $1,965 per capita in 1912—doubtless more—and certainly now exceeds $2,000 for every man, woman and child. The humorous paragrapher will next ask: Have you got yours?

The *per capita wealth* has almost doubled in 20 years, and is nearly four-fold what it was when the Civil War broke out. These are significant facts, and startling. Still it must be remembered that the purchasing power of a dollar has fallen considerably, so that the true increment in wealth has been at a somewhat less rate than these ratios indicate.

The proposed billion dollar loan to the Allies has created no end of discussion, and doubtless many a man has looked upon it as a huge sum that America can hardly spare. We get a better sense of it, however, when we see that it is barely more than half of one per cent of our national wealth.

In 1912, according to the census report, our total national wealth was $187,739,000,000. The following grouping of the grand items of wealth discloses some interesting facts:

1.	Telephone systems	$ 1,081,000,000
2.	Electric light and power	2,099,000,000
3.	Street railways	4,597,000,000
4.	Railways	16,149,000,000
5.	Shipping and canals	1,491,000,000
6.	Public real estate	12,314,000,000
7.	Private property and improvements	98,363,000,000
8.	Furniture and vehicles	8,463,000,000
9.	Clothing and adornments	4,295,000,000
10.	Farm implements	1,368,000,000
11.	Agricultural products	5,240,000,000
12.	Live stock	6,238,000,000
13.	Manufactured products	14,694,000.000
14.	Manufacturing machinery	6,091,000,000
15.	Gold and silver coin and bullion	2,617,000,000
16.	Other property	2,642,000,000
	Total	$187,739,000,000

Items 1 to 4 embrace most of the "public utilities" privately owned. Item 6 includes all real property exempt from taxation, such as public buildings and grounds, public works, churches, etc.

All the "hard money" (item 15) in the country is not 1½ per cent of the total wealth. Private real estate (item 7) constitutes more than half the total wealth. Doubtless this item is greatly undervalued, for no census reporters could have secured statements of the full value of such property, particularly mineral, oil and timber lands. In this connection it is important to note that the value of mineral, oil, timber and agricultural lands owned by the government is clearly not inventoried in this appraisal of national wealth; and it may be taken as almost certain that item 6 does not include the full cost of such public works as roads, bridges, sewers, etc.

In 1903 the wealth of the British Empire was estimated to be $108,280,000,000; and in 1908 that of Germany was $77,864,000,000. From these data we may infer that the close of the Great War will find American national wealth greater than that of the British Empire and Germany combined.

The vast importance of the railways is brought clearly to the front in the table of itemized wealth. Steam and electric railways combined form 11 per cent of the total wealth, or about $220 per capita. The mere statement of this fact serves to show why there was a general slowing up of industry during recent years as a result of political railroad baiting.

The other day James Hamilton Lewis—"Jim Ham" what am—senator from Illinois, raised voice in warning against the billion dollar loan to the Allies, on the ground that "if the billion sought goes to the foreign bankers, one-half of all the available cash in America is taken from the American people." It takes *some* political economist, like the celebrated "Jim Ham," thus to detect a hitherto unseen danger.

The allied nations owe us money, but can't pay cash. They ask for credit till the war ends and longer. The mechanism of the transaction is to be a sale of notes of the Allies to Americans having bank credits that they are willing to exchange for the notes; whereupon the Allies will transfer these bank credits to American manufacturers and farmers, and thus pay for goods purchased. No gold will leave America, but goods will, and in payment will come promises to pay at a future day. Thus will be had on an international scale precisely what daily occurs in countless credit transactions between individuals engaged in production and trade.

Rockefeller is reported to own nearly a billion dollars—probably it is much less—but huge as the sum is it is dwarfed by the grand total of natural wealth. Upon himself and his family he spends but the merest pittance of his income. The rest goes to build more railways, factories, and other tools of industry called "capital," or to keep busy scientists engaged in medical research and the like. But however it goes, practically all his income is used to create increased productiveness on the part of the average worker. By no means has it been an unmixed evil that a few men have acquired great riches, for certainly such men have been wonderfully instrumental in adding to the per capita wealth, and thereby to the annual income of the average man in America.

In a forthcoming census bulletin entitled "Estimated Valuation of National Wealth, 1850-1912," a very detailed analysis of the wealth of the entire country by states will be given.

ROADS AND STREETS

Wood Block Pavement in the City of Wenatchee, Wash.

Contributed by F. J. Sharkey, City Engineer.

LOCATION.

Wenatchee is a city of five thousand population, located in Chelan County, Washington, approximately two miles south of the junction of the Wenatchee River with the Columbia. It is on the main line of the Great Northern Ry., and is the distributing center for the North Central Washington fruit belt.

During the summer and fall of 1913 Wenatchee Ave., the main business street of the city, was paved with creosoted wood block. The improvement is approximately ¾ of a mile in length, the south ½ mile being 62 ft. between curbs and 90 ft. between property lines, the balance being 58 ft. between curbs and 70 ft. between property lines, making a total of approximately 27,500 sq. yds. of pavement, including intersections.

CONCRETE BASE AND SAND CUSHION.

The pavement consists of a 5-in. concrete base, a 1-in. sand cushion and 4-in. creosoted wood blocks. The concrete in the base is mixed 1:3:6, the specifications for cement, sand and gravel or broken stone being the usual standard specifications for such materials. The specifications for gravel or broken stone called for material ranging uniformly in size from that which passed a 2-in. ring to that which was held on a ¼-in. ring.

The southern part of the city is underlaid in many places with a good grade of river-washed gravel, which, however, contains a very small percentage of sand. The contractor opened up a pit of this nature to obtain the materials for concrete construction. The specifications allowed all clean materials to be classed as sand, between what is locally known as "quicksand" and that which would pass a ¼-in. ring. Shortly after the construction of the base had begun it was noted that the material which was being used for sand contained too large a percentage of coarse particles, slightly under ¼-in. diameter, to make good concrete, as the mortar settled to the bottom of the base, leaving the surface of the concrete honeycombed. A controversy arose between the engineering department and the contractor, the contractor contending that his material passed the requirements of the specifications for sand, while the engineer contended that, as several pits of excellent concrete sand existed within an economical hauling distance of the city, the contractor should mix his sand with some other that would provide for the deficiency in fine material. A board of arbitration was appointed to settle the matter, and the writer was instructed to make screen tests of the various local sands, also of the contractor's sand, in order to determine the mixture of the former with the latter which would result in the best grading to be used with the coarse aggregate, and would also be the most economical to the contractor. The results of these screen tests are shown in Table I.

Since the coarse aggregate contained a large percentage of material that was only slightly over ¼ in. in diameter, the mixture of test No. 7 was selected, as it gave the contractor the opportunity to use the greatest percentage of his own product. Although this mixture appears to be deficient in the finer fractions, it resulted in an exceptionally good concrete for the purpose, as it was dense, jellylike and easily floated to a smooth surface.

The concrete was not tamped, but each batch was deposited on that formerly placed and was shoveled down onto the subgrade to the required thickness and floated with a wood float. This float was constructed about 2 ft. square of 2x12-in. lumber, planed to a slightly convex surface and fitted with a long wooden handle. A ½-cu. yd. Koehring boom mixer was used on the work.

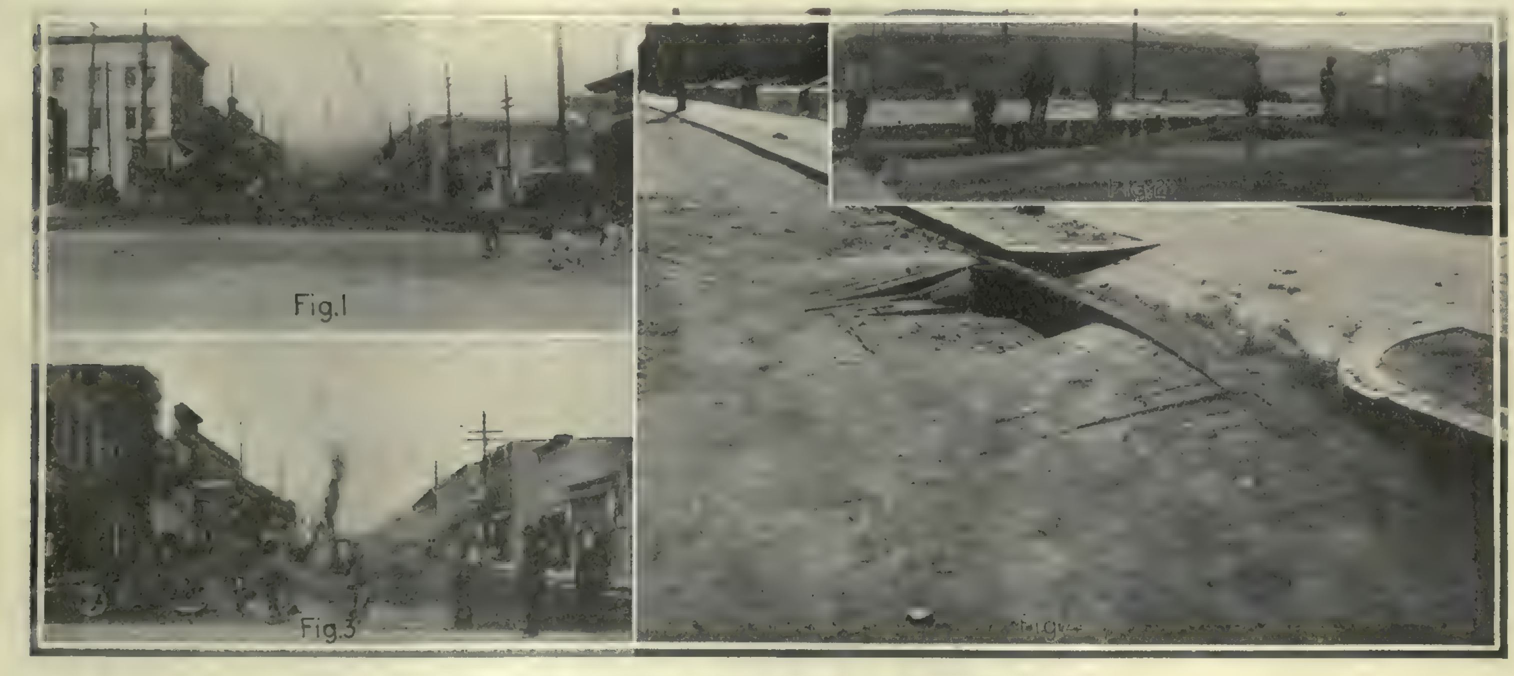
The street had formerly been improved along the south one-half mile with granite curbs and a concrete walk extending from curb to property line. For two blocks of the street, or approximately 900 ft., the west curb had been laid 2 ft. higher than the east curb. On account of this heavy throw, and the nature of the paving used, a special crown was constructed in these two blocks in order to keep the transverse grade from quarter to curb less than 5 per cent, which was considered to be the maximum allowable grade for this type of paving. The nature of this crown is shown in Fig. 1. On account of the exceptionally light longitudinal grade, averaging less than 0.2 per cent, the crown was purposely kept rather high, being one-eightieth of the width between curbs, in order to provide for ample drainage and prevent the blocks from absorbing an excess of water. The two blocks in which a heavy throw was encountered, as mentioned above, were staked for subgrade, the stakes not exceeding 10 ft. apart in either direction. Small stakes were then placed by the inspector alongside the subgrade stakes for surface of concrete. On the rest of the street both subgrade and surface of concrete were finished with a trussed templet, as shown in Fig. 2. Also because of the light longitudinal grade it was decided not to place the concrete with templet from the existing granite curbs, so a line of "ribbon" stakes were run down the center of the street, at subgrade elevation, with another line of stakes at each side of the street as near the curb as possible, and also at subgrade elevation. The stakes were placed not to exceed 8-ft. centers, and 2x5-in. plates were set on top of these stakes at center and gutter. The templet for concrete surface was run along on top of these plates, the concrete surface being kept true to grade in this way.

The sand cushion was placed by means of the same templet run on 1-in. strips placed on the concrete base at center and gutter. In the two blocks of the street where the heavy

WOOD BLOCKS.

Immediately after the preparation of the cushion the wood blocks were laid, culled and rolled with a five-ton roller. A synopsis of the specifications for wood block is as follows:

> Wood to be Douglas fir, with not less than six (6) annular rings to each linear inch measured radially.
>
> Blocks to be cut from 4x18-in. unseasoned timber, sized on one side, to be truly rectangular, and to be accurately 4 ins. in depth.
>
> Treatment to be not less than 16 lbs. per cubic foot of wood.
>
> Distilled fractions of creosote oil used in treating the blocks to be as follows:
>
> 0° C. to 210° C.—Not more than 5 per cent.
>
> 210° C. to 235° C—Not more than 20 per cent.
>
> 235° C. to 355° C.—At least 40 per cent.
>
> Residue above 355° C. shall amount to at least 20 per cent and not more than 40 per cent. Residue must be soft.
>
> Specific gravity of the oil shall not be less than 1.07 nor more than 1.12.
>
> Oil shall contain not more than 5 per cent tar acids.
>
> Oil shall contain not more than 20 per cent napthaline (solid).
>
> Oil must not contain more than 3 per cent water.
>
> Oil must be perfectly liquid, at 100° C., with no deposit taking place above 93° C.



Wood Block Pavement Construction in Wenatchee, Wash.

Fig. 1—Making cushion and laying wood blocks, Wenatchee avenue pavement. Fig. 2—Trussed templet for concrete base and sand cushion, Wenatchee avenue pavement. Note canvas covering in rear to prevent snow from getting into unfilled joints. Fig. 3—Rolling and filling wood block pavement, Wenatchee, Wash. Fig. 4—Heaving of wood block pavement between Second and Fifth streets, Wenatchee avenue, Wenatchee, Wash.

TABLE I.—RESULTS OF SCREEN TESTS OF SANDS FOR WENATCHEE AVE. PAVING.

Test No.	Name of sample.	Per cent passing 4-mesh.	Per cent passing No. 10 screen.	Per cent passing No. 20 screen.	Per cent passing No. 30 screen.	Per cent passing No. 40 screen.	Per cent passing No. 50 screen.	Per cent passing No. 80 screen.	Per cent passing No. 100 screen.
1	Contractor's No. 1	100	70	26	13	8	5	3	1
2	Contractor's No. 2	100	66	23	8	4	2	1	1
3	Pit A	100	96	82	54	34	18	6	3
4	Pit B, fine	100	99	90	68	45	22	[illegible]	3
5	Pit B, coarse	100	97	79	43	25	12	3	2
6	Pit C	100	88	52	27	16	8	2	1
7	Tests No. 2 and No. 5, mixed 1:1	100	85	53	28	15	7	2	1
8	Tests No. 2 and No. 6, mixed 1:4	100	86	50	25	14	8	3	1

Distillation.—Distill 100 grams in a 250 cc. glass retort, with thermometer bulb placed ½ in. above surface of oil at beginning of distillation. Retort to be protected from draughts. Distillation not to be faster than two drops per second and shall take approximately 45 minutes to complete.

Compliance with this specification secured an oil of which a very small part was volatile at ordinary temperatures, and also a highly preservative oil, with practically no "filler." There has been no objectionable bleeding of the blocks.

Due to the fact that the blocks were allowed to stand for some time in piles at the side of the street, in the hottest part of the summer, before being laid, a large number of the blocks curled slightly, even though kept damp in the piles at all times. These blocks split in two when rolled, but a number of the split blocks were used as bats at the beginning of courses. The expense of culling, however, was materially increased over what it would have been had the blocks been laid and filled immediately upon arriving on the street.

Five longitudinal rows of blocks were laid next to the curb on each side of the roadway for gutter courses, and the remainder were laid perpendicular with the curb. Three ½-in. expansion joints were placed on each side of the roadway. These expansion joints were cast the required thickness, from the filler asphalt, by laying a wood strip of the required width and thickness in a bed of damp sand, removing the strip and filling the resulting trench with asphalt. The expansion strips thus made were 3½ ins. wide by ½ in. thick and were laid on the cushion between the longitudinal or gutter courses of blocks. No transverse expansion joints were provided for. The remaining ½-in. between the top of the expansion strip and the surface of the blocks was filled with hot asphalt, to seal the surface.

TABLE II.—DISTRIBUTION OF COSTS OF WENATCHEE AVENUE WOOD BLOCK PAVEMENT.

			Materials									Labor		
Division.	Unit.	Number of units.	Kind.	Unit.	Unit cost.	Units per sq. yd.	Cost per sq. yd.	Division.	Subdivision.	Unit.	Number of units.	Units per hour foreman.	Units per hour labor.	Unit labor cost.
Base	Sq. yd.	27,595[1]	Gravel	Cu. yd.	$1.30	.0973	$0.1263	Base	Mixing	Sq. yd.	27,595[1]	120.5	8.9	$0.0523
			Sand	Cu. yd.	1.00	.0486	.0486		Placing	Sq. yd.	27,595[1]	253	19.9	.0205
			Cement	Bbl.	2.10	.125	.2625	Cushion	....	Sq. yd.	27,595[1]	.....	21.8	.0141
			Water	....	....	....	.01	Top	Laying	Sq. yd.	27,595[1]	.....	87.2	.016
			Mixer (Int. & Depr.)..	....	....	....	.0152		Helping	Sq. yd.	27,595[1]	.....	88.0	.0435
Cushion	Sq. yd.	27,595[1]	Sand	Cu. yd.	1.00	.0278	.0278		Rolling	Sq. yd.	27,595[1]	.....	73.7	.0159†
Top	Sq. yd.	27,595[1]	Blocks	Sq. yd.	1.794	1.0	1.794		Filling	Sq. yd.	27,595[1]	.....	5.9	.0599
			Asphalt filler..........	Ton	37.75	.0031	.1153	....	....	....	....	.....	....	.....
Total cost per square yard of paving..........							$2.3997							$0.2222

Labor, $2.50 per 8-hr. day; block layer, $10.00 per 8-hr. day. Block layer was foreman of cushion, laying, and filling gangs. *Wood blocks, $1.75 per sq. yd., f. o. b. Wenatchee, + $1.10 per M for unloading and hauling (42¼ blocks per sq. yd.). †Including roller rent, $3.50 per day.

An asphalt filler with a high melting point was used. It was heated in a portable kettle of 400 gals. capacity and was poured over the blocks with hand pouring pots. As soon as the asphalt cooled and congealed it was cleaned off the blocks with hot shovels, collected in small piles and again placed in the heating kettle. The method of heating and pouring the filler and cleaning the blocks is shown in Fig. 3. Immediately following the filling the pavement was covered with a ½-in. layer of sand.

The costs of laying wood block pavement are given in Table II.

MAINTENANCE.

Due to the fact that the work of filling was not completed until after extremely cold weather set in, the asphalt did not fill the joints as thoroughly as was desirable. In the spring of 1914 the pavement was cleaned, the sand cover and excess asphalt filler that had been forced out by the expansion of the blocks being removed. This was later found to be a mistake, as it developed that the blocks were in a more serious condition, from being improperly filled, than had been judged. A large percentage of the joints had received very little asphalt, and as a consequence the blocks became loose in the pavement. To remedy this condition, which was rendered more serious from the fact that a loose sand cushion had been used, a 1-inch covering of fine sand was spread over the surface and allowed to remain until worn off by traffic. This seems to have solved the problem as far as filling the joints and tightening the blocks are concerned, but it has caused some trouble in making the pavement heave, due to lack of proper provision for expansion.

In the spring of 1915 several heaved places were noted, one of the worst of which is shown in Fig. 4. All the trouble experienced, however, seemed to be caused by transverse expansion, and occurred within 8 ft. of the curbs on each side of the street, affecting approximately 300 sq. yds. of pavement in all. This heaving was taken care of in two ways: Where the blocks were heaved badly, as shown in the photograph, they were taken up and relaid, a good grade of pitch filler being used in refilling the joints; while where the heaving was only slight the joints were blown out with dry steam from the road roller, at a boiler pressure of 200 lbs., and the blocks were rolled down to place and the joints refilled with paving pitch.

The latter method was in the nature of an experiment, but has accomplished the purpose satisfactorily and at a trifling cost. To supplement this work and provide against future heaving at the same locations a ¾-in. expansion joint has been dug out with a chisel in the gutter courses of blocks along each place where having occurred, this joint being filled with paving pitch. Also eight courses of blocks have been taken up clear across the street each 400 ft. in length of street, and the blocks have been cut off for a 1-in. expansion joint, relaid with equal spaces between the blocks and refilled with paving pitch. The blocks have also been kept damp all summer by flushing the street at night and sprinkling in the daytime when necessary. This has kept the blocks from drying out and shrinking and has also kept further sand and dirt from the joints. From the present excellent condition of the surface of the street, no further heaving is anticipated.

Concrete Viaduct at Canyon City.—A concrete viaduct recently built at Canyon City, Colo., has a total length of 742 ft., carries a highway over four railway tracks, an old river bed, a canal, a road and an abandoned irrigation ditch, and connects at one end with a bridge over the Arkansas River. The grade of the bridge rises from both ends toward the center. The structure consists principally of concrete girder and slab spans varying from 27 to 44 ft. in length. In addition, there are two spans crossing railroad tracks, one of 60 ft. and the other of 65 ft. These are steel plate girders, covered with concrete on the outside only in order to conform to the rest of the structure in appearance. The viaduct carries a roadway about 24 ft. wide and one sidewalk about 5 ft. wide, and was built at a cost of about $1.40 per sq. ft. of roadway and walk.

Some Notes on Methods and Costs of Grouting Brick Pavements.

(Staff Article.)

Brick pavements have commonly grout filled joints. In general the method of grouting pavement joints is the same, but in detail of procedure there is some variation. The statement of practice and the discussion which follow are intended to furnish reliable and practical methods of procedure but not to cover every possible and perhaps useful variation in detail.

MATERIALS AND METHODS.

Materials and Proportions.—The standard grout for pavement filler is 1 part cement, 1 part sand mixed with water to the consistency of a thin cream. Portland cement that meets the specifications of the American Society for Testing Materials is standard. The standard sand is one composed of clean, sharp, well graded quartz grains all of a size passing a No. 12 screen and of which not more than 40 per cent will pass a No. 50 screen. A content of 1 per cent of clay or silt is the maximum generally permitted. There are few variations in practice from these records and no variation should be permitted not based on thorough knowledge.

Grout Mixing.—The prevailing method of mixing grout for pavement is by hand and practically the same procedure is followed everywhere. It is as follows: Equal amounts by volume of cement and sand are mixed dry until a uniform color is secured. Of this dry mixture 2 cu. ft. are placed in a grout box of the design shown by Fig. 1. Water is slowly added while continuously mixing until the desired uniform consistency of thin cream is secured. Ample time is advised for completing the mixing; first bring the mixture to a plastic state and then thin down with gradual additions of water. Continuation of the mixing until all the grout has been applied is advised.

Hand mixing as described has recently been replaced in many instances by machine mixers of the type described in our issue of Mar. 24, 1915. Records of machine mixing carefully performed indicate better results than are obtained by hand mixing.

Applying Grout.—The first step in applying grout filler to brick pavement is to sprinkle thoroughly the brick and to keep them, by repeated sprinkling if necessary, wet during the whole period of application. The grout is then applied in small quantities and swept into the joints until they appear to be full. Extreme care should be taken that the joints are not cemented over and that the filler extends down to the bottom of the brick. After the first application has had time to settle and before initial set develops a second application of somewhat thicker grout is made. When this grout has settled but before it has begun to set, the surface is worked with a rubber lipped squeegee until all joints are even.

Discussion.—The preceding paragraphs give briefly the directions for brick pavement grouting as they are found in specifications. There are in addition many important considerations not found in, and which it is impracticable to include in, specifications. The all-important thing in grouting pavement is to ensure the penetration of the filler to the very bottom of the brick. This is impossible when brick are laid on a sand cushion; the rolling of the brick invariably crowds some of the cushion sand upward into the bottoms of the joints. With careful rolling the penetration of sand upward into the joint need not exceed ½ in.; therefore, to secure a first-class grouting job the first essential is perhaps to make sure that the cushion sand does not penetrate the joints to exceed ½ in. Full depth filling means then the penetration of the grout to the sand filling and as far as may be into this filling to the bottoms of the bricks. Such thorough penetration can be secured certainly, with ordinary labor, only by using a very thin grout —a grout so thin that practically the only difference between it and water is the color. So thin a grout will penetrate all joints, both end and side joints, even with swelled end bricks. In mixing this thin grout precautions are important. Add the water gradually to secure a plastic mortar, then thin this with gradual additions of water to a creamy grout and finally by further additions of water procure the very thin grout described. If mixing is done in a grout box, it is probable that the best form of box is that recommended by the National Paving Brick Manufacturers' Association and illustrated by Fig. 1. Many boxes are made with too steep a slope and there is tendency of the sand to segregate in the lowest corner. If this is used it locks cement and what is far worse blocks the tops of the joints and prevents full depth penetration. At this point the reason for this insistence on full depth penetration of the first application may be considered. If the first grout applied does not penetrate to the bottoms of the joints no number of subsequent applications will remedy the fault for the first application seals the joints at the level to which the grout settles.

Generally two applications of grout are assumed to complete the filling. These may or may not be enough. The grout should be applied as many times as are necessary to fill the joints completely; often three and sometimes four applications are necessary. The first application is made by pouring and brooming ahead with heavy rattan street brooms. A common procedure is to carry the first application over an area of pavement about 50 ft. long the full width of the street, and then return and apply the second coat and so on. All but the first application are worked into the joints with rubber squeegees. The squeegees have two functions. One is to leave the pavement surface smooth and the other is to work all air bubbles out of the grout. It is a good plan to go over the pavement twice, once roughly to elimiate bubbles and once to finish the application. In the finishing operation the squeegee should be pulled rather than pushed to avoid tracking and the motion of the squeegee should be at an angle of 45° with the joints so that the rubber lip will not "dig out" the joint filling. The final process in grouting is, after the grout has set, to cover the pavement with about 1 in. of fine sand and to keep this covering moist while the grout is hardening, which will be about ten days.

VOLUMES REQUIRED IN GROUTING.

The volume of grout filler per square yard of brick pavement depends upon the thickness of the joints and this dimension depends on whether the bricks have lugs, on the character of the lugs, on whether the brick are repressed or not. With theoretical ⅛-in. joints, the volume of joint space per square yard of 2½x8½x4-in. brick pavement is 0.007 cu. yd., and per square yard of 3½x8½x4-in. brick pavement it is 0.0057 cu. yd. The volume of grout required for filling joints exceeds the net volume of joint space since grout is lost by leaking out of the joint, by overflowing the joint and by natural shrinkage. The best guide is records of experience.

A report received from the National Paving Brick Manufacturers' Association after calling attention to variations in joint widths says: "Approximately a barrel of sand and a barrel of cement will grout 25 sq. yds. of brick pavement." Using the same measure the Dunn Wire-Cut-Lug Brick Co. names 35 sq. yds., and the Ohio State Highway Department names 36 sq. yds. H. E. Bilger, Road Engineer, Illinois State Highway Department, reports that one barrel of cement and one barrel of sand will make sufficient grout to cover the following areas:

Type of bed.	Square yards. Repressed	Square yards. Lug.
Sand cushion	32	24
⅝-in. mortar	30	22

More grout it will be noted is required when a mortar bed is used, which demonstrates the fact previously mentioned that on sand cushion rolling crowds the cushion sand up into the joint. These figures also show the great variation in volume of grout required due to the character of the brick. Records kept by U. S. Office of Public Roads on 2,055 sq. yds. of pavement, 85 per cent repressed brick and 15 per cent wire-cut-lug brick show 0.005 cu. yd. sand and 0.031 bbl. cement required to grout 1 sq. yd. On six jobs of grout filling, 3½x8½x4-in. brick pavement, costs of which are given in the succeeding section, the volumes of cement for 1 cement and 1 sand grout were as follows:

Sq. yds.	Bbls. cement.	Bbls. per sq. yd.
462.5	12.5	0.0270
535.5	15.0	0.0280
534.3	15.0	0.0280
621.4	17.5	0.0281
430	11.75	0.0273
1,004.4	27.75	0.0276

All of the preceding data are of course rather inconclusive but the conditions do not permit of conclusive statements. Generally speaking, a barrel of cement and a barrel of sand, this being the unit of measure commonly employed in estimating, will grout from 25 to 35 sq. yds. of brick paving on sand cushion, the first figures being for lug brick and the second for repressed brick of standard 3½x8½x4-in. size.

COSTS OF PAVEMENT GROUTING.

No precise statement of the cost of grouting brick pavement is possible. The volume of materials required not only differ widely as upon organization and management than upon just explained but labor costs depend more the wage rate. Records of actual grouting costs have been secured as follows:

Labor costs for grouting on Illinois brick roads range per square yard from 1.6 cts. to 3.9 cts. As a fair average figure for estimating purposes it is found that, with labor at 25 cts. per hour and no overhead allowed, 2½ cts. per square yard is satisfactory. A report from the National Paving Brick Manufacturers' Association says: "Cost of grouting ranges all the way from 8 cts. to 13 cts. per square yard. Often a range of 33 per cent is observed due entirely to efficiency of managing the work." We imagine that these figures are contract prices instead of costs. A report from the U. S. Office of Public Roads, already quoted from in the preceding section, says: "In 1913 a very accurate record of the amount of materials used in and the cost of grouting 2,055 sq. yds. of brick pavement was obtained. It was found that it required 0.005 cu. yd. of sand and 0.031 bbl. of cement per square yard of pavement; and that it cost 2.96 cts. per square yard to grout the pavement, with labor per day of 8 hours at $1.60 and foreman $4.50 per day. The grout was hand mixed in a box. Eighty-five per cent of the total area grouted was composed of brick of the repressed type, and 15 per cent of the wire-cut-lug type. This cost is probably somewhat higher than the cost to contractors because the work was done extra well and over a comparatively short section. We believe that 2½ cents per square yard would be about correct for ordinary commercial work."

The cost of 1-1 grout filling for 58,000 sq. yds. of brick pavement at Centerville, Iowa, as reported by M. A. Hall, city engineer, was as follows:

Item.	Cts. per sq. yd.
Screening sand at 20 cts. per hour	0.05
Dry mixers at 22½ cts. per hour	0.15
Wet mixers at 20 cts. per hour	0.20
Rubbers at 20 cts. per hour	0.43
Wheelers at 20 cts. per hour	0.13
Other men at 20 cts. per hour	0.03
Water boy at 10 cts. per hour	0.04
Foreman at 40 cts. per hour	0.14
Total labor	1.17

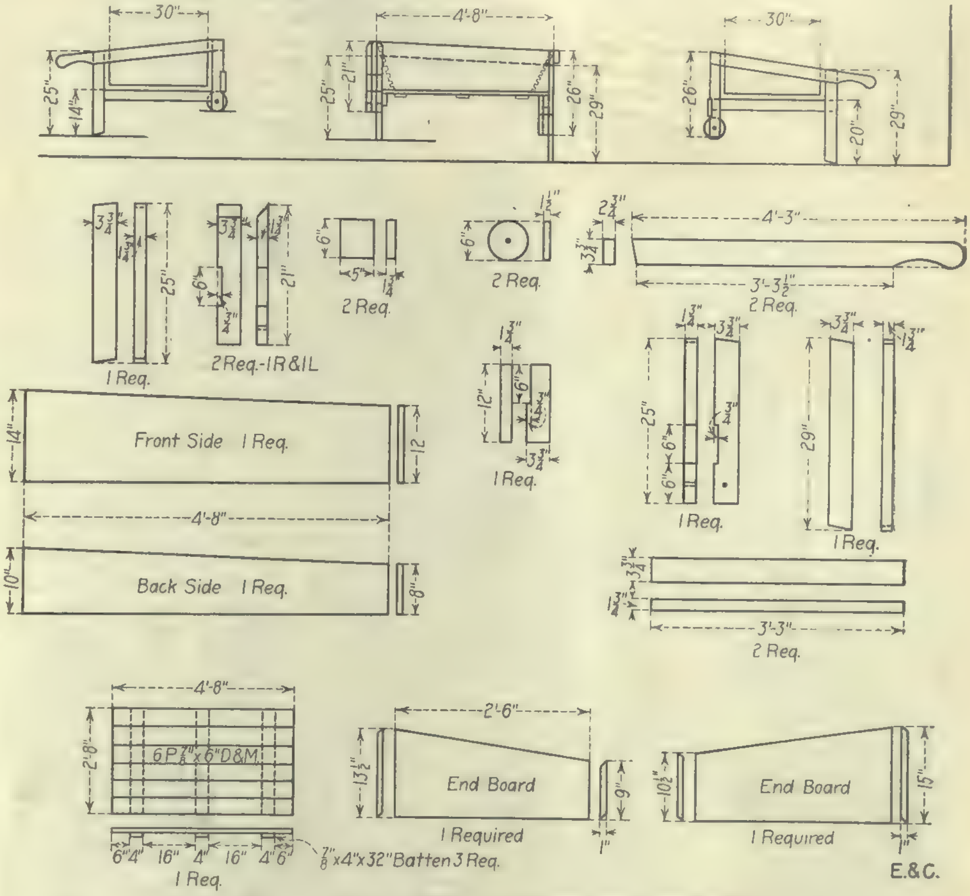


Fig. 1. Grout Mixing Box for Brick Paving.

0.017 bbl. cement at $2	3.40
0.034 ton sand at $1.05	0.35
Total materials	3.75
Grand total	4.92

On 26,500 sq. yds. of this pavement the labor cost of grouting joints is reported to have been only 0.9 ct. per square yard. The costs of 1-1 *grout filling* and *sand covering* for six sections of the Byberry and Bensalem service test road built by the Philadelphia department of public works are reported as follows:

Section 4.	Cts. per sq. yd.
Cement at $1.30	3.51
Sand at $1.885	3.67
Labor	3.49
Total	10.67

Section 8.	Cts. per sq. yd.
Cement at $1:30	3.64
Sand at $1.885	3.34
Labor	2.08
Total	9.06

Section 10.	Cts. per sq. yd.
Cement at $1.30	3.65
Sand at $1.885	3.32
Labor	3.50
Total	10.47

Section 13.	Cts. per sq. yd.
Cement at $1.30	3.66
Sand at $1.885	3.31
Labor	1.86
Total	8.83

Section 18.	Cts. per sq. yd.
Cement at $1.71	3.56
Sand at $2.015	4.67
Labor	3.14
Total	11.37

Section 26.	Cts. per sq. yd.
Cement at $1.65	4.56
Sand at $1.82	3.24
Forms at $32 per M	0.32
Labor	3.63
Total	11.75

The volumes, per square yard, of sand used for *grout and covering* on these six sections were as follows:

Area, sq. yds.	Cu. yds. sand.	Sand, cu. yds. per sq. yd.
462.5	9	0.0195
535.5	9.5	0.0177
534.4	9.4	0.0177
621.4	10.9	0.0175
430	7.6	0.0177
1,004.4	17.87	0.0177

The cost at Carlisle, Pa., of 1-1½ grout filler for brick pavement laid in 1913, with wages at $1.60, cement at $1.32 and sand at $1.50, was 6.8 cts. per square yard. The labor cost, 12 to 15 men, of grouting brick pavement laid at Forth Worth, Tex., in 1914, was 1.7 cts. per square yard. The methods were: The grout for the filler was composed of equal parts of cement and sand and enough water to make it flow properly. An average of 0.021 bbl. of cement per square yard was used. Two grout boxes were used when a full gang was working, and where the work was extensive and the weather permitted fast bricklaying, a third box could have been used to advantage. To keep the men around the boxes from standing idle waiting for a batch to be mixed, the cement and sand were mixed dry on the concrete base or on the finished pavement and wheeled to the boxes as fast as needed. This shortened the length of time of mixing in the box and made it about equal to the time it took for the other box to be emptied, thus keeping the whole gang employed. To keep the cement and sand from separating the grout was agitated continuously until the last bit had been dipped out. The first pouring was made thin enough to flow into all cracks and was kept swept ahead by means of steel street brooms. After the first pouring had progressed 25 to 40 ft., depending upon the weather and whether or not the brick were thoroughly dry, one box was turned back to apply the second and final coating. This second pouring was mixed thicker than the first and rubber squeegees were used to fill the joints flush and keep the blocks free from surplus grout. To obtain the ¼-in. joint at the rail it was necessary to fill it flush with the top as with the rest of the pavement and then, before it has set hard, to clean the grout out with pointed stick or trowel. Soon after the second coat of grout was placed the whole surface was covered with about ½ in. of damp sand. On dry, hot days the brick were well sprinkled before pouring the grout, considerable water being used for this purpose.

BUILDINGS

Design, Construction and Detailed Costs of the Sliding Forms for a Reinforced Concrete Grain Storage House.

Contributed by Wm. Wren Hay, Ft. Sam Houston, Texas.

The following data refer to the design, construction and costs of the sliding forms for a large reinforced concrete grain storage house located in Western Canada. The detailed costs of these forms were compiled in the field while the forms were under construction and were checked from the final costs after the concrete was placed and after the accounting had been totaled. The costs are the result of daily observations as to labor and materials in use, these costs being derived in part from the reports turned in by the foremen and in part by personal check of the amount of work completed each day. They were obtained for the purpose of checking the work against the contractor's estimate of cost, and were also used as a guide for the time of completion of the job, as all work was conducted on a rigid schedule to insure against delay in any part of it.

In estimating for such construction it is customary to figure the actual contact surface at so much per square foot, and to figure the flooring over the bins, the yokes, the jacking, and the maintenance of the forms while being lifted, together with their removal, each as a separate item. The cost data given will therefore be grouped in this manner. It is evident that the form surface is a function of the lineal feet of bin walls, and that the number of yokes will vary in a similar manner, although influenced by the contact of the bin arrangement. The flooring will vary as the area of the bins, while the jacking and the maintenance are further influenced by the height of the bins. The item of removal depends largely upon the bin arrangement and the story overhead, from which are hung the blocks used for hoisting.

DESIGN FEATURES OF BINS.

The bins cover an area of 11,850 sq. ft., their width being 74 ft. 4 ins. and their length 158 ft. 4 ins., including a projecting stairway and elevator tower 12 ft. wide by 17 ft. 10 ins. long. The bins proper consist of 50 circular tanks, each 13 ft. in inside diameter, arranged in five rows spaced 15 ft. 6 ins. on centers by ten rows spaced 16 ft. on centers, forming 23 inner bins and 13 leg openings. The exterior walls are run straight through tangent to the circular bins, these forming 26 additional outer bins. The bins are 70 ft. in height, with a nominal capacity of 500,000 bushels. The bin walls are all 6 ins. thick. The contacts of the circular tanks across the structure were widened out, and upon them rest the columns which support the floors of the cupola above. Lengthwise of the bins the tanks are connected by 6-in. contact walls, each 2 ft. long, except where the elevating legs run between the pairs of tanks. This arrangement of bins is that commonly used for houses of this type where there is an additional storage annex.

FORMS.

In general, the forms consisted of segments made up of 2-in. planks, spaced 28 ins. vertically, to which were nailed 1-in. sheathing. The large circular forms were braced by means of ½-in. rods bolted through the upper and lower segments at an inclination of 45°, forming a truss arrangement which effectually prevented distortion. The skeleton forms were placed on the bin-bottom girders, being nested together to form the 6-in. wall space. The yokes were then straddled across the opening. As fast as the floor was laid over the forms the latter were cut through at certain lines to provide slip joints, and were then tied horizontally by timbers bolted across the wall space on each side of the joints, by means of toggles at the cuts in the segments and by rods bolted from one yoke to another across the cut. These joints divided the entire area into eight sections of six tanks each and one section consisting of two tanks and the tower. They were provided for the purpose of enabling each section to be adjusted for levels independent of the others, but the experience on this work did not seem to justify fully the additional expense.

PLANT FOR CONSTRUCTING FORMS AND PROCEDURE.

The plant used in constructing the forms was centered in a large carpenter shop, 48 ft. wide by 72 ft. long, in which were set two combination, gasoline-driven saw rigs, with 24-in. gage industrial tracks for handling the lumber in and out of the shed. The lumber was routed from the trackage, where it was unloaded from the cars into the shops for cutting, and out on the opposite side onto a large, open-air platform, upon which the segments were nailed on templates and the sheeting erected. All of the segments were cut to shape on these saw rigs, and all of the sheathing boards were also cut to length on them. This work was done some time in advance of the actual operation of sheathing, and the segments were also nailed ready for the boards, in advance. The sheeting was actually commenced 20 working days before the forms were needed for concreting. To maintain the necessary schedule, and yet not crowd the carpenters, a curve of parabolic form was drawn through the points representing the first three days' unit progress, this curve terminating in the day specified for the total area to be sheeted. By accounting for the area sheeted during each five-hour period, and plotting the points, a very close account was kept of the progress. As a result the last segments were being covered when the first completed forms were started up to the top of the girders.

DETAILED COSTS OF THE FORMS.

The following data give the unit costs, in the yard, of the forms, as determined from day to day:

Item.	Cost per sq. ft. of contact surface.
Carpenter labor	$0.089
Superintendent	0.013
Bolts, etc., including labor	0.010
Oiling forms, total	0.002
Lumber	0.061
Total	$0.175

The observed rates of labor were as follows:

Item.	Labor force.	Time required.
Cutting segments, 27,500 ft. B. M.	1 carpenter 2 laborers	20 days.
Nailing segments	4 carpenters 3 laborers	10 days.
Sheathing segments, 18,200 sq. ft.	10 carpenters 2 laborers	20 days.

The carpenters were paid 50 cts. per hour and the laborers 30 cts. per hour, working 10 hours per day. There was a total of 5,150 lin. ft. of bin wall, and the staves were 48 ins. in length. The actual contact area was 20,600 sq. ft. Of this amount only 18,200 sq.

ft. were built in the yard, the remainder for the exterior perimeter of the storage house being cut and framed on the floor during erection. In the totals considered later, this contact area of 20,600 sq. ft. is used.

The lumber for the sheathing was a special 1x4-in. tongue-and-groove pine, with the grooved edge beveled slightly for the circular forms. Its cost was $28 per M. The cost of the common lumber varied from $17.50 to $22 per M, depending upon the size. There was a total of about 11 ft. B. M. per square foot of building used in these forms, divided as follows:

	Ft. B. M.
Segments	2.2
Staves	1.1
Flooring	3.3
Miscellaneous, including gallery, staging, timber for joints, etc.	4.4

OILING.

The form surface in contact with the concrete was oiled with two coats of light oil. There was no trouble whatever due to sticking or swelling, as the oil penetrated to a considerable depth and prevented the entrance of water. A paraffin oil, from which the small residue of kerosene remaining after "freezing" had not been removed, was used. This oil cost 22 cts. per gallon in barrel lots. One gallon of oil covered 160 sq. ft., two coats, one man applying it at the rate of from 350 to 400 sq. ft. per hour.

YOKES.

The yokes used on the forms were constructed of timber, the legs being 6x8-in. pieces, 8 ft. long. The jacks, which were of the pump type, were seated on two 6x6-in. pieces, through which ran the 1¼-in. jacking rod. The head piece was a 3x8-in. timber. Double ⅝-in. bolts were run across the top and middle, and the forms were hung from the yokes by means of ½-in. rods through both segments and the jack seat. Each yoke contained about 85 ft. B. M. of lumber and 25 lbs. of bolts and iron, and cost slightly over $5 in place. There were used on this set of forms 244 yokes. In general, there were four yokes to each circular tank. Where the joints occurred a yoke was placed on each side of the joint.

The joints were made by overlapping pieces of 2x6-in. timbers where the face of the form was cut, the opening being covered with a piece of tin. The segments were held together by a toggle joint, consisting of a short section of 1½-in. pipe running through four steel plates bolted to both segments, on each side of the cut. There were 80 of these joints, the cost of each being about $12, of which $4.50 was for materials and $7.50 for labor.

TOTAL COSTS OF FORMWORK.

The following are the final costs as returned for the various items discussed:

		Per sq. ft.
Forms, labor only:		
Carpenter shop and yard	$2,112	or 10½ cts.
Placing, including floor	1,439	or 7 cts.
Materials, incl. iron, etc.	1,470	or 7¼ cts.
Total	$5,021	or 24¾ cts.
Maintenance, leveling, repairing, etc.	$ 667	
Yokes, including setting jacks, bolts, plates, etc.	1,220	
Joints, including timbers, bolts, plates, etc.	960	
Total, no removal	$7,868	
Estimated cost to remove	500	
Total cost of forms	$8,368	

There were 54¼ cu. yds. of concrete per vertical foot of the bins. This concrete was placed at the rate of 10 cu. yds. per hour, in 17½ days of 20 hours each, requiring a vertical movement of 3 ft. 9½ ins. per day. The cost of the jacking gang was about $100 per day, with labor at 30 cts. per hour. The cost of placing and finishing the concrete walls was $1.00 per cubic yard, plus an overhead charge of 30 cts. per cubic yard, or a total of $1.30 per cubic yard. It cost about $10 per ton to place the ⅝-in. rods used for reinforcing and contacts, plus $6.50 per ton for handling in the yard, or a total of $16.50 per ton.

Methods and Equipment Used in Wrecking a 101-ft. Steel Stack.

(Staff Article.)

Figure 1 illustrates the methods and equipment used in wrecking a tall steel stack located on top of a seven-story building in Chicago. The stack had a height of 101 ft. and a diameter of 4 ft. It consisted of twenty-one 4-ft. 9¾-in. sections, the lower five of which were made of ⅜-in. steel plates and the remainder of ¼-in. plates. The stack rested on a cast iron base, supported on a brick pier, the latter extending about 6 ft. above the roof.

The gin-pole used in wrecking the stack had a total length of about 89 ft., and consisted of a 12x12-in. x 75-ft. timber spliced to a 14x14-in. x 43-ft. piece, the splice occupying a length of about 29 ft. This gin-pole was erected by means of another pole, placed and braced as shown in Fig. 1, the latter consisting of a 9x9-in. timber, 53 ft. long. In erecting these gin-poles a hand-power winch, mounted on a platform, was used.

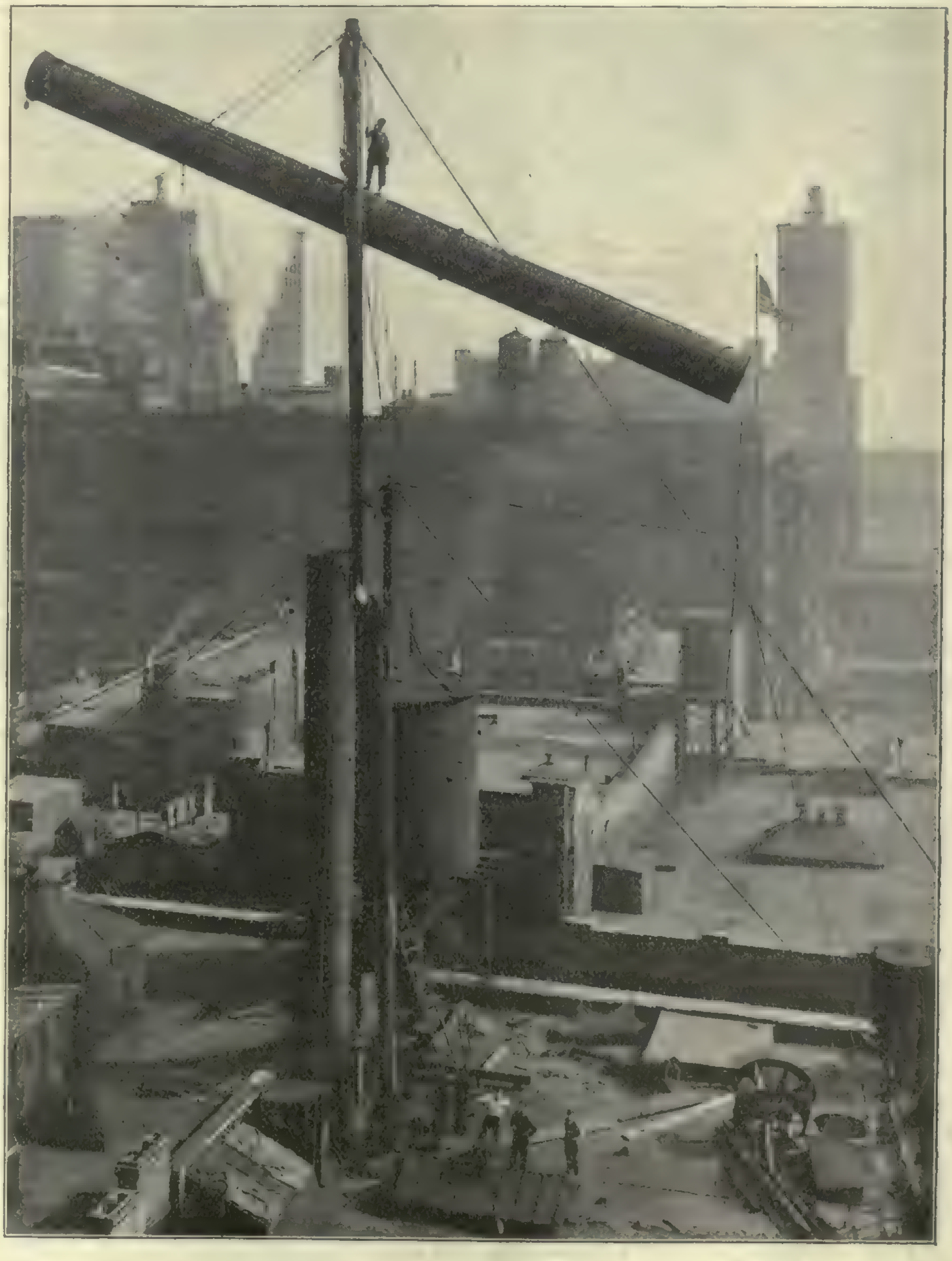


Fig. 1. View Illustrating Methods and Equipment Used in Wrecking a 101-ft. Steel Stack Located on Top of a Seven-Story Building in Chicago.

The flat-top roof, which was comparatively free from obstruction, offered a convenient working platform. The guy lines for the gin-poles were attached to adjacent buildings, this part of the work being difficult and slow.

As shown in Fig 1, the stack was lowered to the roof in two parts, the upper section having a length of about 63 ft., and the lower one a length of about 38 ft. After the upper section had been lowered to the roof it was cut into three sections, to facilitate lowering it to the ground. These sections were rolled to one side, and the lower section then taken down. In lowering this section a block and tackle was attached at about the mid-point of the long gin-pole, and the section then lowered to the roof, with the aid of the winch. It was then cut into two pieces by removing the rivets at a joint.

The long gin-pole was then dismantled and lowered, by means of the shorter one, in the following manner: First the splice in the former was loosened and the upper timber lowered until its base rested on the roof. It was left, braced, in this position until the splice bands were removed and the lower 14x14-in. timber was lowered. The latter was then lowered to the roof. The erection gin-pole was then moved over to the edge of the building, and, together with the winch, was used to lower the five sections of the stack to the ground.

The wrecking crew consisted of a foreman and four men, the work being done by the Abel Transfer Co., of Chicago.

Results of Some Tests to Determine the Shrinkage and Time Effects in Reinforced Concrete.

(Staff Abstract.)

Investigations and tests have been carried on at the Experimental Engineering Laboratory of the University of Minnesota to determine the shrinkage and time effects in reinforced concrete. In a recent bulletin of this university, Franklin R. McMillan has given the results of these tests and investigations, which show that certain changes take place that are due neither to poor construction nor inadequate design, but rather to the nature of the material itself—its tendency to shrink and yield under load. The following data were abstracted from this bulletin:

LONG TIME TEST OF A 5½x30-IN. x 12-FT. CONCRETE BEAM.

Design and Construction of Beam.—The beam was 5½ ins. deep, 30 ins. wide, and 12 ft. long between supports. It was reinforced with ten uniformly spaced longitudinal rods and with transverse rods spaced 12 ins. on centers. Both sets of rods were ⅝-in. plain round and extended straight through without hooks, the longitudinal rods being placed with their centers 4⅝ ins. below the top of the beam and the transverse rods directly beneath them. The longitudinal rods provided 0.796 per cent reinforcement.

The beam was designed to carry, in addition to its own weight of 2,000 lbs., a total live load of 1,500 lbs. supported at the third points. With the steel ratio of 0.008 and the ratio of the moduli of elasticity of steel and concrete taken at 15, the computed bending moments and stresses were as follows:

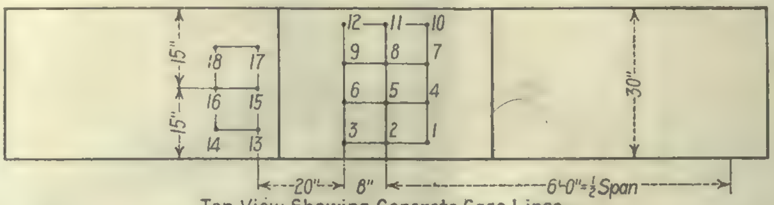
	Bending moment, ft.-lbs.	Steel stress, lbs. per sq. in.	Concrete stress, lbs. per sq. in.
Dead load......	3,000	8,000	335
Live load......	3,000	8,000	335
Total	6,000	16,000	670

The concrete was composed of Minneapolis limestone, an ordinary bank sand known locally as "Bryn Mawr" sand, and a standard grade of Portland cement. It was hand mixed in the proportion of 100 lbs. cement, 2 cu ft. sand, and 4 cu. ft. stone, the sand and stone being measured loose. Transverse and compression specimens for auxiliary tests were taken from each of the two batches required to complete the casting of the beam. From the date of pouring, March 25, 1913, throughout the curing stage and period of test, the slab was exposed to the ordinary room temperature of from 60° to 80° F. The auxiliary compression specimens were cast in the form of 8x16-in. cylinders. At the age of 27 days the concrete cylinders from the first batch showed a compressive strength of 2,540 lbs. per square inch and a modulus of elasticity of 3,770,000; those from the second batch gave corresponding values of 2,430 and 3,160,000. At the age of 353 days the cylinders from the first batch showed a compression strength of 3,580 lbs. per square inch and a modulus of elasticity of 3,780,000; the corresponding values for the second batch were 2,785 and 3,370,000.

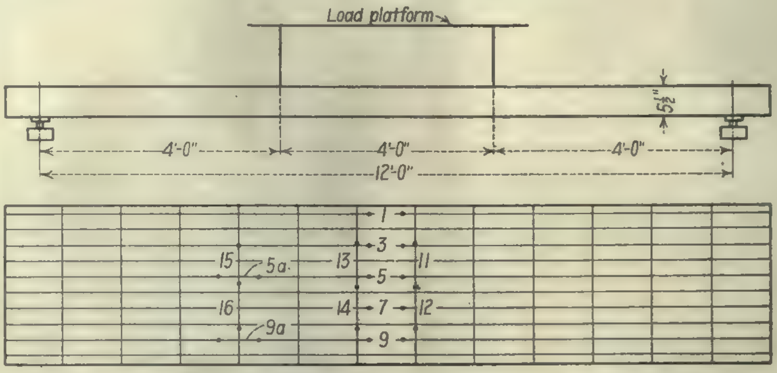
TABLE I.—LOADING SCHEDULE FOR BEAM TEST.

Date, 1913.	Age, days.	Load change.
May 5	41	Slab lifted from floor to the supports.
June 13	80	First live load of 500 lbs. applied.
June 14	81	Live load removed.
June 16.	83	500 lbs. live load reapplied.
June 17	84	Live load removed.
June 21	88	Live load of 1,500 lbs. applied.
June 30	97	All live load removed.
July 10	107	1,500 lbs. live load reapplied.
July 19	116	All live load removed.
July 19	116	1,500 lbs. live load reapplied. This live load of 1,500 lbs. remained in place without change until Apr. 20, 1914.
1914.	Months.	
April 20	13	1,500 lbs. live load removed and reapplied.
April 23	13	1,500 lbs. live load removed and reapplied.
April 27	13	1,500 lbs. live load removed and reapplied.
April 30	13	1,500 lbs. live load removed and reapplied.
May 4	13	1,500 lbs. live load removed and reapplied.
May 8	13½	1,500 lbs. live load removed and reapplied.
May 8	13½	Live load increased to 2,500 lbs.
May 8	13½	All live load removed.
May 8	13½	Live load of 2,500 lbs. reapplied.
May 8	13½	Live load reduced to 1,500 lbs.
July 24	16	All live load removed.
July 28	16	Live load of 1,500 lbs. reapplied.
Sept. 19	18	1,500 lbs. live load removed and reapplied.
Dec. 5	20	1,500 lbs. live load removed and reapplied.
1915.		
Jan. 4	21	Load still in place. Date of last readings shown.

Loading and Gage Lines.—The load was applied at the third points, the ends of the beam resting on 1-in. round rods. The arrangement of the gage lines is shown in Fig. 1, the lines on the top of the beam being so placed that both longitudinal and transverse measurement could be taken. The gage points on the under side of the beam were drilled into the reinforcing rods. The readings were taken by means of the ordinary laboratory type of "Berry" strain gage, reading over 8-in. gage lengths.



Top View Showing Concrete Gage Lines.



Note: All gage lines 8 ins.; longitudinal rods 4⅝ ins. and transverse rods 5 ins. below top of beam.

Bottom View Showing Steel Gage Lines

Fig. 1. Gage Lines and Reinforcement in 5½x30-in. x 12-ft. Test Beam.

Loading Schedule.—The loading schedule is given in Table I, the slab being cast March 25, 1913.

RESULTS OF TESTS.

The important observed data of the test are completely presented in Figs. 2 and 3, which represent respectively the results of deformation and deflection measurements. The striking feature of both of these sets of measurements is the magnitude of the change which takes place with time. To show more clearly the relative magnitude of the time changes the curves in Figs. 4 and 5 were prepared, in which the total deformation is separated into its three elements: elastic deformation, the time effect and the shrinkage. The discussion of the experimental data will be presented under these headings.

In explanation of the three elements, the following brief discussion of the phenomena of the test is given: When the beam was first lifted to position on the supports, observations made before and after this change showed that a longitudinal compression and a slight transverse extension took place. These deformations are referred to as the dead load effects. During the following 47 days as the beam stood without further load (except for the small live loads applied near the end of this period) it was found that the longitudinal compression increased, and that the transverse measurements likewise showed a compression. Following the application of the live load the same behavior was observed, with the shortening in both directions continuing with more or less regularity. The transverse change seems to be due to the shrinkage of the concrete, and hence an equal amount of the longitudinal compression can be accounted for in this same way. That part of the total deformation not accounted for by the direct load effects or shrinkage is due to a gradual yielding of the material under stress, a phenomenon that is observed in ordinary compression tests of concrete. Thus we have the three elements of the total deformation: First, the deformations produced by the dead and live loads or what we might call elastic deformations; second, the shrinkage due to the drying out during, or following, the setting period; and third, the gradual yielding of the concrete under load which is here referred to as time effect.

Elastic Deformation.—The consideration of this subject is somewhat complicated by the shrinkage and time effect. For, due to the former, the beam was in an unknown condition of stress when the deformation measurements were begun, and the effect of the time change in relieving or intensifying this stress condition is still further complicated by additional shrinkage effects. Thus when a load is removed the beam is not free to return to an unstressed state, or even to the state of normal dead load stress.

It will be observed on the curves of Fig. 2 that the deformations produced by the release and reapplication of the load at the various times are relatively a small part of the total deformations. Bearing in mind the statements of the preceding paragraph we may refer to these load effects as elastic deformations. It is recognized that in deforming a material like concrete the response to the load will be less sudden than in a material like steel. However, the results of this test seem to indicate that any change in deformation that takes place after the first few hours is more in the nature of a permanent set.

In Table II the live load changes have been summarized without distinguishing between the different observers or different periods of the test, except that load changes after the extra 1,000 lbs. were used have been kept separate under reference numbers 9 and 10.

TABLE II.—AVERAGE DEFORMATIONS FOR LOAD CHANGES AND POSITION OF THE NEUTRAL SURFACE.

Reference No.	Load change.	Number of observations included in average.	Longitudinal deformations in concrete and steel* At the center Concrete.	Steel.	Value of k.	At the quarter point Concrete.	Steel.	Value of k.
1	500 to zero	[illegible]	+ 225	— 180	.56	+150	—150	.50
2	Zero to 500	1	— 160	+ 200	.44	—120	+160	.43
3	500 to 1,500	1	— 600	+ 680	.47	—460	+620	.43
4	1,500 to zero	8	+ 680	— 644	.51	+541	—546	.50
5	Zero to 1,500	7	— 646	+ 678	.49	—487	+557	.47
6	1,500 to 2,500	1	— 518	+ 552	.48	—420	+490	.46
7	2,500 to zero	1	+1,188	—1,156	.51	+926	—970	.49
8	Zero to 2,500	1	—1,188	+1,152	.51	—926	+920	.50
9	1,500 to zero	2	+ 806	— 754	.52	+620	—640	.49
10	Zero to 1,500	2	— 772	+ 768	.50	—610	+635	.49
	Average				.50	...	...	.48

*Deformations are given in millionths of an inch per 8-in. gage line.
Minus sign indicates compression, the plus sign tension.
The proportional depth to the neutral surface in terms of the depth from the top surface of the concrete to the lower surface of the longitudinal steel is represented by k. Expressed in terms of the depth to the center line of the longitudinal steel, the values of k would be 4 per cent greater than the values shown.

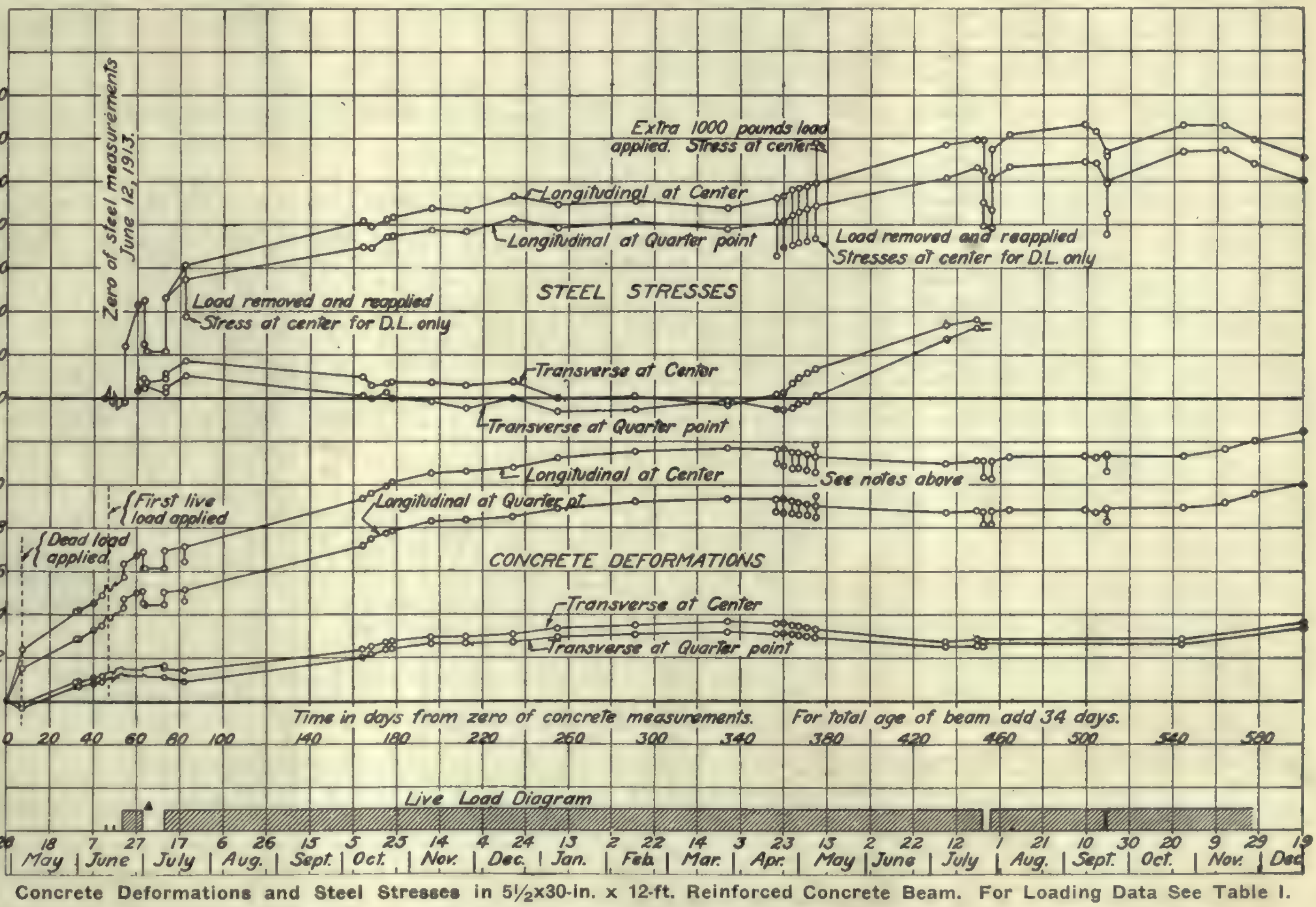


Fig. 2. Concrete Deformations and Steel Stresses in 5½x30-in. x 12-ft. Reinforced Concrete Beam. For Loading Data See Table I.

It was observed that in nearly every instance the concrete deformation resulting from the removal of a load is greater than that resulting from the application of the same load, and that exactly the opposite is true of the steel deformations. If the greater of these two values be taken to represent the elastic deformation we get the following stresses for the center of the beam, these stresses being based on an assumed modulus of elasticity of 30,000,000 for the steel and 3,500,000 for the concrete:

Reference No.	Load change.	Deformations.* Concrete.	Steel.	Stresses, lbs. per sq. in. Concrete.	Steel.
4 and 5	1,500 lbs.	680	678	297	2,540
7 and 8	2,500 lbs.	1,188	1,156	520	4,330
9 and 10	1,500 lbs.	806	768	353	2,880

*In millionths of an inch per 8-in. gage line.

By comparison with the stresses assumed in design it will be seen that a close agreement exists in the case of concrete but a large discrepancy in the case of steel. A similar disagreement between measured and calculated steel stresses is usually observed in the first application of a test load to a beam. The two explanations usually offered to account for this disagreement, namely, arch action, and strength of the concrete in tension, can hardly be urged as applicable to the conditions of this test in view of the continued increase in deflection and steel deformation. The increase in steel stress is due either to the opening up of additional tension cracks in the concrete or the breaking down of the bond through the region of maximum moment, either of which would indicate that the steel would not entirely return to the unstressed state with the release of load. The return, however, is probably considerably more than appears, for the reason that measurements taken over an ⅛-in. gage line show only the average deformation for that length and give no hint as to what the real maximum may be at sections where cracks occur. For with 2-in. gage lines, stresses 50 per cent greater than shown by 8-in. measurements have been obtained in some other tests, and the results of bond tests (Bulletin No. 71, University of Illinois) indicate similarly a rapid change in steel stress in a short length of beam. It is in this same way, largely, that the writer accounts for the disagreement between measured and calculated steel stresses in a beam loaded for the first time, giving no weight to the claim of arch action, or to the strength of concrete in tension once cracks have formed. With the application of the extra 1,000 lbs. the deportment of this beam is analogous to that of a beam in which the test load is the first load applied. It will be shown below that the deformation due to the release and reapplication of the 1,500 lbs. and that produced by the extra 1,000 lbs. are approximately in proportion to the loads themselves, and hence the former does not differ widely from what would occur in a beam loaded for the first time. It therefore seems that these movements can be considered as elastic deformations, representing fairly well the full bending effect and thus emphasizing the importance of the large total deformations shown by this test.

From Table II the deformations due to the several applications of the 1,500 lbs. and to the extra 1,000 lbs. are found to be respectively 678 and 552 millionths (reference Nos. 5 and 6); these are in the ratio of 1.23 to 1 which, compared to the load ratio of 1.50 to 1 shows an agreement within 18 per cent. Comparing the deformation due to the 1,500 lbs. after the extra 1,000 lbs. had been applied, the ratio is 768 to 552 or 1.4, a somewhat closer agreement than in the first case.

Time Effect.—As previously explained this term is used to designate the gradual yielding that takes place with time in concrete under load, a change or deformation distinct from that due to the shrinkage of the material in hardening. That such a movement takes place to some extent is generally recognized, but it is doubtful if the possibility of its continuing over such long periods as shown by these tests has been fully considered.

The increase of deformation with time is readily seen in the curves of Fig. 2, but the lower curve of Fig. 4 affords a better opportunity to study this effect. This curve has been prepared by subtracting from the curve of total concrete deformation for the center of the beam, the amounts known to be due to shrinkage, thus leaving a net deformation curve, the ordinates of which represent only the load and time effects. The deformation indicated on this curve as resulting from the dead load is probably somewhat too large for the reason that the zero observations were made several days before the beam was lifted to its position on the supports, it not being recognized at the time that the shrinkage was of such importance. But adding the dead and live load deformations as they appear on this curve it will be seen that they represent only one-third of the deformation at the end of 600 days without including the shrinkage. If this latter be included the immediate load effects represent but one-fourth of the total deformations. In this connection it should be remembered that the concrete was of more than average quality and that the beam did not receive its dead load until six weeks old nor its full live load for another period of six weeks. Also as explained later the shrinkage measurements were not begun until the concrete had cured for 34 days. The importance of this time change in concrete should not be overlooked, for even though the strength of the structure be unimpaired such annoying features as unsightly cracks and the necessity of frequently refitting doors have resulted from excessive sagging. And in certain types of structures the safety might be threatened by these large deformations, as suggested, for instance, in regard to vertically reinforced columns.

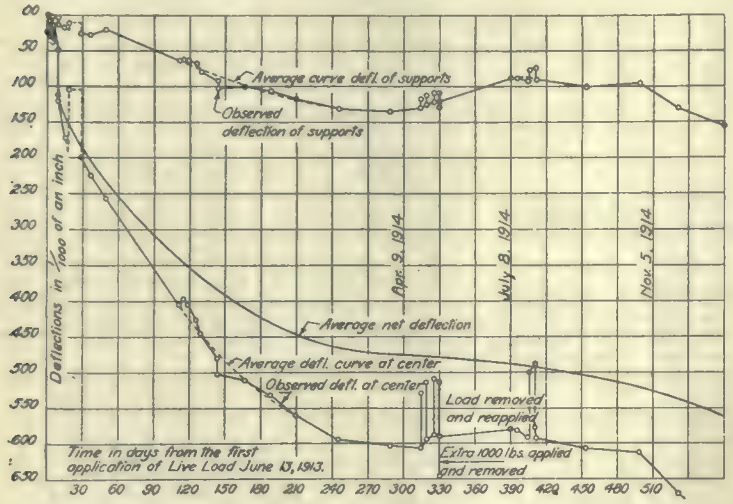


Fig. 3. Deflection Curves for 5½x30-in. x 12-ft. Reinforced Concrete Beam. For Loading Data See Table I.

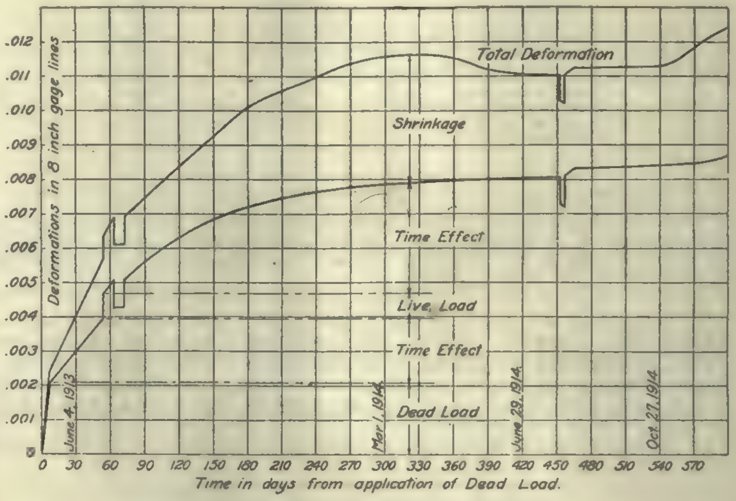


Fig. 4. Separation of Concrete Deformations at Center of 5½x 30-in. x 12-ft. Beam Into Elastic Deformation, Time Effect and Shrinkage.

In Fig. 5 the upper curve represents the time-stress relation in the longitudinal steel and the lower curve the shrinkage in the concrete plotted downward to a scale of equivalent steel stress. This latter represents only that portion of the shrinkage that took place from the time steel stress measurements were begun. It might be inferred that the sum of the ordinates of these two curves represents the steel stress that would have existed had there been no shrinkage. It is impossible to say how nearly this may be true, for while the presence of cracks permits the concrete to shrink in segments instead of as a continuous mass, the considerations of the preceding article indicate that the effect of the uncracked concrete on the average deformation in a gage length may be very great. This is further indicated by the ready response of the steel stress to the swelling of the concrete as shown between the three-hundredth and four-hundredth days on this curve.

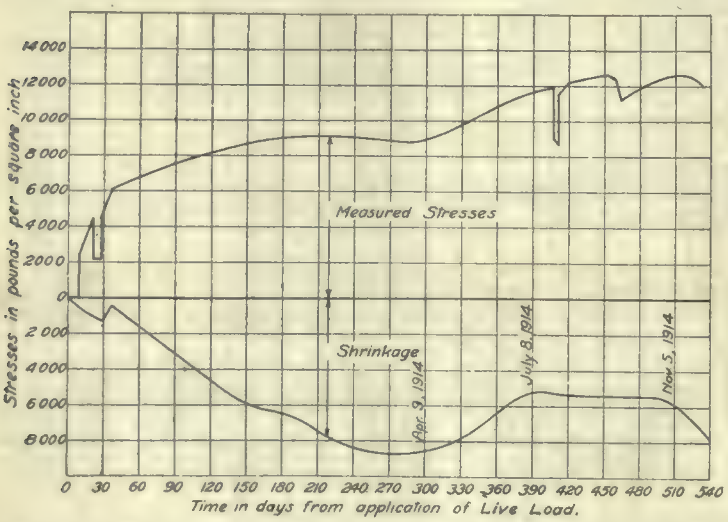


Fig. 5. Upper Curve Shows Time-Stress Relation in Longitudinal Reinforcement at Center of 5½x30-in. x 12-ft. Beam. Lower Curve Shrows Shrinkage in Concrete to Scale of Equivalent Steel Stress.

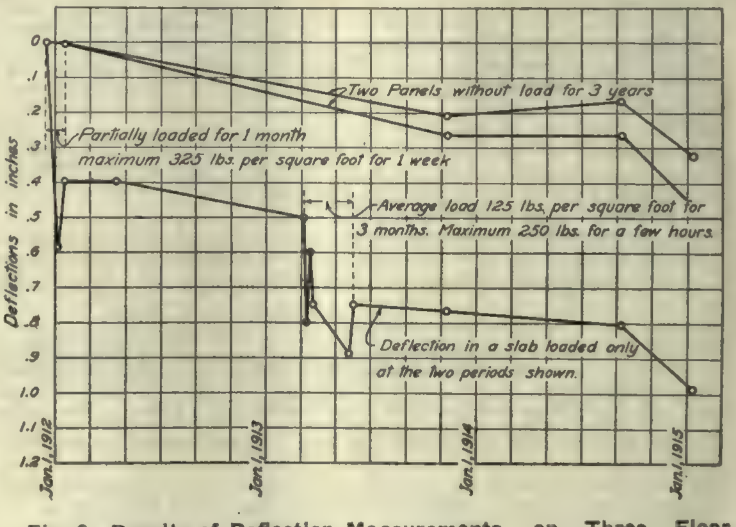


Fig. 6. Results of Deflection Measurements on Three Floor Panels of a Reinforced Concrete Building Extending Over Period of Three Years.

Very little in the way of definite conclusions can be drawn from this time-stress curve of the steel, for the unrecorded shrinkage that took place in the first 34 days of curing combined with the unknown dead load stress presents an unsurmountable difficulty. However, two important items can be noted: First that the live load steel stress in this test, or in other beam or building tests, might easily be overestimated if the dead load were not sufficient to crack the concrete; for with the zero of live load measurements established under the dead load condition of no cracks and the steel under compression due to shrinkage, the certain cracks produced by the application of the live load would throw onto the steel a dead load tension previously carried by the concrete and thus exaggerate the real live load stress. That some such action was present in this beam and could be in many other tests is quite possible. The greatest error from this cause would occur where the dead load was relatively large and the test begun shortly after the removal of the forms. Second, the gradual increase of steel stress with time may be due either to the further yielding of the concrete in tension, thus opening up new cracks and increasing the average deformation over the observed gage length, or to a complete breaking down of the bond through the region of maximum moment and thus equalizing the deformation in this length. For the time change in the steel stress is not of the same nature as that in the concrete, the steel itself being unaffected so long as the yield point is not exceeded.

Shrinkage.—In determining the shrinkage in this beam the deformations obtained from the transverse gage lines at both the center and the quarter points have been used. If allowance be made for the evident error in the first deformations shown, it will be seen that the total deformations given by these two sets agree very closely. It is this total deformation transversely that has been taken as the shrinkage, neglecting the very slight change due to the application of the live load. In the preparation of the lower curve of Fig. 4 the shrinkage determined as just described has been subtracted from the total deformations in the longitudinal gage lines. In the lower curve of Fig. 5 the shrinkage is represented to a scale of equivalent steel stresses but shows only the amount which took place from the time the live load was applied.

From a study of the transverse deformations in the steel and concrete in Fig. 2 it will be noted that in general the latter are much greater than the former, showing the effect of the steel in resisting shrinkage or else the partial failure of the bond. In view of the fact that these transverse rods were short without hooks or bends, and were placed below the longitudinal steel, and further, that the concrete was cracked the entire length of each rod, it is possible that some bond slippage did occur. However, when swelling occurred as through May and June of 1914, as explained later, the unit expansions in steel and concrete agree very well. This is as would be expected, for the steel being under compression from previous shrinkage would respond at once to any expansion in the concrete.

Of the total deformation in Fig. 4 the proportion due to shrinkage is seen to be quite large and this is still more significant when it is remembered that these shrinkage measurements were not begun until the slab was thoroughly cured, from a practical point of view at least. For it was 34 days old when these measurements were begun and the concrete had shown a compressive strength of 2,500 lbs. per square inch in the 27-day cylinder tests.

One significant feature brought out by this test is the ready response of the concrete to changes in the moisture content of the surrounding air, even very slight changes being enough to cause either an actual swelling in the concrete or a noticeable reduction in the rate of shrinkage. This accounts for the singular fluctuations in the curves of Figs. 2, 4 and 5. An inspection of these curves will show that an actual swelling of the concrete (i. e. a negative shrinkage) began about April 1, 1914; this point will be represented by the 340th day in Fig. 4 and about the 295th day in Fig. 5. This swelling continued until midsummer and then after a period of nearly four months in which no change took place the shrinkage began again at a very rapid rate. It will be noticed that the swelling began at the time of the year when the moist spring air is freely admitted and the intensity of artificial heat greatly reduced. Previous to this the drying effect of the air with a vacuum system steam heat in use would be at its worst. During the drier summer months the swelling ceased and the shrinkage became pronounced again with the advent of the steam heat in the fall.

The coincidence of these changes with similar changes in the wooden supports is further evidence that the concrete is very susceptible to moisture changes. In the upper curve of Fig. 3 is shown the rise and fall in the wooden supports during the period of this test. That these were coincident with the swelling and shrinking in the concrete can be seen by adding to the time scale of Fig. 3 the 47 days which elapsed from the beginning of the transverse measurements of Fig. 2 to the beginning of deflection measurements of Fig. 3, or by comparing Fig. 3 directly with the shrinkage curve in Fig. 5 as these are plotted to the same zero of time measurements. Also the rate of change of net deflection during this same period shows the effect of the swelling in the concrete itself.

The sharp rise in all these curves together with the sudden break in the deflection curve of Fig. 3, all occurring at the same time, bring out sharply the effect of the dry heat. Very noticeable illustrations of this same effect have been frequently noted in slabs over boilers or other warm, dry places. In some cases very alarming sags have been observed.

The effect of shrinkage acts in two ways to increase the deflection in beams and slabs: First, the compression fibres must shrink a greater amount than those on the tension side due to the effect of the steel, this inequality resulting in increased deflection; and second, the shrinkage on the tension side operates to increase the number of cracks and thus, by increasing the average deformation, further increase the deflection. These effects decrease with an increase in the depth of the beam, for the angular change would be less as the depth increased. The effect of the shrinkage however is much less than that of the time effect in increasing deflection, because the latter acts on both top and bottom to produce increased deformation.

In buildings of considerable dimensions the shrinkage in the lower floors will result either in a few large cracks or a much larger number of very fine ones, depending upon the type of construction, arrangement of reinforcement, etc. In the upper floors, away from the influence of the foundation, the effect might be to change the plan dimensions of the structure. This again would depend upon the details of the design. The total shrinkage as shown by the results of this beam beginning with the 34th day, is ½ in. in 100 ft., or a total of perhaps twice this amount from the time of casting.

Deflection.—As a means of establishing the similarity between the results of these tests and the condition to be found in existing structures the deflection measurements are most useful, for the continued deflection in many structures is commonly observed. The results of these measurements, shown in Fig. 3, need but little comment. The characteristics of this curve are identical with the deformation curves previously discussed. Especially should be noted the retarding effect of the swelling, previously explained, and the increasing rate of deflection following the application of the extra 1,000-lb. load. Combined with this latter effect is the renewed shrinkage beginning with the period of dry winter conditions. In comparing this curve with the schedule of loading operations in Table I it will be seen that some of the load changes have been omitted; enough, however, have been included to show the relation between the total deflection and the amount from each application of the load. The net average deflection represents the difference between the average total and the average of the supports without indicating the rise and fall with the load changes.

There seems to be no reason to believe that the increased rate of deflection near the end of this curve will continue indefinitely, for it seems to be due largely to the increased rate of shrinkage which should cease as the drying out ceases. However there is the possibility that this changing rate will continue from season to season, each subsequent swelling being followed by a period of increasing deflection, the total steadily increasing with time. How long this may continue is of course a matter of pure speculation.

Position of Neutral Axis.—In the discussion of elastic deformation it has been stated that the deformations indicated by measurements on 8-in. gage lines represent only the average, and that in the case of the steel the maximum may be considerably greater. The variation in the case of the concrete is small, for whether the beam acts as a homogeneous beam or as a reinforced section with no tensile strength in the concrete, calculations show that compressive stresses do not differ greatly. It is therefore evident that the neutral surface rises somewhat at each cracked section and the results of the measurements on 8-in. gage lines show only the average position of this surface. Its mean position for this test is seen from Table II to be about five-tenths the depth from the compression surface to the lower face of the steel.

OTHER TESTS.

In addition to the foregoing test, the following tests were made and recorded by Mr. McMillan: A long-time test of four 4x5-in. x42-in. beams; shrinkage tests under variable conditions of curing; a long time test of a 6x8-ft. two-way reinforced concrete slab; and a test of a 10x10-ft. one-way reinforced concrete slab.

OBSERVATIONS ON BUILDINGS IN SERVICE.

This material is presented to show that the progressive changes discussed in this paper are not confined to laboratory slabs and beams. It will be appreciated that such data as presented in this section are not readily available, owing to the difficulty of knowing all the attending conditions and of securing the data itself or the permission for its use. For this reason only a few items are included. These have been taken from the most available source and by no means represent the most pronounced evidence of time changes that are to be found.

In Fig. 6 are given the results of some deflection measurements extending over a period of three years on three floor panels in a well constructed reinforced concrete building. Two of these panels are so situated as to have received practically no load in the three years, eight months since casting. The third panel has been only partially loaded, as is shown on the drawing. This floor system was designed for a live load of 300 lbs. per square foot and was eight months old when the measurements here shown were begun. These results are presented because they show, without being complicated by any over-loading, the remarkable effect of these time changes in a building constructed according to accepted practice.

In another building a crack opened up on the under side of a reinforced concrete slab that has been only partially loaded during the several years it has been in use. This crack has developed, at least as far as could be determined with the unaided eye, within the past 2½ years, as have others in the same panel, all near the center of the span extending across the main reinforcement. Another crack is noted here only because it brings out sharply the effect of continued sagging. This crack, which is about 0.15 in. wide, extends lengthwise over a partition wall, in the story below, that was not intended as a bearing wall and not built until after the forms had been removed from under the slab. The progressive sagging in the panel has been sufficient to bring it to a firm bearing on the partition with the result that this crack has opened up all along the top of the slab. Of course no reinforcement had been provided for a negative bending at this place and hence this large crack.

SUMMARY OF RESULTS OF TESTS.

These tests are of sufficient extent to warrant certain statements and conclusions which should be given consideration by those responsible for reinforced concrete design and construction. These conclusions should be prefaced with the statement that while they will prove applicable to a wide range of conditions and structures, it is recognized that by a careful study of mixtures and materials it may be possible to produce a concrete largely free from the defects upon which these conclusions are based.

Shrinkage.—With materials and mixtures as used in these tests it is safe to predict a shrinkage of from ¾ to 1 in. or more in 100 ft. when exposed to the ordinary dry air of a heated building. It cannot be definitely stated when shrinkage will cease under these conditions, but certainly not within a year. However from one-half to two-thirds of the amount indicated may be expected within 40 to 60 days after exposure to dry air. The effect of thorough wetting in the early curing stage seems to have no effect in reducing the total shrinkage, the only effect being to retard the beginning of the action, this in spite of the fact that the strength of the concrete is materially increased by this treatment.

Slight changes in the moisture content in the air will retard the shrinkage or even cause a swelling which seems to warrant the belief that structures open to the elements would never show the same total shrinkage as found in these tests.

The continued shrinkage in beams and slabs acts to produce an increasing deflection though not to the same extent as the time yielding discussed in the next paragraph.

Time Effect.—The yielding of the concrete under compressive stress with time, a phenomenon similar to the yielding of ductile metals when stressed beyond the yield point, is greater as the unit stress is greater and seems to go on indefinitely. In these tests the deformation due to yielding was found to be from three to five times that produced immediately upon the application of the load. On the tension side of a beam or slab the effect of time is to cause a gradual increase in the steel stress from the breaking down of the concrete in tension or the failure of the bond. The combination of the extension at the bottom and a shortening at the top produces in beams and slabs a continually increasing deflection. With the same unit changes top and bottom, the deflection is less the deeper the beam.

Possible Results.—A few of the possible results that may be looked for where these time changes are in progress are suggested here. The production of cracks in floors, ceilings, and partitions even though in no sense indicating a structural weakness is an undesirable feature. And in certain places, with some types of structures or details, cracks might leave the reinforcement accessible to moisture and thus prove a source of danger. Sagging of the structural frame work may cause the binding of doors in partitions, a feature that is both expensive and annoying. The tilting of columns by the unequal shrinkage in different floors might be a source of high bending moments and column stresses. But of far more importance than these may be mentioned the two following possible effects, both of which might in certain instances be of serious consequence:

(1) The continued yielding in the upper fibres of a beam, coupled with the gradual breaking down of the concrete in tension may result in a progressive destruction of the bond from center toward the supports, similar to that occurring with the progressive loading of a beam as shown by D. A. Abrams in Bulletin No. 71, University of Illinois. Also the drying out incident to the large shrinkage movement may assist in this destruction of the bond.

(2) The possibility of high stresses in the longitudinal steel of compression members seems to be the most important conclusion to be drawn from these tests. The time yielding of the concrete under stress combined with the excessive shortening due to shrinkage may result in deformations from five to fifteen times those expected from the ordinary calculations. In columns of the ordinary ratio of vertical steel in which no allowance has been made for the spirals the resulting steel stress is probably well within the elastic limit, but in those columns designed on the assumption of large loads being carried by the hooping the steel stresses may approach dangerously near the yield point.

The Restoration of Old Buildings.

(Staff Abstract.)

The following data on the restoration of old buildings were abstracted from a paper by W. A. Forsyth, presented before the Institution of Municipal and County Engineers, England:

All repairs or replacements should be distinctive, yet harmonious, for they form part of the story in stones. If the truth of the story is veiled by attempts at imitative reproduction the values of the building are lost.

PRECAUTIONS.

It is important that such structural works as underpinning be not too hurriedly decided upon and carried out. Ample test and observation must be made, for it is known that many a building was safer before than after that operation.

Materials used in repairs should, as far as possible, be new, and local traditional custom should influence their choice and method of building. The use of old materials from other buildings is misleading, and tends to create an undesirable market in such commodities. All old materials, however, such as glass, metal, etc., must be carefully collected and stored.

The tendency to over-repair should carefully be avoided: anticipated defects must not be considered, as a great deal of wanton injury will thereby be perpetrated.

Above all it must be remembered that repairs cannot be hastened; slow-setting materials are invariably those of greater lasting quality.

Any additions that may become necessary should be designed in a different manner from the old buildings to which they are to be attached. They need not be unsightly, although possessing a modern character, so that no mystery need be cast upon the structural story of the fabric.

GROUTING.

Repairs are chiefly required for old walls more than any other features. These have invariably become defective from their faulty bonding, from roof thrusts, or from weak foundations. The solidifying of the walls is usually necessary before such operations as underpinning, the insertion of damp courses, the provision of tie rods, etc., can be commenced.

No greater advance has been made in the repairing processes in recent years than in that of grouting. Many a condemned building has been saved and many a weak structure made sound by this means, and more particularly when used under pressure.

The injurious effects of vibrations upon ancient buildings, especially those having rubble-built walls, due to fast and heavy modern traffic, is a matter of grave importance.

It frequently happens that a fractured rubble wall, a weak footing, an insecure bridge has failed, and can only be repaired by first consolidating the masonry before foundations or other repairs are dealt with. Briefly stated, the method of applying cement grout under pressure is as follows: The operation, like underpinning, must be performed in small sections. All loose, dry mortar and dust is first removed; that which escapes, after being raked from the open joints, is blown out. Great care must be taken not to dislodge the aggregate of the wall—that is, the rubble, the bricks or stones, as the case may be. Large facing stones should be wedged up.

The parts of the wall thus cleared should then be well saturated, also under pressure, after the face joints are blocked up, usually by wet clay. This moistening will slake the inert properties of old lime, and assist the process of solidification. The grout, mixed according to requirements, is then forced by the machine into the wall through a small aperture left for the purpose. The clay joints should be watched, in case the grout escapes prematurely; experience will determine when the particular section is fully grouted.

It is usual to use mortar of one part of cement to one part of sharp, but not too coarse, sand. Frequently neat cement is injected into the fissures. The effect of these injections is to solidify the wall, leaving it in a state reasonably safe for the underpinning, the cutting out of cracks, and bonding in strong material, or other operations.

The clay sealing of the joints is removed after ordinary setting has begun to take place, when it will usually be found that the grout has fully penetrated the wall or structure under treatment. It is then desirable to point the more open joints of the external face to exclude weather. It is not necessary, however, to point internal joints, but to leave them open in order to show that the old materials have been grouted. Grouting by hand has its limitations, and is dependent upon gravitation. Under mechanical pressure the liquid rises to considerable heights and travels surprising distances.

There are occasions—usually in thick walls—when hydraulic blue lias lime mortar would be adequate as a grouting medium. Expansions and, in many stones, an unpleasant discoloration are then avoided.

Lime grout is very desirable where walls have not fractured but have hollow places. Lime mortar built walls have endured a sufficient time for all ordinary purposes. There are many limes which harden to a very great degree. "Smeaton" used Leicestershire limes in the erection of lighthouses. One of the Derbyshire limeworks has been working continuously for seven hundred years.

A great advantage of this method of repair is that the two faces of a wall are maintained during repairs.

Winchester cathedral has been saved by grouting. Sir Francis Fox has also grouted and saved historic bridges condemned by county authorities; he has so treated the walls of a large institution when the entire rebuilding was threatening the trustees, whose finances could not bear the strain; he has grouted the walls of an early eighteenth-century London building upon which a dangerous-structure notice had been served by a watchful district surveyor, who, after testing the repaired house, accepted the process for the more customary one of demolition.

Many a condemned external or party wall is pulled down when grouting and bonding in of new work would have rendered the structure safe.

MASONRY.

The superficial decay of stonework is largely due to atmospheric causes, which are usually more aggressive in the neighborhood of large towns.

No moulded or carved feature should be on any account reproduced either in stone or any other material. The Society for the Protection of Ancient Buildings has always recommended that badly decayed ashlaring be rebuilt in roofing tiles laid horizontally and rendered in mortar.

The same methods are applicable to brick walls, and it has the great advantage of ensuring the pinning up of the new material where such is not always possible with the insertion of large stones or bricks.

When a weak wall cannot be grouted, and it is only possible to repair by bonding in new material, it is important that the more interesting face be retained at the expense of the less valuable.

Rubble facing which has become loose should be repaired by re-using the old stones or flints, cleaning and mixing them with lias lime mortar stiffened by a small proportion of cement, and the whole laid in and worked up to a form board, after the manner of concrete building.

In less decayed rubble facing the loose members may be reset and pinned in with a roofing tile. This was a mediæval practice.

In the repair of masonry and brickwork reinforced concrete can be structurally used to advantage in footings, floors and lintels. The proportion of steel to concrete must not be unduly large, but sufficient for taking up tensile stresses, and the metal must be well covered by the concrete.

Large Increase in Lake Iron-Ore Shipments.—Shipments of iron ore down the lakes from the Lake Superior region in August amounted to 8,081,117 gross tons, as compared with 5,869,477 tons in August, 1914. The following tables gives the August and season shipments by ports and the corresponding figures for 1914 in gross tons:

	August, 1915.	August, 1914.	To Sept. 1, 1915.	To Sept. 1, 1914.
Escanaba .	938,162	724,951	2,995,862	2,465,692
Marquette .	659,293	368,430	1,773,653	1,049,791
Ashland ...	931,324	662,951	2,801,219	2,079,776
Superior ..	1,375,086	1,886,418	4,439,088	7,576,831
Duluth	2,668,070	1,203,081	9,378,530	4,152,367
Two Harbors	1,514,362	1,023,646	5,418,068	3,953,650
Total	8,081,117	5,869,477	26,806,420	21,278,107
Increase ...	2,211,640	....	5,528,313	....

The increase of 2,211,640 tons for August contrasts with a decrease of 1,814,808 tons in August, 1914, from August, 1913. The Duluth percentage to Sept. 1, 1915, was 34.99, against 19.51 per cent last year, while the Great Northern dock at Superior shipped 14.32 per cent of the total this year, against 33.57 per cent to Sept. 1, 1914.

WATER WORKS

Some Considerations to Be Borne in Mind in Purchasing Water Meters.

(Staff Article.)

Admitting that the only equitable way of selling water is on the meterage basis the selection of the best meter to meet local conditions is still a problem worthy of the best attention of the water works operator. There are meters and meters; some are relatively expensive and others cheap in first cost, some retain their accuracy for years without attention and others are not so dependable. Thus there are many considerations which should govern the selection of meters for a given locality.

The setting the meter is to have is one of the first matters to be considered. Meters are expected to operate, oftentimes, when set outdoors, under a great variety of conditions such as in the air or under water, either with or without attention and lubrication, and surrounded by soils of various sorts, or protected by a meter box. Water ranges from hard to soft, and is sometimes impregnated with minerals, limes, sodas and aquatic vegetation. Sometimes water bearing considerable sediment and sand is to be metered. The pressure of the water, both as to its intensity and fluctuation, is a factor to be considered. In a word, it is doubtful if there is any other mechanism from which so much is expected and to which so little attention is paid as is true in the case of the water meter under the methods in vogue in some water departments. Thus it will be seen that in choosing a meter its future setting and service conditions should be carefully considered, as well as the attention and care it is to receive. The low cost meter under favorable operating conditions will render satisfactory service, but there are conditions calling for the best grade of meter obtainable.

Low first cost is often given too much weight in selecting a meter. It should be remembered that the freight on cheap goods is about the same as on high grade goods, and the cost of installation is about the same in both cases. Cheap goods usually require repairs sooner than do the more expensive supplies and the burden of repairs and renewals falls on the water utility. The labor item is the one to give greatest consideration. If the part broken is a piston, an upshaft or a gear the cost of the repair part is very small, but the cost of all the labor involved, both field and office, in making the repair and again placing the meter in service is a much higher figure. In fact, in such cases, the labor cost of making the repairs is several times greater than the material cost. It will thus be seen that the burden falls on the water utility even though the meter was purchased on a guarantee basis requiring the manufacturer to furnish repair parts free for a certain period following installation.

To illustrate, suppose a meter is sold on a two-year guarantee whereunder the manufacturer agrees to furnish free any repair parts required during the first two years of the meter's service. If a part fails during that period it is "replaced" by the manufacturer; that is, a duplicate part is furnished, but the labor cost of exchanging the old and new parts is borne by the department. How large an item this is may be seen when one stops to consider all the work involved. Department employes must shut off the water, take out the meter, substitute another meter or a piece of pipe after bailing out the setting, and take the old meter to the shops where it is repaired and tested. Considerable bookkeeping and clerical work is required in making out repair and test cards, etc. Thus it comes about that any meter which, for any cause, has to be repaired during the first year or two of its life becomes an expensive meter, regardless of its first cost.

The considerations here enumerated, and others clearly allied thereto, show the importance of choosing a meter with due regard to all the conditions under which it is to operate. First cost is an important item, of course, but we have shown that it is not always the factor of greatest weight.

These observations on meter selection were suggested by reading a paper by A. M. Burgess, Superintendent of Water Works at Galveston, Tex., before the Southwestern Water Works Association.

Methods Employed in Field-Coating Two Pipe Lines—Applying Bitumastic Enamel with Special Machines.

(Staff Abstract.)

How protective coatings were applied in the field to two California pipe lines is here described. The first line to be considered is a 4-in. high pressure gas line, 5 miles in length, laid by the Pacific Gas and Electric Co. The joints were welded by the oxy-acetylene process. The soil traversed is a heavy black adobe with peculiar characteristics. During the wet season adobe is a mass of black, sticky paste, while in summer and fall, as it drys out, it shrinks and cracks and sets as hard as concrete. The pipe was tarred and covered with felt burlap and pitch as described by W. M. Henderson in a recent issue of The Gas Record. Common laborers on this job were paid $2.50 per day.

Adobe soil, as a rule, is sour and will give an acid test. To protect the pipe line from the action of this soil it was decided to wrap the line with a tarred burlap and felt paper. The paper selected for this purpose was prepared ready roofing made up of burlap, asphalt and felt. This was bought in rolls cut in 80-ft. lengths and 16-in. widths or about 2½ ins. greater than the circumference of the pipe.

A heavy pitch was selected for painting the pipe and covering in order to hold it together. This pitch at atmospheric temperature is hard and so when applied it was necessary to heat it to about 150° F.

When the welder had finished a section of pipe, the pipe covering gang of three men came along. The 80-ft. strips of covering were cut to 20-ft. lengths. These were laid on the ground as a carpet in strips paralleling the pipe line. One man applied the hot pitch to the pipe, while another did the same to the upper surface of the covering. The covering was then applied to the pipe and a wrap was made lengthwise. This, when smoothed down promptly, sticks to the pipe. To insure perfect tightness, No. 18 soft iron wire was bound spirally about the covering. The whole outer surface of the covering was then given a final coat of hot pitch. When cool, this presents a hard, waterproof surface that cannot be penetrated.

The high temperature at which the hot pitch is applied prohibits the use of brushes and so mops were made by wrapping a skein of cotton mop yarn on one end of an extra heavy hoe handle. Each morning the old mop is cut away and a fresh skein of yarn applied. This pipe covering cost as follows:

	Per ft.
P. & B. ready roofing, 16-in. width	$0.0256
Wire mops, fuel for furnace, etc.	.0018
Pitch, "S" floatine	.0068
Labor	.0102
Total coating cost	$0.0444

APPLYING BITUMASTIC ENAMEL WITH MACHINES.

The other pipe line to be considered is the 170-mile, oil pipe line recently laid by the Valley Pipe Line Co. It is described by H. W. Crozier in a recent issue of the Journal of Electricity, Power and Gas. Two-thirds of the line was laid with 8-in. steel pipe and the remainder with 10-in. pipe. The pipe was furnished by the Youngstown Sheet & Tube Co. of Youngstown, Ohio. Wrought iron couplings were used. It is interesting to note, in passing, that a gasoline motor-driven screwing machine was used for screwing the whole of the pipe. So far as known, this is the first pipe line where all the pipe was screwed by machine, and the second where a machine was used at all. The principal feature of the pipe screwing machine is a steel gear with set of pipe tongs attached, the gear being mounted upon the end of a tubular frame which surrounds the pipe being screwed, and also supports a 4-cylinder 40-HP. automobile-type power plant. The screwing machine has traction rollers for moving it along the pipe and a pair of gear driven legs or spuds for raising and lowering, as well as tongs for holding firmly to the completed line and the necessary clutches, gears and control levers for its operation. It is believed that the work done on this line conclusively proves that pipe can be perfectly screwed by machine if properly supervised and that work can be done much more economically and promptly than if done by hand.

Machine for Applying Coating.—The matter of covering for protecting main oil pipe line from the corrosive action of the soils through which it passes was gone into thoroughly and due consideration given to a number of different kinds of protective covering which were offered. The method which has been used to the greatest extent in California consists of wrapping the pipe with either a roofing paper or a saturated roofing felt after a hot application of asphalt has been made and securing the whole with wire to assist in holding the wrapping. Asphalt coating has also been used, as well as crude oil treatment consisting in pouring crude oil into the trench after the pipe is laid and mixing it with sandy material around the pipe.

Bitumastic Enamel has been applied to about 10 miles of the Producers Transportation Co.'s pipe line near Buttonwillow in the marshy bottom lands near the San Joaquin River with very satisfactory results.

The results of a careful investigation and consideration given the various materials resulted in the decision to use Bitumastic Enamel. The excellent condition after five years' service of the 10-mile section of the Producers' pipe line, the decision of the United States Government to use this material on the Panama Canal gates after considering several hundred competitive materials, its use in the navy and merchant marine, and the further considerable reason that its cost would be no more and probably slightly less than the method so extensively used in California, namely, that of the saturated roofing paper and asphalt, were some of the considerations leading to this decision. The excellent condition and appearance of the finished work lead to the conclusion that this decision was eminently wise.

A contract was entered into with the firm of Hill, Hubbell & Co. of San Francisco, who undertook to take charge of the pipe after it was screwed to apply the Bitumastic Enamel, lower the pipe in the trench and do the backfilling work.

As this was a job of considerable magnitude the contractor developed machines for the purpose of applying the protecting covering, which consists of two coats, the first a coat of liquid primer and the second a coat of Bitumastic Enamel, the Enamel being solid at ordinary temperatures.

The machine for applying the priming coat travels on wheels resting on the pipe and has a rotating brush and scraper on the front end for removing dirt and mill scale, and on the back end a large wheel supporting, on moving spindles, the rotating brushes for applying the priming material. This is a most necessary arrangement, as by centrifugal action the priming material is forced to the outer edges of the brushes. The machinery and supporting fly-wheels are driven by a 6-HP. gas engine. There are three tanks, one for Bitumastic Solution and the other two for water and fuel for the engine.

Two men are required to operate this machine and in addition three men operate a long lever mounted on wheels with which pipe is raised slightly as required. The pipe when completed by the pipe screwing machine is left on 4x6-in. wooden skids which rest across the trench, and as the priming machine moves along it is necessary that the pipe be raised and the skids taken around the machine and replaced, and by means of this long lever on wheels the pipe is raised slightly with hose covered chain sling, the skid removed, placed behind the machine, the pipe lowered again and the machine then proceeds.

The priming coat sets quickly, usually within two hours if the weather is good, but, in any event, within four hours. A second machine, quite similar to the first, follows, and places upon the pipe the Bitumastic Enamel coating, approximately ⅛ in. in thickness. The enameling machine is operated by hand simply by turning a crank, which causes it to move along the pipe and it is served with melted enamel supplied from large kettles mounted on wheels, petroleum distillate being used as fuel. The enamel coating after being placed is touched up where required and the company's inspector follows behind and gives it a thorough examination, using a mirror for the purpose of inspecting the lower portion of the pipe.

Cost and Other Data on the Reconstruction of the Hamilton, Ontario, Water Works.

(Staff Abstract)

Complete reconstruction of the Hamilton, Ontario, water works was found necessary in 1912. The original system was installed in 1859 and had been gradually extended until 1912 when the rapid growth of the city necessitated reconstruction. At the latter date there were four steam pumps in operation having an aggregate daily pumping capacity of 13,500,000 imp. gals. There were three mains to the city of 18, 20 and 30 ins. diameter, respectively. Two of these pumps and the 18-in. force main were installed in 1859 as a part of the original works. These pumps are of the vertical walking beam plunger type and are now something of a curiosity. They are still in commission for emergency use in the event of interruption to the electrically driven turbine pumps installed during the reconstruction to supplement the pumpage of the other two steam pumps.

OLD AND NEW INTAKES.

Hamilton lies at the westerly end of Lake Ontario where at its extreme end a sand ridge cuts off the lake from Burlington Bay, on the shores of which the city lies. Owing to its location and this sand ridge, through which a short canal is cut to the lake, combined with the fact that most of the sewage from the city is treated at disposal works before entering the bay, it has never been found necessary to treat the water taken by the intakes from Lake Ontario.

In connection with the original installation two intakes extended into the lake—one of cast iron, 20 ins. in diameter, for a distance of 1,000 ft., and the other a wooden box intake 3 ft. square extending into the lake a distance of 300 ft. Each had its inner end in a settling basin from which wooden conduits lead to the wells at the pumping station. It is interesting to note that one of these wooden conduits placed in 1859 was found to be in first class condition after 55 years' service.

It was decided to construct a new intake, 4 ft. in diameter and 2,100 ft. in length, which would bring it to a depth of 32 ft. of water in the lake. This steel intake pipe, including intake piece, sluice valve and expansion joints, cost $20,520 delivered on the site and was riveted in lengths of approximately 140 ft., on the ends of which were flanged pieces. The price mentioned includes also the lead gaskets and bolts.

The accepted bid for laying this pipe was $35,000, which included the building and placing of the intake crib and a concrete valve chamber and house at the settling basin end. As ice ridges formed out in the lake for a distance of about 1,000 ft., and in some places 30 ft. high, it was necessary to protect the pipe to lay it in a trench on the lake bottom so that when filled in again the pipe was covered. Concrete in bags was placed around the pipe for 300 ft. from the shore line as an added precaution. Four piles were driven in the trench in such a position that when a 140-ft. section was floated into position two piles would be at each end of the section. Across the two piles at each end a sill was bolted at grade and the pipe was lowered to rest upon these sills and was there held in position by wooden blocks on either side. A cap was bolted across the two piles over the pipe after the section had been bolted to the preceding section by the divers. Besides securing proper alignment the object in driving these piles was twofold; first, for ease in joining up two sections clear of the sand, and, second, to offset as much as possible the tendency of divers to fail in bolting up the lower sections of the pipes because of difficulty of access. As there was little possibility of scour on account of the method of construction adopted it was not considered necessary to space the piles closer and the above arrangement has proved quite satisfactory.

In an examination of the plans for intake cribs adopted by the cities on the Great Lakes it was found that the minimum size was 40 ft. square and of sufficient height so that the mouth of the intake facing upwards was at least 7 ft. above the bed of the lake. This minimum size I did not consider necessary, but designed the intake crib to be 24 ft. square, placing rip-rap around the outside, and this has since been found quite sufficient. No iron was exposed about the intake opening, but these were constructed with oak plank to prevent the formation of anchor ice. In the gate valve house were placed fish screens for obvious reasons. A reinforced concrete conduit 4 ft. in diameter and 2,000 ft. long was constructed to the large well at the pumping station. This conduit before reaching the pump well passed through a screen chamber through which the two old wooden conduits also passed. At the intake and outlet of each conduit were placed sluice valves so that any conduit could be cut off entirely or in part. Each of the turbine pumps feed from a small and separate well connected with the main well with a gate valve cut-off. By this method any foot valve can be inspected and repaired if necessary without interfering with the water supply of the other pumps.

THE NEW PUMPING PLANT.

In the construction or reconstruction of any water works system the pumping plant is of paramount importance. What power to use, whether steam, gas or electric, will depend principally upon the cost of power delivered on the shaft. Other considerations will be the capital cost of installation, including size of relative buildings, cost of operation, and depreciation. It should also be borne in mind that if the electric power be brought from a distance that it will be subject to interruptions and is consequently less reliable than the other agencies mentioned.

In Hamilton on account of the low cost of electric power ($16.50) per annum, it was decided to increase the number of electric driven pumps to meet the future demands and the pumping station for the units already installed was enlarged. Two new electric driven turbine pumps were installed, each of 6,500,000 gals. (Imperial) per 24 hours, or of the same capacity as two units already in operation. There is a steam plant also, having a capacity of 13,500,000 gals. per 24 hours, which is generally held in reserve or to carry the peak load during periods of heavy consumption.

The subject of plunger pumps has been well covered in several text books, but the development of the centrifugal into its present efficiency is less known. This applies not only to the design and construction but also to operation. It is only comparatively recently that this type has been efficiently applied to water works pumping problems. Almost any machine shop or foundry could build a centrifugal pump that would deliver more or less water against a certain head, but little attention was formerly given to efficiency, or to accessibility during operation, everything being sacrificed to low first cost. Most pumping station centrifugal pumps are driven by electric motors and consequently the operating cost is a definite and known quantity and it then becomes a question of getting the maximum efficiency from the pump under the existing conditions.

A centrifugal or turbine pump has certain fixed characteristics. For instance, in a turbine pump operating at constant speed, as it will if driven by synchronous motors, the amount of water pumped increases with the drop of pressure in contra-distinction from the piston pump which always pumps the same quantity of water no matter what the pressure.

If then a turbine pump is designed to deliver a quantity of water through a pipe or a piping system of certain diameters and length at its maximum efficiency and another turbine of exactly the same characteristics is started to pump through the same piping system the frictional head from the delivery piping will increase due to the increased quantity of water and consequent increased velocity of water through it with the result that the increased head will reduce the individual deliveries, so that the total deliveries from the pumps is equal to twice the delivery of the individual pump at the increased head, instead of twice that of the original pump if pumping by itself. If these two pumps are to work together most of the time the efficiency curve for each pump should be at its maximum over the variations in head between one and two pumps working.

If two turbine pumps deliver into a piping system that decreases the individual delivery of each pump by more than 10 per cent it will have the tendency to cause the delivery to swing from one pump to the other so that one pump will be delivering water and the other practically churning. This may be remedied by increasing the sizes of the impellers.

It is usual to keep the length of suction tubes of all pumps under 25 ft. and most pumps have suctions not greater than 20 ft. to minimize the possibility of air leakage.

It has been found in a number of cases with turbine pumps that the tips of the impellers wear very rapidly when the suction tube length is greater than 12 ft. With less than this height there is little or no wear. The reason for this wearing is probably imperfections in the design of the turbine pump as built today, although some manufacturers guarantee over 80 per cent efficiency.

The two stage turbine pumps that Hamilton installed at its main pumping station pump against a head of 285 ft. with an efficiency of 75 percent under full load. The bids for two 6,500,000 gal. (Imperial) turbine pumps in place varied from $5,500 to $9,800. Extra impellers capable of lifting the water to 300 ft. were included and the pumps had to be successfully operated for two weeks before acceptance.

Booster Station.—Besides the main pumping station there was built a booster station to replace steam and air lift pumps and to carry the water to greater elevations than possible with the main pumping station without causing excessive pressures in the lower portion of the city. This station contains four turbine pumps each of 1,000,000 imp. gals. per 24 hours. Two of these pumps raise the water about 80 ft. above the level of the reservoir to which the main station pumps delivered the water and two pumps raise the water 280 ft. above this level. Two stage pumps only were necessary for the lower level below the mountain plateau, but six stage pumps were required for the higher elevation. The problem at this station was to determine approximately the heads to which the pumps would generally work so as to get the greatest efficiency out of them. The pumps were directly connected to the mains fed from the main pumping station and about 75 ft. below the level of the reservoir that the main station fed.

Besides the usual annual and daily fluctuations in head with the added effect of the draft of these pumps on the static head there was the difference in level of two reservoirs on the main system to be considered. One of these reservoirs was only used in case of emergency or while cleaning or repairing the reservoir generally used, but as it was 60 ft. lower in elevation and two miles distant across the city, and nearer the pumping station, it naturally produced considerable variation, and practically made the problem of obtaining maximum efficiency with turbine pumps under all working conditions indeterminate. The pumps as built and operated give a maximum efficiency of 60 per cent, although under certain conditions the specified efficiency of 75 per cent is obtained. Bids for these four pumps in place varied from $6,000 to $6,800.

The main pumps are driven by 750 HP. motors, the lower level pumps at the booster station by 50 HP. motors, and the higher level by 130 HP. motors. All these pumps run at 750 R. P. M.

As stated before there were in commission from the main pumping station three rising mains, 30, 20, and 18 ins. in diameter, respectively. They were connected to the pumps in the usual haphazard way prevalent in many plants in this country. It was decided to build a fourth main 36 ins. in diameter and about equal to the other three mains in discharging capacity. Although nearly two miles of this main had to be built to bring water to the outskirts of the city, along a line already used by the other three mains, it was decided to take a slightly longer route away from this line to avoid the danger of a bad blowout, putting all the mains out of commission.

The connections from the pumps were carried to a header pipe 4 ft. in diameter running at right angles and at a lower elevation than these connecting pipes.

Between each of the old pipes and the header a gate valve was placed and as the new 36-in. main leaves from the end of the header the whole arrangement proved very flexible in operation. On each of the mains was installed the usual check and gate valve besides the Venturi meter for measuring the discharge.

CAULKING DATA.

Before laying the large main to the city, and other mains throughout the city, tests were made to ascertain the relative efficiency and speed in making poured joints and lead wool joints; also the relative efficiency of joints caulked by pneumatic hammers and by the usual hand method.

It was found that with the pneumatic hammers between four and five poured lead joints could be caulked to every one in which lead wool was used. This difference was due, generally, to the hammers becoming wedged in driving in the lead wool. It was also found that the compression in the caulking went deeper in the poured than in the wool joint, thus giving greater density.

Several alternate joints were caulked by the pneumatic hammers and by hand and this section was gradually put under pressure. It was found that every joint caulked by hand commenced to leak slightly at 110 lbs. pressure but that the pneumatic caulked joints remained tight.

To carry the construction of these mains through quickly and efficiently by the city forces an air compressor with pneumatic caulking tools was purchased.

The city had a small steam shovel with a half-yard dipper which did the excavating and also the lifting of the pipe into the trench. A 12-ton dinky engine with cars and track was also purchased and with this equipment (which also did the back filling) as many as 15 36-in. pipe were laid in a day in a trench which had a variable depth but always sufficient to give a top covering over the pipe of 5½ ft. This large main was laid to grade with blowoffs every half mile to the city and having the usual gate and relief valves.

To compare the relative speed of hand and pneumatic caulking, tests were made with the results shown in the following:

Size pipe, ins.	CClass.	Depth of lead joint, ins.	Weight of lead used, lbs.	Depth of yarn, ins.	No. of hand caulkers.	No. of joints per day.	No. of machine caulkers.	No. of joints per day.
36	C.	3½	121	1	2	4	2	12
30	C.	3	90	1	2	6	[illegible]	15

From the above it will be seen that on the 36-in. pipe the machine men caulked three times as many joints as the hand men and 2½ times as many on the 30-in. pipe. Due to many local conditions entering, as, for instance, the filling in of old wooden bridges and the building of concrete culverts, which were charged to the cost of the mains to the city, no cost data are given. The cost of a length of 2,157 ft. of 24-in. main in the city, under normal conditions, with a depth ranging from 7 to 9 ft., averaged $1.86 per foot.

The length in feet of new mains in this reconstruction comprised: 12,900 ft. of 36-in., 13,800 ft. of 30-in., 6,000 ft. of 24-in., 4,600 ft. of 20-in. and 2,500 ft. of 18-in. main. The total cost of this work including intake, conduit, pumping stations and mains was $750,000.

ACKNOWLEDGMENT.

Paper before annual convention of the American Society of Municipal Improvements by Mr. Andrew F. Macallum, City Engineer of Hamilton, Ontario.

Data on the Leakage from Lead Joints in Cast Iron Water Mains.

(Staff Abstract.)

It is not correct to assume that all of the direct leakage from water mains takes place at lead joints and cracked pipe, for there is an appreciable amount of leakage from defective service pipe, hydrant valves, blow-off gates, leaky packing at gate valve stems, etc. While, therefore, the "gallons per capita per day" unit is well adapted to represent the total underground leakage, a more appropriate unit in which to express the leakage at joints is the "gallons per day per lineal foot of lead joint," and in the data given herewith this unit of measurement has been used.

In the writer's experience with the Factory Mutual Fire Insurance Companies questions have frequently arisen between the managers of corporations insured by them and public water works officials as to what becomes of the water passing from public mains into private fire protection yard systems. In such cases the water works official is usually well satisfied to install a meter on the main feeder and charge the consumer with the registered quantity of water, allowing him to use it for whatever purpose he desires, while the attitude of the insurance companies has been that if all domestic and manufacturing water is used from a separate metered line the interests of the community are not jeopardized by omitting meters from the fire service lines, provided, of course, that these are used solely for this purpose. In other words, the water for extinguishing fire in protected plants should be as freely supplied and with as little obstruction to flow as it would be if taken from street fire hydrants. The arguments on both sides of this proposition are so well known that they will not be repeated.

TABLE I.—ANALYSIS OF LEAD JOINTS IN WATER DISTRIBUTION SYSTEM OF MEDWAY, MASS.

Cast iron pipe		Number of lead joints						Linear ft. of lead joint		
		Straight pipe								
Size.	Linear ft. laid.	12-ft. lengths.	Short lengths.	Specials.	Gates.	Hyd.	Total.	Per jnt.	Total.	Per ft. of pipe laid.
12-in.....	3,279	274	3	34	5	...	316	3.56	1,124	0.34
10-in.....	11,498	958	5	63	9	...	1,035	3.01	3,116	0.27
8-in.....	10,471	873	6	45	9	...	933	2.48	2,309	0.21
6-in.....	34,761	2,897	40	308	61	107	3,413	1.91	6,519	0.19
4-in.....	645	54	1	6	2	...	[illegible]	1.36	[illegible]	0.13
	60,654						5,760		13,154	

In one instance at a risk in eastern Massachusetts, having both high and low service connections with public mains, it was found that considerable quantities of water were escaping from the high service reservoir, and as this occurred during a dry season, when there was a natural shortage of supply, the water works officials deemed it expedient to shut off this particular connection, which they did without notification to the corporation. In the study of the situation which followed the writer found that 11,000 gals. per day were being lost through the underground system, thus representing about 7.3 gals. per day per lineal foot of the 1,500 ft. of lead joint involved. As this was deemed excessive, the points of greatest loss were approximately located by meter readings on the various systems into which the system was divided by gate valves, the joints were uncovered in the worst sections and those found leaking were repaired. By this means the loss was reduced to about 2,000 gals. per day, or 1.3 gals. per lineal foot of joint. The pipes in this instance were 6 and 8 ins. in diameter; total length, 5,500 ft.; length of lead joint, 1,500 ft., and average pressure, 105 lbs.

A short time after this experience a favorable opportunity came for conducting a test for leakage on a small new public water works system at Medway, Mass. This work was built by the Hanscom Construction Co. of Boston, H. A. Symonds, consulting engineer, under the supervision of Mr. Erastus Worthington of Dedham, Mass. The sources of supply are driven wells from which water is pumped through the distribution system to a standpipe 30 ft. in diameter by 80 ft. high, the capacity per foot of height of which is thus 5,288 gals.

The distribution system is made up of cast iron pipes 6 to 12 ins. in diameter, Class E, New England Water Works Association specifications. The lead in the 6-in. sockets is 2 ins. deep and in the 8, 10 and 12-in. sockets 2½ ins. deep. In Table I the system is analyzed with respect to the lead joints.

At the time of the test the system had been entirely completed, with the exception of service connections, none of which, however had been put in. The mains and standpipe had been filled about 10 days previously and the hydrants had been thoroughly flushed out, thus removing most of the air. With the standpipe again filled, and with pumps stopped, the observation for leakage was made for a 24-hour period by simply noting the rate of lowering of the water level. During this time the static pressure at hydrants in all parts of the town was found to vary from 37 lbs. to 99 lbs. and to average for the entire system about 75 lbs. A careful inspection of the entire route of the pipes revealed no evidence of large leakage, and it is believed that practically all was at lead joints.

The total loss in 24 hours was found to be 22,400 gals., which, corrected for small known drafts and a slight leak in the standpipe, showed a net loss taking place in the underground mains of 20,800 gals. Reducing this to the unit by dividing by 13,154, gives 1.58 gals. per day per lineal foot of lead joint, an equivalent of 9 gals. per capita of the population on the pipe lines. The possible errors in determining ought not to exceed 5 per cent, so that the correct figures for this case should lie between 1.50 and 1.65 gals. per day per lineal foot of lead joint. As the construction work was carried out under good average conditions by reputable contractors, employing experienced pipe layers, joint makers and calkers, without the expectation that it was to be tested, it is felt that the results are fairly representative for the size of pipe and class of work.

Table II contains a list of cases, believed to be accurately reported, where similar determinations have been made, and it is presented here for comparison.

This table shows, what general experience confirms, that bottle-tightness in lead joints of cast iron water mains is an impossibility. So long as pipe lines are built in this way (and from our present knowledge there seems no better method for general practice), leakage must be reckoned with. The problem, then, is to reduce it to a minimum. In this endeavor two general lines of action are possible—first, the substitution of some more satisfactory material for lead, and, second, an improvement in the design and construction of the lead joint. Under the first heading there has already been produced a substance called "Leadite," which has been quite extensively used. Whether this will solve the leakage problem and become the universally recommended material for cast iron pipe joints is still an open question. Under the second heading, a general stiffening of specifications under which pipe is laid, with more careful supervision of joint making, laying in deeper trenches to reduce expansion and contraction, mechanical injury, etc., and rigid tests for leakage after completion would have a tendency to produce tighter work.

TABLE II.—DATA ON LEAKAGE FROM LEAD JOINTS.

System.	Pipe sizes, ins.	Pipe length, ft.	Pressure lbs.	Leakage, gals. per day per lin. ft. lead joint.	Remarks.
Privodence high service.......	16	29,400	114	0.22	3 yrs. old.
Milton, Mass., W. W. system..	4 to 12	16.900	85	1.30	10 yrs. old.
Nine small W. W. systems....	6 and 8	......	50	0.47	New.
Metro. Water Wks., Boston	60	8,220	66	0.90	New.
	48	116,563	50-150	3.16	New.
	42	11,744	50-150	2.43	New.
	36	25,663	50-150	3.19	New.
	30	7,287	50-150	0.81	New.
	24	20,553	50-150	3.44	New.
	20	40,231	50-150	7.00	New.
	16	49,903	50-150	4.65	New.
Plymouth Cordage Co.........	6 to 10	11,780	60	2.00	Fire protection system (old).
Hamilton Woolen Co..........	6 and 8	5,500	105	7.30	Fire protection system (before repairs).
Hamilton Woolen Co..........	....	......	...	1.30	Same, afer repairs.
Medway, Mass., water works.	6 to 12	60,654	75	1.58	New.

STANDARD OF TIGHTNESS.

The standard of tightness which is to be regarded as acceptable will be subject to much difference of opinion, depending upon the point of view. The 7 gals. per day per lineal foot of joint reported by the Metropolitan Water Board as leaking on one section of 20-in. main seems to the writer to be much in excess of a reasonable performance, and no doubt in that case leaks were discovered by the test and afterwards repaired. At this rate a 12-in. main would lose 25 gals. and a 20-in. main 43 gals. per day at each joint. On the other extreme, shown in Table II, probably few jobs can equal the record of the Providence High Service of 0.22 gals. per lineal foot of joint.

If leakage on new work can be limited to 1 gal. per day per foot of joint under 100 lbs. pressure the performance can be called good and acceptable. It would seem that, below this limit, thought and energy might better be expended in tracing other forms of waste than that at lead joints.

ACKNOWLEDGMENT.

From a paper before New England Water Works Association by Mr. Arthur H. Smith, Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies, 31 Milk St., Boston, Mass.

Water Borne Typhoid in Sacramento, Cal.—Interesting Application of Liquid Chlorine.

(Staff Abstract.)

Until the present year the city of Sacramento derived its water supply from the Sacramento River without treatment of any kind. The river is subject to pollution from many sources. As a result of the use of such water the city has had a continued death rate from typhoid fever averaging 53½ per 100,000 population for each five year period since 1895. In 1914 there were 23 deaths and 253 cases were reported. The death rate for 1914 was 36.5 per 100,000. Some of these fatal cases were imported; the death rate for local cases was 25.44. The annual cost to the city, by five-year periods from 1891, due to sickness and death from typhoid, was estimated at $34,000, $49,300, $95,000, $85,000, $104,125, and finally the cost for 1914 was $150,350.

CHLORINATION PLANT INSTALLED.

The city health officer, Dr. Norman E. Williamson, made several reports to the city authorities in which he advocated chlorination of the water supply as the only feasible means of furnishing a safe supply within a short time. As a result of these reports a liquid chlorine plant was installed by the Electro Bleaching Gas Co. of New York City. It consisted of three units, one on each of the city's three intakes.

The average composition of the river water is as follows:

Hardness	32.00
Solids	100.00
Free ammonia	.04
Alb. ammonia	.10
Alkalinity	34.00
Chlorine	2.00
Sulphates........................	Faint trace
Turbidity	50.00
Nitrates	.4
Nitrites	.0
Bicarbonates	41.00
Oxy. con. 5 min........................	2.00
10 min................................	3.30

Bacteriological examinations have varied as follows:

Total count varying from 70 to 1,920.

Colon count as high as 20 per c.c. on one examination.

Fermentation in from 1/10 to 1/100 of a c.c.

Turbidity varying from 50 to 1,000 with an average of 122.

It was found on experimentation that 2.9 lbs. per 1,000,000 gals. of chlorine or 0.36 of a part per million, produced a water which showed no fermentation in 24 hours but fermentation in two or three out of five 10 c.c. portions in 48 hours and that 3.2 lbs. per 1,000,000 gals., or 0.4 of a part per million, resulted in complete absence of fermentation in all five 10 c.c. portions in 48 hours.

The test for oxygen consumed, made by the city analyst, showed .8 of a part per million before treatment on one test and .5 of a part after addition of chlorine. Two other examinations showed .6 p. p. m. before treatment and .4 p. p. m. after treatment. There was no apparent relation between the oxygen consumed and the dosage of chlorine required.

The water was drawn as mentioned before through three intakes. Various intakes or combinations of intakes were used, depending upon which pumps of the four in the pumping plant were employed. For instance, if the Braun pump was used, the draught was directly on the 20-in. intake and indirectly through an angle on the 30-in intake. It was found that the best immediate results were obtained if the dosage of chlorine was equal on these two intakes; thus the friction in the 20-in. intake was more than overbalanced by the angle through which the water passed from the 30-in. intake. Another combination was the Snow pump through a 40-in. intake and the Allis drawing directly from the 30-in. intake and through an angle from the 20-in. intake.

RESULTS PROVE SUCCESSFUL.

It was very important to determine whether the action of chlorine was complete in the intake pipes before mixing occurred or whether extra chlorine in one intake would act on the water from any intake when mixed in the discharge pipe. If the action was complete in each pipe, it would be absolutely necessary to determie the accurate dosage for each pipe. If action could occur after mixing of the waters, the total quantity of chlorine necessary was all that needed to be computed. To determine this, the 20-in. intake was left untreated while the Allis pump was in operation, the entire dose being put into the 30-in. intake on which there was a direct draught. The distance from the point of application of chlorine in the 30-in. intake to the point of mixture with the water from the 20-in. intake was 325 ft. The amount of water which passed through the 30-in. intake in relation to that which passed through the 20-in. was computed to be as 11 to 3. The velocity of the water in the 30-in. intake was computed as 1.2 ft. per second with a discharge of the Allis pump of 200,000 gals. per hour which was the pumping rate at the time of experiment. The length of time therefore between the application of chlorine in the 30-in. intake and its mixture with water from the 20-in. intake was 6½ minutes. For the engineering computation in connection with this problem, I am indebted to Mr. C. G. Gillespie.

It was found that water taken shortly after the mixing showed no fermentation in five 10 c.c. tubes in 48 hours. On repeated tests the water taken from the taps in the city gave the same result when the water was allowed to enter through the 20-in. intake untreated. Therefore it made little difference since the action of the chlorine was completed after reaching the pumping station whether a proper distribution was made at the intake or not. The total quantity of the chlorine delivered was all that needed to be computed. This saved a great deal of labor in supervision. During the daytime the chlorine was set at a dose which would be right for the highest pumping rate of the day; during the night, the dose which would be sufficient for the highest pumping rate of the night. Thus only two changes were made in the 24 hours. Of course there would be an excess during the lower pumping rates, but this was considered advisable for a margin of safety. The plant has given perfect satisfaction.

Proper dosage was arrived at March 22, 1915, and there has been since that time a marked reduction in the typhoid rate. Seven local cases were reported during April, May and June, 1915, as against 26 local cases for the same period in 1914. This is a reduction of 73 per cent. Much more marked should be the change in the typhoid rate next winter as that is the time when the typhoid incidence is highest and practically all the cases in winter would be of water origin.

ACKNOWLEDGMENT.

From an article in the July, 1915, Bulletin of the California State Board of Health, by Norman E. Williamson, M. D., Health Officer of Sacramento.

New British Method of Coating Steel Pipes.

(Staff Abstract.)

In many places in Africa it has been found necessary to take up short lengths of steel mains which have only been laid a few years. The tensile strength per unit of area of mild steel as compared to cast iron may be taken at about 3½ to 1, so that so far as tensile strength is concerned a steel pipe 3/16 in. thick is as strong as a cast iron pipe ⅝ in. thick if the same factor of safety is required. It therefore follows that steel pipes are very thin compared to cast iron pipes, and are much more easily penetrated by corrosion than cast iron pipes when the pipes are laid in certain kinds of soil, so it is necessary to cover steel pipes with some protective material to obtain the same life. Coating the pipes externally with bituminous composition is insufficient in pyritic soils, and it is now usual to cover the pipes with jute dipped in bituminous composition after giving the pipe a preliminary protective coating. While visiting the British Welding Company's Works, near Glasgow, last year, the speaker inspected a new method of protecting the pipes, and a brief description is submitted:

The pipe is first heated in an oven to a slightly higher temperature than the bath, and it is then dipped into the solution and allowed to stay there for a few minutes. It is then taken out of the bath and placed in a lathe where it is slowly revolved. Hessian cloth (jute) dipped in the coating solution is then wrapped around the pipe while it is revolving. At the same time as the cloth is being wrapped around the pipe firebrick or earthenware pipe crushed to pass through a 1/16-in. screen is allowed to fall on the Hessian cloth, and is pressed into it. Pipes ordered by the Metropolitan Water Board of London, 36 ins. in diameter and ½ in. thick and 24 ins. diameter and ⅜ in. thick respectively, were being coated in this manner during my visit. The thickness of the three coatings when finished is about 3/16 in., and this should prove a very effective protection in cases where the pipes are subject to acid sub-soils. The soils which usually cause most corrosion are those containing pyrites and certain salts with an acid base. The organic acids derived from peat beds also attack pipes internally and externally, and it is necessary to protect the pipes in such cases. The internal protection is usually provided by a bitumastic composition, but this only lasts for a comparatively short time, so it is necessary to treat the water in cases of this kind so as to make it alkaline. If steel pipes are properly protected there is no reason why the life should not be as long as that of cast iron.

ACKNOWLEDGMENT.

From the inaugural address of W. Ingham, President of the South African Institution of Engineers.

Novel Method of Digging a Trench 214 Ft. Deep.

(Staff Abstract.)

A novel method of trench excavation was recently adopted at the new dam construction for the Burnley water works at Lancashire, England. Owing to the faulty nature of the carboniferous formation, the trench had to be sunk to a depth of 214 ft. before a satisfactory bottom was reached, and as the timbering of such a deep trench would be very costly, it was decided to carry out the excavation by driving galleries from a series of shafts sunk on the center line of the trench. This obviated the shoring up of a wall of earth over 200 ft. deep. After a satisfactory bottom had been reached that portion of the trench was filled in, and the earth above was excavated as the core wall was built up. This method has proved very successful, and the work is being carried out at a much less cost than it would have been under the old method of sinking from the surface. The same method was adopted in sinking the trench for the dam at Kinder Scout for the Stockport water works.

From inaugural address of W. Ingham, President of the South African Institution of Engineers.

GENERAL

The Engineering Contractor.

By Halbert P. Gillette, Editor in Chief of "Enginering and Contracting."

(A paper read Oct. 19 at the American Builders' Week Convention, San Francisco.)

Engineering is the application of science to the problems of economic production. In so far as contracting is scientific, it is engineering. Engineering contracting, therefore, may be defined as the scientific building of structures and plants. In its more highly technical branches, engineering contracting requires the services of the trained engineer, and it then becomes an amalgamation of the profession of engineering with the business of contracting. But, as I conceive it, there are certain less technical branches of engineering contracting, in which the business part overshadows the engineering part. To cite instances of each kind, we have those contracting firms that design and construct reinforced concrete buildings. They are typical of the highly technical engineering contractor. We have firms that build roads, but do not design roads and do not themselves operate intricate plants. They are typical of the slightly technical engineering contractor.

There is, of course, no clear line of demarcation between the different classes of engineering contractors, nor is there a clearly marked line between the ordinary contractor and the engineering contractor. Here, as elsewhere in the realm of human activities, the classes merge into one another.

EVOLUTION OF THE ENGINEERING CONTRACTOR.

With a steadily increasing number of graduates from engineering colleges, it became evident more than 15 years ago that many engineers would be forced into the contracting business whether they wished to enter it or not. There were not enough purely professional vacancies for the rapidly increasing number of engineers. At about the same time a few engineers began to ask themselves whether they had not been taught to hold very narrow ideals as to what constituted engineering. They could see that all of engineering did not lie in the designing of engineering works, and they began a campaign of education the slogan of which may be said to have been: Engineers need business and business needs engineers.

I recall writing an editorial article many years ago in which I pointed out that there were 20,000 students enrolled in the engineering colleges of America and that the U. S. Census reports showed only 40,000 practicing engineers. The inference was that the time had come to urge most young engineers to cease looking forward to purely professional careers, but to begin planning to enter those lines of business and political administration that seemed to offer a chance to apply engineering knowledge effectively. Subsequently, both in books and articles, this theme received elaboration until our professors of engineering took it up. In several of the engineering colleges there now are courses designed to give engineers a training in accounting, management and general business practice.

The first branches of contracting in which engineers made a notable success were those that I have termed highly technical, such as structural steel and reinforced concrete work, hydro-electric plant design and construction, difficult foundations, etc. Where the work consisted mainly in handling men, and but to a minor degree in designing or selecting materials and plant, it was inevitable that engineers, trained as was then the custom, would make a less pronounced success. Perhaps it will always remain impossible for the average college educated engineer to equal the average self-educated contractor as a manager of "men in the rough." There is, without doubt, a great advantage in having "come up from the ranks" if one wishes not only to understand the men of the ranks, but to have their sympathy. It is for this reason that I formed my first contracting partnership with an experienced bridge foreman. And I have always advocated such a union of the trained engineer with the experienced manager of men, whether it be in a partnership or as co-officials of a contracting company. In the case of a successful partnership of this sort, each member of the firm is apt to attribute its success to himself. So the centrifugal force of their egotism often drives them apart, usually with ill effect upon their subsequent contracting careers.

While no statistics are available, I have but to look back twenty odd years to see a very marked increase in the percentage of engineers who have succeeded as engineering contractors. Contracting is, in many lines, a business full of hazard. Hence a large percentage of failures will be found, regardless of whether the contractor is an engineer or not. It is a business that calls for a sort of courage—"nerve," if you please—which relatively few men possess in the right degree. And usually it requires a man capable of standing constantly "in the trenches" without worrying unduly. In short, it is a peculiarly trying business, with its ups and downs, its superabundance of work and its scarcity of work, its spells of bad weather that knock out the profits and its spells of good weather that make work seem incessant.

One contracting friend of mine told me that he had finally devised a way that led him to be satisfied regardless of weather. "I have bought a farm," he said, "and when it rains I am happy because of the crops; and when there is a long dry spell I am also happy because of my grading jobs."

It was an engineering contractor, I believe, that invented, or at least popularized, the "cost plus a fixed sum" form of contract. Following his success in the hydraulic and building fields, other firms have devised various modifications of this form of contract. Others adhere to the old "percentage contract" and, on that basis handle large work not only throughout America, but in foreign countries. Probably it is such firms that are most commonly regarded as the typical engineering contractors, for they are not only officered in large part by engineers, but they employ large engineering staffs.

SCIENCE OF MANAGEMENT.

About sixteen years ago while in the midst of trouble from rising wages and rising prices that threatened to wipe out all prospective profits on certain contracts, I chanced to read Taylor's paper on "Shop Management." I saw that I could apply to my work some of the four principles advocated by him. My success in the application of two of the principles—unit timing and piece-rate payment—led me to conceive the idea of formulating a code of laws or principles of management derived from the experience of many men. Finally, I published some of these "laws" in condensed form and I called them part of a science of management. Hard upon their application there came a veritable flood of literature along the same lines—a flood that has progressively increased. Successful management must always have been scientific. But it had apparently not been realized that such a branch of knowledge as a science of management could be developed. Even yet there are those who deny the possibility of such an achievement. Yet, in spite of all the quackery that has attached itself to this science, there is abundant evidence that a true science of management is being created, and largely through the efforts of engineers who have had experience as managers.

Obviously if such a thing as a science of management exists, or will exist, there will be an increasing percentage of engineers who will succeed in contracting and in other lines of business.

There was a time when only a few men, men of long experience, could be relied upon to design a bridge or locate a railway. Theirs was an art not reduced to printed rules—not a science. But eventually a science of strains and stresses was evolved, and with it came the ability to teach bridge designing so that comparatively inexperienced engineers were competent to design a more economic bridge than the most experienced rule of thumb engineer had ever designed.

Similarly, after Wellington reduced railway location to a science, railway location could be taught, and long experience was not so essential in the railway location as it had been. Thus, in fact, has each department of knowledge had its initial period when it was unsystematized and acquired mainly by personal experience, to be followed later by a systematizing and reduction, in large measure, to rules. So it is not to be wondered that even so intricate an art as management should eventually come to be analyzed and formulated, and thus pass by degrees into a true science. In the development of this new science of management the engineering contractor has been an important factor. He has been among the first, if not the first, to recognize the possibility of producing such a science, and has certainly done his share in adding to its literature. To mention but one phase of management, the recognition of the utility of unit costs as a means of securing economic work and the invention of methods of recording and analyzing unit costs, brings a realization of the worth of some of the literature that engineering contractors have written. This was a part of scientific management that Taylor entirely ignored in his "Shop Management," nor did he ever seem to see that there are many other principles of management than the four outlined by him in that paper—a paper that is indeed great in spite of its narrowness.

To apply the laws of management most successfully requires certain personal qualities, certain education and certain kinds of experience, to a brief consideration of which we may now pass.

NATURAL QUALITIES OF THE MOST SUCCESSFUL ENGINEERING CONTRACTOR.

A somewhat extended acquaintance among contractors has given me opportunity to observe the most marked characteristics of those who have succeeded notably, as well as of those who have failed notably. "Grit," "nerve," courage—call the characteristic that makes a fighter what you will—is perhaps the most outstanding quality in the highly successful contractor. A mild, rabbit-like man has, I dare say, never succeeded as a contractor unless he has had discernment enough to attach himself to a fighting partner. The fighter is usually the leader, even in those walks of life where intellect is supposed to be supreme. I do not mean the quarrelsome man for whom trouble is a lodestone, I mean the man who makes "trouble" for those who have brought trouble upon him, the man whose backbone is not all wishbone. His is the sort of fighting spirit that flares up even after the sheriff has sold him out, the will-not-quit sort.

Next to courage is the quality that some call parsimony—a watchfulness as to the road the pennies are traveling. The successful contractor may bid in millions, but he camps on the cents. He may gamble, but after his bet is placed he lets no one filch the "pot" from him in driblets.

The third quality that distinguishes most successful contractors is their magnetic personality. They are "good mixers." They have a wide acquaintance and are on good footing with those with whom they deal. If luck frowns upon them, they do not lose temper and blame all losses on the engineer in charge of the work. Even when the engineer is largely to blame, they grin and try to let him see the fact without telling him so. The fighting spirit is strong in them, but stronger is the "horse sense" that tells them not to fight the engineer or the proprietor for whom they are doing the work.

I hardly know what to call the fourth quality of the successful contractor, for it is a composite of several qualities, some of which have already been named. It is, however, about 75 per cent integrity or honor of the sort that makes a banker feel that he is loaning money to a man who will not "welch" even if the opportunity offers and the incentive is strong. I have seen a good many contractors let their bondsmen finish their jobs and their bankers whistle for their money, but of such there are none to my knowledge that have subsequently succeeded in business. A banker is a pretty keen psychologist, as the popular expression for character reading now goes. If he sees symptoms of the "dead beat" in a man, there is speedily an end to that man's financial progress.

The successful contractor is himself a pretty good psychologist, even if he would not recognize his own picture under such a title. His natural proclivity as a "mixer" also implies a tendency to "size up" ever man he meets. Is a man fat? Then he may be judicial, but he is probably not "scrappy" enough to make a good foreman. Does a man wear glasses? He may be a "shark" at figures, but is likely to be "shy" on the subtle art of getting jobs save by being the lowest bidder.

In addition to the five qualities just named, the most successful engineering contractors are usually gifted with an inventive faculty. They devise ways of accomplishing their results more economically than their competitors. Is it a dam? The standard design or the standard method of construction is not for them. They see a new and better way. They are the inventors of the rock-fill dam, the hydrauliced earth dam, and the hollow concrete dam. Is it a great bridge across the East River? Then a great engineering contractor, John Roebling, invents—you may fairly call it so—the Brooklyn suspension bridge. Is it a pavement? Then an engineering contractor, Warren, invents bitulithic. Is it a building? Then an engineering contractor, Ransome, invents a twisted steel bar and a whole system of concrete reinforcement.

It would be a formidable task indeed to compile a list of engineering contractors who have won fame or fortune or both by virtue of their inventions of new types of structures and machines. Many there are whose names few of us know, although we use their machines. Who were the American contractors who invented the Fresno scraper, the "wheeler," the elevating grader, the power scraper, the rolling tamper, the gang rooter? What contractor first used a well driller, or cable drill, for blast hole work? Uncle Sam owes him a great debt of gratitude for the use of that type of drill on the rock work at Panama. If I am not mistaken his name is Kerbaugh, of Philadelphia. At any rate, I gave him that credit in print 12 years ago and no one has risen to claim priority.

So I might go on indicating the named and nameless contractors to whose ingenuity the world owes much. But my object is merely to call attention to one of the most important characteristics of successful contractors, namely inventiveness.

EDUCATION OF ENGINEERING CONTRACTORS.

This I must pass over quickly. A broad engineering education, coupled with short courses in the law of contract, accounting and cost keeping, science of management, and engineering economics, should form the basis of any course designed for the engineering contractor. In many respects the present courses that lead to the degree of Mining Engineer more nearly meet the requirements than the present courses leading to the degree of Civil Engineer. But changes are being made in some of the civil engineering courses which tend to give much greater emphasis to the business side than has been the case in the past. If, coincidently therewith, civil engineering students are taught to be better "mixers" and are given some practice in the actual management of men, it may be possible, before long, to secure a civil engineering degree that will indicate a knowledge of something beside pure and applied mathematics.

Educators are almost unanimous in the belief that the chief object of an education is to teach a man how to think. But, I fear, the common conception of "how to think" is so narrow that it fails to embrace "how to deport oneself." How to act is quite as important in the business and professional world as how to think. A salesman may have a very fine thinking mechanism, but he will fill few orders if that be his sole characteristic. A rival salesman with a "think-tank" no bigger than a sardine can will beat him to death, if he has a genial smile and a real spirit of good will back of the smile. Thinking is but half the game of life. Acting is the other and often more important half. Action is both a matter of heredity and a matter of acquired habit. A complete education should give a man habits as well as ideas and training in logic. The habit of going among men, the habit of studying their habits, the habit of being courageous, affable, honorable—these are things certainly not less important than a training in science. I fear they are, however, the very things that few educators have tried to cultivate in their students. The outstanding explanation of the excellence of the engineering training that West Pointers receive is the existence of a training in habits.

REDUCING THE RISKS OF CONTRACTING.

In closing this paper, I am going to depart somewhat from the field indicated by its title for I regard this as a time particularly opportune for a word as to the steps that should be taken to reduce the risks of contracting. A very great part of the risk is incident to the vagueness or the one-sidedness of contracts and specifications. Engineers aim to be fair—indeed I believe them, as a body, to be the fairest class of men—but unfortunately few of them have ever held the hot end of the contracting poker. At the cool end of the poker one can be astonishingly calm and critical; one can see how easy it should be to avoid blistering the hands. Just a little more foresight here, a trifle more agility there, and the ledger need not show up in the red.

But, engineers or contractors, we are all of much the same clay on this earth, and most of us will make much the same brick in the hereafter. It is useless to expect perfection, but occasionally we can try to move a few pegs nearer to it. Assembled together, we can discuss freely our respective troubles and their possible alleviations. I have long been hopeful that engineers engaged in designing and contractors engaged in construction would periodically meet to discuss such topics as: The Economic Size of Contracts, The Ratio of the Bond to the Size of Contract, Bid Bonds vs. Certified Checks, Semi-Monthly vs. Monthly Payments, Full Payments vs. Fractional Payments for Work in Progress, "Kid" Inspectors, Bonus Payments for Speedy Completion, Time Extensions Dependent on Weather Conditions, Award of Contracts Prior to the "Building Season," Methods of Payment for Extra Work, Arbitration Clauses in Contracts, Specifying Results vs. Specifying Methods of Attaining Results, Percentage Contracts, "Cost Plus" Contracts, "Bonus" Contracts, etc. My pen tugs at the traces when I start jotting down the things that could and should be discussed jointly by engineers and contractors. I take this occasion to urge the desirability of bringing engineers and contractors together, locally as well as nationally, and at frequent intervals, that they may learn more of one another's points of view, of one another's difficulties. Recently a certain group of contractors formed a coalition to fight the acts of certain engineers.

They had suffered, as they believed, injustices, and they were determined to go "higher up" for redress. I am not familiar with the details that culminated in the decision to "fight," but I am satisfied that a far better decision would have been a decision to "confer." Fights, whether before a court, or a commission, as a referee, are quite unsatisfactory methods of securing justice.

In conclusion it may be said that in spite of the ill effects of competition from uninformed bidders, there is a great and growing field for men who combine scientific knowledge with business ability, in brief for engineering contractors.

Movable Bulkhead for Testing Steel Pipe Line in Sections After Erection.

The possibility of testing conveniently in sections after installation steel pipe lines of large size, was demonstrated at the water power development of Jordan River, in Vancouver Island. This development was completed in October, 1914, and the construction of one of its dams by hydraulic filling was described in detail in our issue of May 21, 1913.

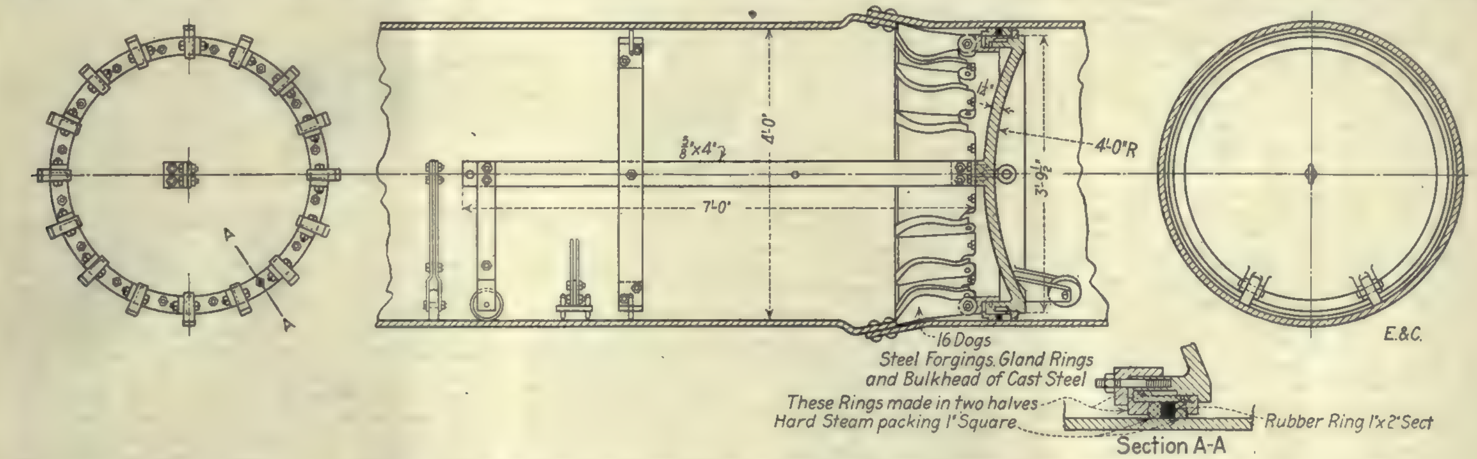

A
A
⅝"x4"
4'-0"
7'-0"
1/4"
4'-0"R
3'-9½"
16 Dogs
Steel Forgings. Gland Rings and Bulkhead of Cast Steel
These Rings made in two halves
Hard Steam packing 1" Square
Rubber Ring 1"x2" Sect
Section A-A
E.&C.

Fig. 1. Bulkhead for Testing 48-in. Lap Welded Steel Pipe After Installation.

From the forebay in the ridge steel pipe lines run to the power house, a distance of 9,290 ft. The longest of these lines is 54 ins. in diameter for 1,960 ft. from the forebay, and then is 48 ins. in diameter to the power house. For 2,509 ft. below the forebay, the pipe is riveted steel, made up in parallel courses and varying in thickness from ¼-in. to 7/16-in. Below this, and extending to the power house, the pipe is lap-welded, varying in thickness from ½-in. to 1⅛-in. Riveted spherical bump joints are provided, those in the heavier pipe being double riveted and in the lighter pipe single riveted. The standard length of the sections of this pipe is 30 ft., and they are made up of two large sheets of steel with one longitudinal joint, the two lengths being welded together to form the section. The specials or bends are made up in the same manner with the angle at the center or circumferential weld. It was planned to test the pipe in comparatively short sections, so that in case of failure the amount of water in the section under test would not be sufficient to do any damage. To make these tests, a bulkhead was designed to fit in the pipe at the upper end of the section under test and to confine the water between that point and closed gates at the lower end of the pipe.

The bulkhead (Fig. 1) was made up of a dished steel casting about 2½ ins. less in diameter than the internal diameter of the pipe. The circumference of this casting formed the base of a packing gland built up of steel rings which confined the packing. The packing consisted of two rings of 1-in. square hard steam packing, one on either side of a ring of rubber packing 1-in. thick and 2 ins. wide. The back steel ring of the gland was provided with 16 forged steel dogs which held the ring from moving up the pipe, the ends of the dogs resting against the end of the next section of pipe at a riveted joint. The pressure of the water against the bulkhead compressed the packing by forcing the bulkhead or disc into the back ring of the gland, which was in turn held securely in place by the dogs, thus making a water-tight joint. The whole contrivance was mounted on rollers to enable it to be moved along the pipe.

The pipe line was cut at the upper end of the welded portion of the pipe, and the bulkhead was lowered from here by means of a light wire rope to the upper end of the section to be tested first. Some trouble was experienced at first in setting up the bulkhead in the pipe, but after several unsuccessful attempts the pipe crew learned to overcome the difficulties and were able to make a tight joint.

The pipe was filled up to the bulkhead through a by-pass from one of the old lines, and the pressure was raised to the required test pressure by means of a large hand operated boiler test pump. The bulkhead was provided with an air valve to exhaust all air from the pipe and make sure that the space was entirely filled with water. A pressure gage was attached to the pipe and in each test the pressure was raised by means of the pump to 35 per cent in excess of the pressure due to the static head, this pressure being recorded at the lower end of the section under test. Before making the excess pressure test, each section was tested under static head by hammering along the welds with 3-lb. hammers.

The bulkhead was designed by the Pelton Water Wheel Co., San Francisco, Cal., and the tests were also conducted by this company. The illustration is re-drawn and the description extracted from a paper by Charles A. Lee, construction engineer, before the Canadian Society of Civil Engineers.

Removing Concrete Piers by Blasting.—In attempting to remove some old concrete piers from a stream the use of dynamite was resorted to. These piers had a diameter of 3 ft. 1 in., and were encased with a ½-in. sheet iron shell. In the first attempt holes were drilled at various points aound the pier, in the plane of the bed of the stream. Dynamite was then placed in these holes and exploded. The results were not entirely satisfactory, as a jagged fracture was secured, with projections extending above the bed of the stream. The following procedure was therefore used in removing the remaining piers, with the result that a clean break was secured in the plane of the bed of the stream: Using a piece of cloth, a pocket, about 2 ins. wide and of a length sufficient to go completely around the pier, was made. This pocket, or collar, was then filled with dynamite and placed around the pier on a level with the surface of the mud. The dynamite was then exploded and a fine even break was secured as though the pier had been sawed off.

Design and Construction of the Tower Foundations for the Cristobal-Balboa Transmission Line.

(Staff Abstract.)

The Cristobal-Balboa transmission line is a part of the system of generation and distribution of power for the Panama Canal. The power is generated at a hydro-electric plant just below the spillway of Gatun Lake. The current is delivered at 2,200 volts to a substation east of Gatun Locks by lead covered cables in duplicate, vitrified clay, 20-way duct lines on the downstream slope of Gatun Dam, crossing the locks through a tunnel under the floor. By means of transformers, switches and protective devices the current is delivered to the transmission line at 44,000 volts. This line follows the Panama Railroad from Cristobal to Balboa, a distance of 47 miles. It follows the right-of-way of the Panama Railroad throughout its length, this being the only feasible way of crossing the Isthmus, except the canal itself. The various wide and deep arms of Gatun Lake, and the almost impenetrable jungle on all sides, preclude the use of any route other than that chosen. The advantages of easy maintenance, the possibility of future electrification of the railroad, and the fact that all settlements and all canal works are reached by the railroad, were important factors in the selection of this route.

SUPPORTING STRUCTURE FOR TRANSMISSION LINES.

The supporting structure for the wires is a track-span bridge consisting of an *A*-frame on each side of the track with a heavily braced cross bridge, the wires being carried by suspension insulators from cantilever brackets outside of the *A*-frames. The line is in duplicate throughout; the power wires hang in a horizontal plane on each side of the track, and the ground wires are carried on top of the *A*-frames (see Fig. 1).

DESIGN OF FOUNDATIONS.

The foundations are subject to some rather difficult conditions of design. The Panama Railroad, as relocated outside of the canal prism, abounds in curves, which introduce angle towers as a usual, rather than special, condition. Clearness of vision for engine drivers demands a wide bridge, and 36 ft. is the standard adopted. This locates the foundations on the slope of the fills or cuts, and it was impossible to excavate pits large enough to build a gravity type of anchor without undermining the track and endangering traffic. The type adopted is shown in Fig. 2 and consists of a sub-base 1 ft. thick surmounted by two pedestals 4 ft. 2 ins. high, anchored by a pile under each pedestal, formed by drilling and casing an 8-in. diameter hole, expanding the bottom with dynamite, and filling with concrete, reinforced, for tension only, against the uplifting effect of the overturning moment on the tower. Varying conditions along the right-of-way caused numerous modifications of the type, but the essential features are retained in all cases.

As may be noted in Fig. 2, the anchor bolts extend the entire depth of the pedestals, and are anchored to two 70-lb. rails by a plate, the lower nut of the bolts being below the plate and the rails above it. The rails are embedded in the sub-base, and the reinforcing rods from the anchors extend through the sub-base almost to the top of the pedestals, the tension on the anchor bolts being transmitted by the bond of the steel to the expanded anchors.

In many cases on steep fills a firm bearing could not be secured 18 ft. from the center of the track and 4 ft. 5 ins. below the top of rail. In such cases the form shown in Fig. 3 was used, the excavation being carried down as far as necessary to bring the outer edge of the sub-base into good material. The space between the sub-base and the pedestals was filled to form a base 30 ins. wide, which is sufficient to carry the pedestals and to embed the reinforcing steel and old rails. This type of construction proved to be almost as usual as the standard type, as a large proportion of the railroad is on an embankment, due to the fact that it crosses the water courses on the east side of the Chagres and Rio Grande valleys, for over half its length, the canal occupying the valleys on both sides of the Cordilleras.

Another modification of the standard type was made in crossing a tidal swamp between Gatun and Cristobal. In this case the surface soil, a black organic mud, would not carry the weight of the structures, and four piles under each footing were driven to rock by drilling, casing, and filling with concrete. The longest of these piles was 120 ft., and the average for three miles (54 towers) was 50 ft. The original builders of the Panama Railroad laid a pontoon of logs across this swamp, and the present fill has been gradually brought up about 4 to 6 ft. above sea level. Wash drill borings at the site of each foundation showed black mud with rotted swamp grass and reeds for 10 to 20 ft., then the logs of the original pontoon, badly rotted and crumbling in the air, then from 10 to 30 ft. of coral sand mixed with mud, then a layer of clear beach sand over the sandstone. The penetration of drilled piles was checked against the wash drill borings, and each hole was driven 3 ft. into the rock. An 8-in. casing was driven the full length, using a long cast iron sleeve to keep the joints in line. The term "drilled" is really a misnomer, as the operation consisted in driving a joint of casing, stirring up the mud and sand with the bit, and mucking out the hole. Each hole was cleaned out with a hand bailer just before concrete was placed, and was expanded at the bottom with a half stick (8 ozs.) of 45 per cent dynamite, which had the effect of bringing up most of the thin mud and water at the bottom of the hole. Concrete for these holes was mixed with 25 per cent extra cement, as a factor of safety.

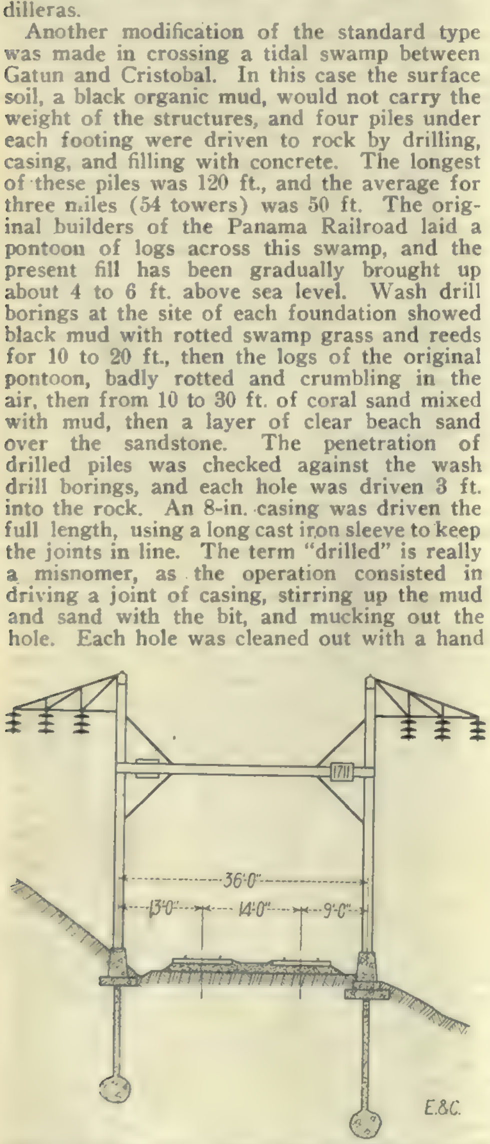


Fig. 1. Type of Track Span Bridge Used for Cristobal-Balboa Transmission Line.

FIELD ORGANIZATION.

The organization employed in constructing these foundations included the field engineering parties, the construction gangs proper, and the clerical force of timekeepers, field cost clerks, and material and property clerks. Construction was started with a small force, which was rapidly increased to a maximum of 500 employees, the increase being of course, mainly in the construction gangs. For purposes of accounting and record, the mile, as marked by the Panama Railroad mile posts, was used as a unit, each track span bridge being designated by a serial number beginning at the mile post north of it, as 7M-1.

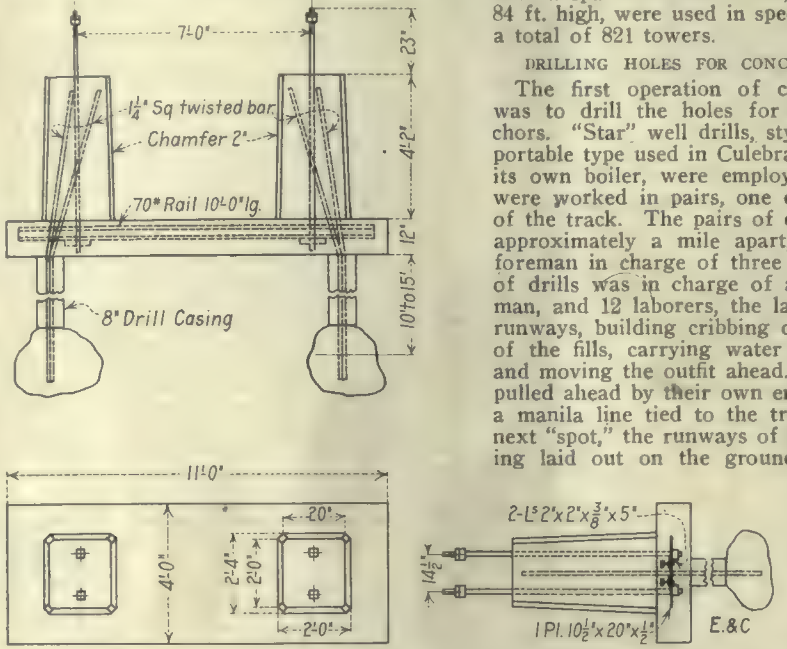


Fig. 2. Details of Standard Foundation for "Bridges" of Transmission Line.

LOCATING TOWERS OR "BRIDGES."

The first field work was the location of towers along the center line of track. Starting at a point fixed by the Chagres River Bridge, towers were spaced uniformly 300 ft. apart on tangents and curves of 2° 1' or less, 250 ft. apart on curves and from 2° to 5°, inclusive, and 200 ft. apart on curves over 5°, of which there are only four on the entire route. The chaining was done on center line of track, and stakes were set on the center and 10 ft. each way on the tangent at this center. From these "end stakes," a rectangle 20 × 36 ft. was marked out, the corners on one side of the track giving both alignment and spacing for the anchor bolts and forms. Between the end stakes, "drill stakes" were set at the point where holes for the anchors were to be drilled, 8 ft. 4 ins. apart.

It soon developed that the end stakes were liable to be disturbed by men working around the drills; hence they were usually placed after the drilling was finished, only drill stakes being set on the first survey. A full set of line stakes appeared, as in Fig. 4, and a good instrument man with West Indian negroes as chainmen and stakemen could set twelve bridges in an eight-hour day. As the equal spacing of support is quite essential for satisfactory catenary trolley construction, one or another of the three standard spans was staked according to the rule above given.

To obtain clearance at turnouts, station buildings, culverts, etc., it was occasionally necessary to use a shorter span than 300 ft. on tangents and light curves, and in such cases the next shorter standard span was staked, the bridge was moved laterally, or the obstruction removed, the only exception being sub-station dead-ends and one 334-ft. span across the Gatun River. Field book records of chaining and stakes were kept, and the Panama Railroad stationing of each track span bridge recorded.

In general, the foundations were placed 18 ft. each way from the center line on single track, and 13 ft. from the center line of the main track on sidings. As sidings are spaced 14 ft. from the main track, the opposite foundation is 9 ft. from the center line of the siding, the standard 36-ft. bridge being used in 791 cases. Twenty bridges of the same type, but 22 ft. wide, were employed in the approaches to Gatun and Cristobal sub-stations, in crossing the Chagres River bridge (suspended from the bridge girders) and over the hill pierced by Miraflores tunnel. Five bridges with a span of 39 ft. 6 ins., and five bridges 84 ft. high, were used in special cases, making a total of 821 towers.

DRILLING HOLES FOR CONCRETE ANCHORS.

The first operation of construction work was to drill the holes for the concrete anchors. "Star" well drills, style No. 15, of the portable type used in Culebra cut, each having its own boiler, were employed. These drills were worked in pairs, one drill on each side of the track. The pairs of drills were spaced approximately a mile apart, with one white foreman in charge of three pairs. Each pair of drills was in charge of a negro sub-foreman, and 12 laborers, the laborers laying out runways, building cribbing on the steep sides of the fills, carrying water for drill boilers, and moving the outfit ahead. The drills were pulled ahead by their own engines winding up a manila line tied to the track ahead of the next "spot," the runways of 3x12-ft. plank being laid out on the ground or on cribbing while the machine was drilling. This moving was difficult and hazardous at times, on the sloping berm of narrow fills, and it comprised from 50 to 80 per cent of the cost of drilling. The planking and old ties for cribbing were moved ahead on push cars on the track, at a considerably less cost than they could have been moved by hand.

All drill holes were cased with light 8-in. pipe, except in solid rock, to avoid the possibility of the hole caving in before or during concreting, as every span is required to be an anchor span. To the best of the writer's knowledge, only one hole—the first one—is open to suspicion.

EXCAVATING PITS AND SPRINGING ANCHOR HOLES.

After the drill moved off the hole, a detachment from the concreting and labor gang excavated a pit 6x13 ft. to grade, or lower if necessary to secure a firm footing, the drill holes being carefully plugged with a bundle of twigs to avoid dropping loose material into them. The engineer next set a grade stake with its top at the correct elevation for bottom of pedestals, and either checked or set the end stakes, 20 ft. apart on center line of foundation. The iron men then came in, and, after a stick of dynamite had been set off in the hole, measured the depth and cut reinforcing rods to fit. One stick of 45 per cent dynamite or Trojan powder, set off by a hand magneto, sufficed to clear the hole and expand the bottom to an approximate sphere of 2 ft. diameter, in fill or clay material. In rock, the "springing" was done twice, to insure a large pocket.

FORMS FOR BASE.

The carpenters then erected the form for the sub-base, and a stiff frame for aligning and supporting the anchor bolts, bringing the top of the form level with the grade stake, and the top of the side rail of the frame 5 ft. higher. A light wooden template, 20 ft. long, was then laid along the top of the frame, the end rails being placed 6 ins. above the side rails to support it. The center marks on its ends were adjusted over the tacks in the end stakes by means of plumb-bobs, and the templates tacked in place. A 3 x 6-in. beam, with holes bored 14½ ins. apart, to fit the anchor bolts, was next lined up exactly under the holes in the template and spiked to the side rails, the template was removed, and the alignment of all bolt holes checked with a steel tape, across the track and longitudinally. A variation of ⅛ in. was allowed, as being the practical limit of accuracy of a tape with a West Indian at one end. The construction of this form is shown in Fig. 5.

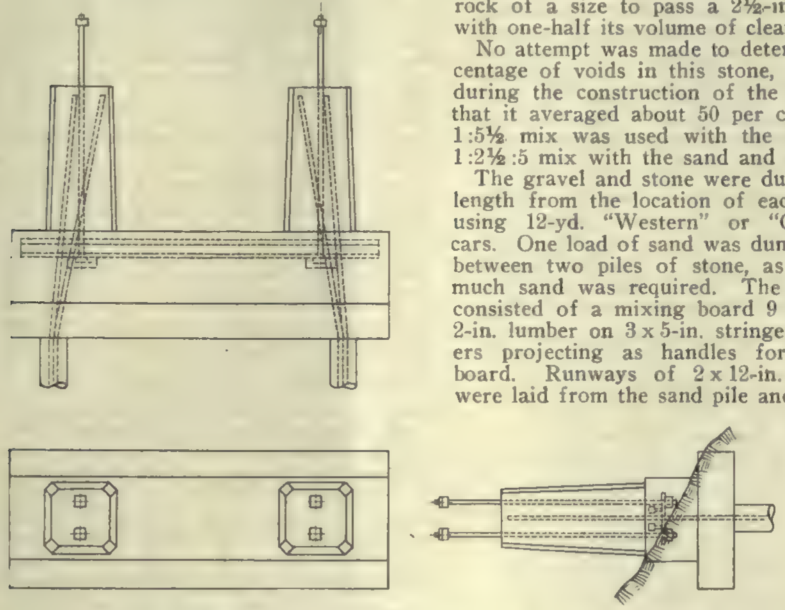


Fig. 3. Modified Type of Foundation for Steep Slopes of Fills.

PLACING REINFORCEMENT FOR BASE.

The iron men then took charge, after having previously exploded a stick of dynamite in the hole and measured the depth. They next lowered the reinforcing rods in the hole, dropped the bolts through the holes in the 3 x 6-in. beam, put the plates on the bottom, and laid the two old rails in place. The tops of the bolts were brought to grade by running the nut at the top up or down. Each bolt was tested with a carpenter's level for plumbness, and a split template was tacked across the top of the sub-base form to hold the alignment during concreting.

Reinforcing steel was cut and bent, and minor repairs to tools and equipment used in concreting were made, in portable forges sheltered by a corrugated iron roof, the "shop" being moved about a quarter of a mile at a time by the iron gang on a push car. Saws, shovels, picks, cold chisels, etc., were sharpened in this shop during "off times" of the day.

All forms, including the bracing and framework to hold the anchor bolts, were made easily removable, and were used over and over until worn out by nail holes or the rough and tumble handling they received when unloaded to clear a train bearing down on a push car load moving ahead. The placing and removal of forms was done by West Indian negroes under the direction of a white American carpenter, a gang consisting of 10 carpenters, 4 iron men, 2 flagmen, and the omnipresent "aguatero," or water boy. The water boy deserves special mention, as it is no simple or unimportant matter to find good drinking water for 20 negroes working under a Panama sun along the track. The boys were under twelve years of age, and the writer has known them to carry a five-gallon can full of water for a mile and a half. The British negro will not drink anything he things will give him "feevah", and he cannot work without water.

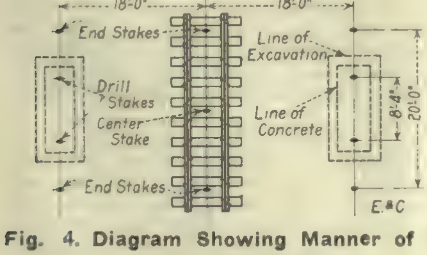


Fig. 4. Diagram Showing Manner of Staking Out Foundations.

MIXING AND PLACING CONCRETE.

After the forms and the reinforcement were placed, the next operation consisted of mixing and placing the concrete. All concrete was hand mixed, the materials being either Chagres River gravel, not washed nor screened, but fairly clean and well graded as it came from the dredges; or crushed trap rock of a size to pass a 2½-in. ring, mixed with one-half its volume of clean sand.

No attempt was made to determine the percentage of voids in this stone, as tests made during the construction of the locks showed that it averaged about 50 per cent voids. A 1:5½ mix was used with the gravel, and a 1:2½:5 mix with the sand and stone.

The gravel and stone were dumped one rail length from the location of each foundation, using 12-yd. "Western" or "Oliver" dump cars. One load of sand was dumped half way between two piles of stone, as only half as much sand was required. The mixing plant consisted of a mixing board 9 ft. square, of 2-in. lumber on 3 x 5-in. stringers, the stringers projecting as handles for moving the board. Runways of 2 x 12-in. rough plank were laid from the sand pile and stone pile to the board. A barrel for water was set alongside the board, and filled by men with buckets, carrying from streams or ditches, and, for most of the distance from the canal. The operations involved in concreting were as follows: Three men with wheelbarrows loaded the board with ½ cu. yd. of stone and ¼ cu. yd. of sand, the stone being placed first. Four men with shovels spread the stone and sand evenly over the board, and spread the cement on top. The loaders then proceeded to fill the wheelbarrows and load the board across the track, and the mixers to pile the batch up in a steep cone, in the middle of the board. They then "cut" the batch over, dry, into two piles at the side of the board, shoveled it back into a ring, and a fifth man then poured in the locally as required. When the whole batch "cut" it again, the water man adding water water from the barrel. The mixers then piled the batch into a cone again, wet this time, and has been finished, and not before, it is shoveled into the form and tamped into the drill holes and around the irons. The mixers then moved across the track, and the loaders recharged the first board while the second batch was being mixed.

The sequence and completeness of all the steps of mixing and placing were specified and strictly maintained, as it is not safe to trust to the judgment of the West Indian negro. He learns to do a certain thing in a certain way at a certain signal, and, with supervision, will do just that and do it well.

The process, above described, errs, if at all, on the side of overmixing. A complete cycle required about 15 minutes, and one gang of 4 mixers, 3 loaders, 1 water man, and 2 water carriers could mix 12 to 16 cu. yds. of concrete (for four different forms) in an eight-hour day.

When the drill holes and sub-base were filled, the concrete gang moved to the next "bridge," while the carpenters set and braced the pedestal forms. The latter were removable forms of 2-in. lumber, lined with galvanized iron for smoothness and durability, and fastened with bolts (see Fig. 6).

Four carpenters, working together, set up, aligned, and braced the four pedestals in between 30 and 40 minutes. The concrete gang, on completing the sub-base ahead, returned and filled the four pedestals, the carpenters in turn moving ahead.

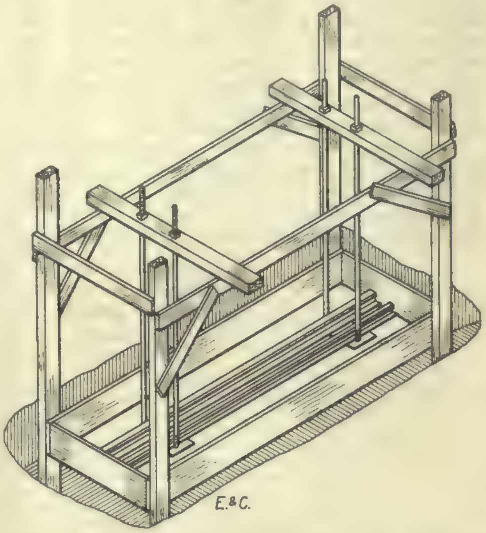


Fig. 5. Isometric View of Form for Foundations.

REMOVING AND RESETTING FORMS.

The forms which were filled one day were removed the next, their removal being the first work of the day for the carpenters. As the various pieces were removed, they were piled up beside the track, and were moved ahead by a push car to a point near the next excavation, where they were re-erected after being cleaned, and having the nails pulled out.

A detachment from the excavating gang finished the foundation by backfilling to the level of the sub-grade, cleaning ditches, disposing of surplus sand, stone, or gravel, and cleaning up the right-of-way. Any surplus iron or lumber was piled up to be removed by the work train.

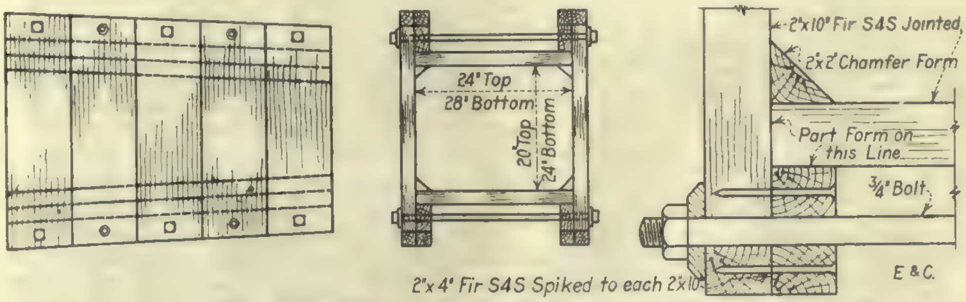


Fig. 6. Details of Portable Forms for Pedestals.

DISTRIBUTING METHODS AND HANDLING OF WORK TRAINS.

One of the principal difficulties encountered was the distribution of material in small lots all the way across the Isthmus. Another difficulty was in getting the men from their homes to the widely separated working points. To take care of these two features, a work train, in charge of a qualified crew and under the direction of a material foreman, was employed throughout the job. Material was shipped via the Panama Railroad to stations along the route, and was handled by the material foreman to the various gangs. As soon as the engineering parties had marked out the location of towers, gravel or stone and sand were hauled out and dumped at each bridge. Reinforcing steel, old rails, anchor bolts, and form lumber were unloaded in piles at about four places to a mile. Coal and casings for the drills were unloaded at about eight places per mile, sheets of old corrugated iron roofing, some of it left on the Isthmus by the French canal diggers, were laid on the ground to prevent loss of coal.

Cement was unloaded into portable sheds, 8 ft. x 8 ft., with a capacity of about 400 sacks of cement. Two of these were placed in each mile, and refilled as required. The sheds were built of 2x4-in. and 2x6-in. lumber, with sides, roof and door of corrugated iron roofing, the floor not attached to the walls. They could be lifted bodily by ten men, and were handled either by the train or on push cars.

Saturday of each week was devoted to the distribution of small tools and supplies and to the collection of empty cement sacks. Each foreman was required to hand a list of his needs to the general foreman or material foreman on or before Friday, for the next week. Such material as was not on hand was secured from the quartermaster's storehouses on Friday, and delivered on Saturday by train.

On completion of a mile, the entire outfit of each gang was loaded on the train, hauled to a new location, and set down ready for work. The drills, of course, completed the mile first, and were moved first, usually four or six drills at a time, including all those under one drill foreman. The concrete gangs followed two to five days behind the drills. A unit organization included two drills operated by one gang, one carpenter and iron work gang, and one excavation, concrete and backfill gang. An engineering party kept stakes set ahead of two or three unit gangs, and recorded the elevations, spacings and progress behind them. Five such units were organized and continued until near the completion of the foundations.

In addition to the distribution of materials and supplies, the work train made a trip morning and evenings as a labor train, taking men to work and bringing them in at night, over about half the line. Later trains operated by other departments of the canal work were utilized elsewhere.

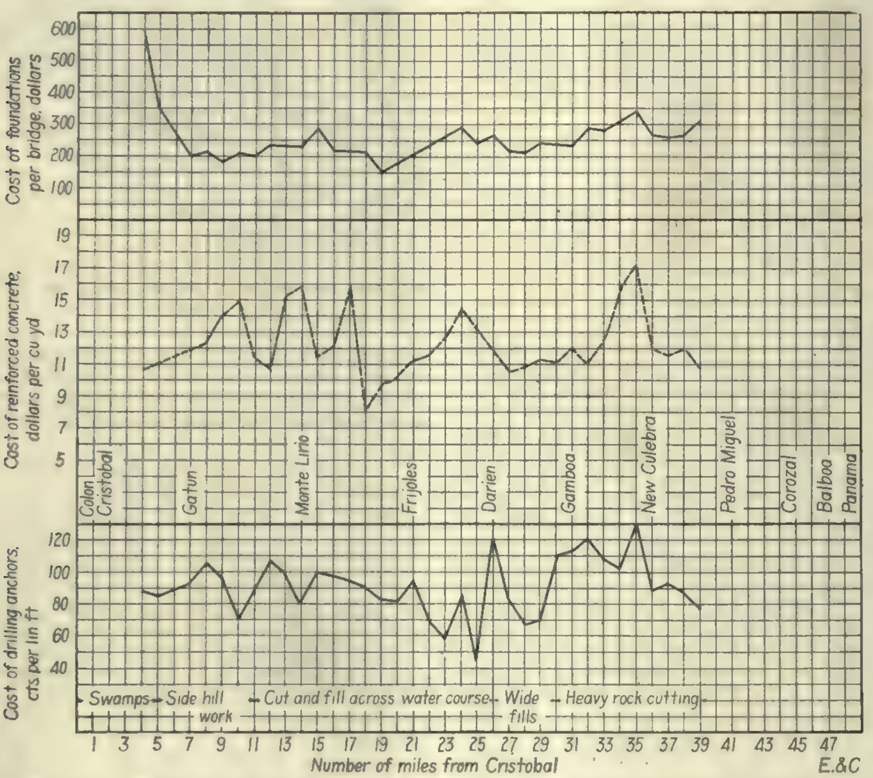


Fig. 7. Diagram Showing Cost of Drilling, Cost of Reinforced Concrete Work, and Total Cost of Foundations at Various Points Along Cristobal-Balboa Transmission Line.

LABOR CAMP.

For twelve miles near Frijoles, a camp was established, as the nearest town was 14 miles away—too far for efficient labor train service. The camp at Frijoles was erected by the quartermaster's department on the edge of Gatun Lake, and consisted of nine tents, 20x 40 ft., for "silver" (negro) employes, and five tents, 14x14 ft., for "gold" (white American) men.

All tents were floored and screened, and were provided with flies for protection against sun and rain. A branch of the Panama Railroad commissary was established where food supplies could be purchased, and the silver men did their own cooking. The gold men clubbed together to operate a mess, the cook and waiter being paid by the Commission and the supplies bought at the commissary.

TEST LOADS.

Test loads were applied to four foundations, at points where conditions were least favorable, by piling pig iron in excess of the load which was to be carried. In no case was any settlement noted, although elevations were taken and measurement checked at frequent intervals. At least two sets of readings were taken with a wye level on each anchor bolt, the distance across the track being checked at the same time. In three cases a sliding of the fill moved the foundations out of line and grade, and it was necessary to partially wreck and repair them.

COST DATA.

The diagram of Fig. 7 gives the cost of drilling for the anchors, the cost of the reinforced concrete, and the cost of the foundations for bridge, for work along the first 39 miles from Cristobal. Miles 4 and 5 are mostly in the tidal swamps between Gatun and Colon. Work was started at miles 34 and 35, and the cost values for this part of the work involve factors of new organization and inexperienced labor. It is believed the costs for the remaining distance are fairly representative of average conditions on any average railway, except for the climate factor.

ADAPTABILITY OF PEDESTAL TYPE OF FOUNDATION.

The type of foundation described is adaptable to tower structures in general. The pedestal piles can be made by boring with a posthole auger, where soil conditions permit. This was done on the Isthmus where clay cuts 1,000 ft. or more in length were found. The auger hole is not easy to case up, however, and its use requires firm ground. In locations where the transportation of materials for concrete is expensive, as on long cross country transmission lines, for isolated anchor towers on lines using wooden poles, for special installations at sub-stations, for track-spanning bridges on the electrification of existing steam railroads and for other types of foundations which require strength against both downward and upward pressure, the expanded pile, surmounted by a pedestal, should be serviceable and economical.

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ACKNOWLEDGMENT.

The foundations described were designed in the office of the Electrical and Mechanical Engineer of the Panama Canal Commission, and were built under his direction. The data were taken from a paper by Ira W. Dye, general foreman in charge of field engineering, construction and clerical organization on the work, in the January Proceedings of the Engineers' Society of Western Pennsylvania, p. 973.

A meeting will be held on Oct. 22 at noon at the Fort Dearborn Hotel, Chicago, of Sub-division 63, the engineers' division of the Chicago Association of Commerce. All engineers, architects, contractors or builders interested are invited to be present. Mr. H. M. Saumenig will address the meeting on the subject "An Americanization of English Quantity Methods."

The Lighter Side of Engineering and Contracting

Watchful Praying.

E. E. DAVIS, superintendent of water works at Richmond, Va., each year makes a speech at the annual meeting of the American Water Works Association in which he invites that organization to hold its next meeting in his city. Richmond gets at least two votes each year: Mr. Davis' and ours—we will vote for anything advocated by such a famous story teller. His stories have become a convention feature; he is always on hand to press Richmond's claims as a convention city. This year, to illustrate how he is always on the job, he told this story of a man who lost out by a little oversight in his follow-up system: Two preachers, strangers in a Southern city, were being entertained over night at the home of a hospitable citizen. The latter liked his mint julep in the morning and while enjoying one on this occasion thought of the parched throats of the two reverend gentlemen upstairs. So he sent two juleps up to them with his compliments. This so moved one preacher that he fell on his knees to return thanks. He was very thankful and it took him a long time to tell about it. While he was thus engaged the other preacher inhaled both juleps. The thanksgiving detail disposed of, the thankful one arose and reached for his julep. Seeing two empty glasses, he marveled, whereupon his companion said: "Brother, you must watch, and pray."

The Engineer Bane Daid.

P. J. Hannon, the railroad contractor, has a friend who devotes his spare moments to the gentle pastime of making one blade of grass grow where two grew before. In other words he is an amateur farmer. A few weeks ago Hannon's friend engaged a Swede, newly arrived in this country, as a farm hand. The new man was expected to be on the job at 4 o'clock each morning, but he was late so frequently that the farm superintendent threatened to fire him. Then the Swede bought an alarm clock and for several days everything was fine. But one morning he arrived at work about 3 hours late. The superintendent immediately discharged him despite his protests that the alarm clock was to blame. The former employee went to his room and swore at the alarm clock. Then he took it to pieces, found in the works a dead cock roach. Then he broke loose. "By haal," he said, "Ay tank it no wonder, the clock stop, the engineer bane daid."

J. H. MAXEY, one of the few contractors now engaged on a really truly railroad contract, is the proud and haughty owner of a Ford. The other day he went into a barber shop. Just after the hot towels had been applied, the porter, greatly excited, rushed in and shouted: " "Am dat yo Fode outside, Mr. Jim? If it's yourn yo bettah look out for it. De ants am draggin' it under de sidewalk."

A Building Contractor's Satire on Architect's Specifications.

General: The plans and specifications are to be taken together. Anything shown in the plans and not mentioned in the specifications and anything mentioned in the specifications and not shown on the plans is to be considered as both shown and specified; and anything wanted by the architect or any of his friends, or anybody else, (except the contractor) shall be considered as shown and specified, implied and required, and shall be provided by the contractor without expense to anybody but himself. If he can do the work without expense to himself, the work shall be taken down and done over again, until the expense is satisfactory to the architect.

Architect: The term architect herein appearing shall be understood to mean the architect or any engineer that he foolishly but courteously employs to assist in making trouble for the contractor.

Plans: The plans are to be considered diagramatic, and are to be followed only where space conditions make it possible to avoid so doing. Coincidence between the plans and executed work shall not be considered a claim for extra compensation. The architect is not required to recognize coincidence. Anything that is right on the plans is to be considered right; anything that is wrong on the plans shall be discovered by the contractor, and shall be made right without telling on the architect or on bills. Anything that is forgotten or missed out of the plans and specifications, but which is necessary and required for the comfort and convenience of the owner, shall be provided by the contractor, to the satisfaction of everybody (except the contractor) and in full accord with the evident intent and meaning of the specifications, without extra cost to anybody but the contractor.

Rules and Regulations: The work throughout shall comply with all rules, regulations, caprices and whims of all city, county, state, national and international departments, bureaus and officials having or not having jurisdiction. TAMMANY HALL shall be considered an official department.

Materials: All the materials shall be the best of their several kinds. The contractor is expected to know and provide the best, irrespective of what is specified in detail. The architect reserves the right to change his mind about what is best. Any changes necessary to make work and material fit the mind of the architect shall be made by the contractor without extra charge.

Permits: The contractor shall obtain and pay all fees, annual dues, assessments and subscriptions to masked balls, organizations and coat and hat checks.

Guarantee: The contractor shall guarantee and does guarantee that he will keep in complete working order, anything that the architect asks him to attend to, so long as there is more work in sight in the architect's office.

Arbiter: In case of any dispute arising as to the nature, character or extent of work shown, specified or implied, the matter will be decided by referendum and recall, after which the decision shall be set aside and reversed by the architect and designer-in-chief of the national government.

Payments: Payments, if any, shall be made on the architect's certificate. Architect's certificates shall not be considered negotiable, nor are they legal tender. When once issued, the architect assumes no responsibility for their future usefulness. Partial payments shall be made as the work progresses in the amount of 85 per cent of the value of the work done as judged by the architect. In no case shall the judgment of the architect cover more than enough to pay the wiremen and helpers every Saturday night. The material men must take the customary chances. The final payment, if any, shall be made when everybody is satisfied (but the contractor). Any evidence of satisfaction on the part of the contractor shall be considered a just cause for withholding final payment.

The contractor shall accept and hereby does accept the conditions hereinbefore appearing, for himself, his ancestors and progenitors, his family, heirs, executors, his ox, his assignee and the stranger within his gates.

Some Satisfaction Anyway.

THE citizen felt he had a grievance and stormed angrily into the office of the water department of an Eastern city. "See here," he announced fiercely to the clerk, "You send a man up to my house and take out your old gas meter." The clerk politely informed him that he was in the wrong office. "Isn't this the office of the gas department?" demanded the man. "No," replied the clerk, "this is the water office." "Oh, it is," said the citizen. "Well, then, send a man up to my house at once to turn off the water. I'm not going to walk a mile and a half for nothing."

Skinner Mulveys Says: Johnnie Kane says Indians are plum fools on booze. He met one the other day. Indian offered him gun, saddle and then his horse for a drink of whisky. "Why didn't you give it to him," I asked. "What, let him have my last drink, nit?" said Johnnie.

CURRENT NEWS

The Doings of the Week.

Unusual betterment in trade conditions was a feature of the past week. Business activities continued to show gains. Payments through banks were nearly 20 per cent higher than for the corresponding period in 1915. The outstanding optimistic development of the week was the Government October crop report giving practically final figures on the harvest yield. This shows the largest wheat crop in the history of the country (over 1,000,000,000 bus.) and record crops for other agricultural products. In the construction field there has been a slight improvement over last week as regards new work coming up for bids. The lateness of the season, of course, is responsible for the falling off in some lines of work. Most cities have about completed their program for paving improvements for the present year, and are now preparing estimates for next year. Highway construction also shows the approach of cold weather. In the building field there are many signs of improvement. In Chicago building permits for September amounted to $8,579,050 as against $4,926,000 in September, 1914. It is expected that building construction in this city for the entire year of 1915 will total perhaps $85,000,000. Autumn plan fillings are assuming large proportions in the east. In the iron and steel trade the records of previous weeks were sustained. Exports of iron and steel products in August made the unprecedented record of 401,000 tons. The U. S. Steel Corporation produced ingots at the rate of 1,690,000 tons for the month. Orders for about 100,000 tons of bars, plates, shapes and axles were placed by the car builders. Bridge contracts closed included 1,200 tons for the Central R. R. of New Jersey, 3,000 tons for the Long Island R. R., 800 tons for the Northern Pacific R. R. and 200 tons for the New York Central & Hudson River R. R. Fabricating shops took contracts in September equal to 67 per cent of capacity. The low bid on 60,000 tons of steel for the Brooklyn Rapid Transit R. R. averaged $44.60 per ton for fabricated material delivered in Brooklyn. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Oct. 13, were as follows:

Finished Iron and Steel.	Oct. 13.	Oct. 6.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.559	1.509
Iron bars, Pittsburgh	1.40	1.40
Iron bars, Chicago	1.35	1.35
Steel bars, Pittsburgh	1.40	1.40
Steel bars, New York	1.569	1.569
Tank plates, Pittsburgh	1.40	1.40
Tank plates, New York	1.569	1.569
Beams, etc., Pittsburgh	1.40	1.40
Beams, etc., New York	1.569	1.569
Skelp, grooved steel, P'gh	1.40	1.40
Skelp, sheared steel, P'gh	1.45	1.45
Steel hoops, Pittsburgh	1.50	1.40
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	2.00	2.00
Galv. sheets, No. 28, P'gh	3.50	3.50
Wire nails, Pittsburgh	1.75	1.75
Cut nails, Pittsburgh	1.70	1.70
Fence wire, base, P'gh	1.60	1.60
Barb wire, galv., P'gh	2.60	2,60

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.40 cts.

Railways.—No developments of particular importance in the railway construction field occurred during the past week. No big jobs came up for letting, nor does there seem to be much prospect that any will make their appearance in the near future. Many of the railroads are now making good showings as regards earnings and some of them are buying quite liberally in the iron and steel market. Betterments, extensions and other improvements, however, are being held in abeyance.

Roads and Streets.—No particularly large undertakings in the state highway field came up for advertising during the past week. Massachusetts is calling for bids on one or two contracts, New Jersey is calling for proposals on one road and Idaho is calling for bids on about 32 miles of road work. Ohio opened proposals on over $200,000 worth of work on main market and inter county roads in northern Ohio. Philadelphia, Pa., opened bids Oct. 14 on street improvements to cost about $181,750. Kinston, N. C., awarded $160,000 street paving contract. County Commissioners at Bedford, Ind., awarded a $62,000 contract for a section of the Dixie Highway.

Bridges.—A fair amount of new bridge work reached the call for bids stage during the past week. No notably large structures, however, appear to have been advertised. Bids will be opened Nov. 3 at Wabash, Ind., for a $40,000 reinforced concrete bridge. County auditor at Houston, Tex., receives proposals until Nov. 1 on a $35,000 structure. The California, State Highway Commission is asking bids on a 300 ft. reinforced concrete bridge. Numerous smaller concrete bridges are being advertised by counties in Kansas and in Illinois. The Philadelphia & Reading Ry. awarded contracts amounting to about $64,000 for bridge work on its Richmond branch at Philadelphia, Pa.

Drainage and Irrigation.—A considerable amount of drainage and irrigation work probably will come up for advertising this fall. In the far west, particularly in California, Washington and Oregon, several notably large irrigation projects are now nearing the construction stage. Bids are now being asked on a large judicial ditch job in Roseau and Beltrami Counties, Minnesota, the work calling for 1,433,962 cu. yds. of excavation; the estimated cost is $193,173. The Donna Irrigation District, Donna, Texas, opens bids Nov. 1, on improvements, estimated to cost $425,000. The work includes 2,000,000 cu. yds. of earth excavation. Several smaller drainage jobs, ranging around 150,000 cu. yds. each, are being advertised.

Water Works.—No particularly large undertakings in the water works field were advertised during the past week. Hartford, Conn., is asking bids on about 830 acres of clearing and grubbing for the Nepaug reservoir basin. The Winnipeg, Man., Water District opens proposals Oct. 25 for supply of 200,000 bbls. Portland cement for use during 1916. Bids are being asked by a number of cities for supply of pumping machinery and other equipment. Coatesville, Pa., awarded contract for its high service system. Manchester, N. Y., let contract for water works. Lumberton, N. C., awarded contract for water works and electrict light plant. East Liverpool, O., let contracts amounting to about $195,000.

Sewerage.—Most of the work advertised this week covers small jobs. Idaho Falls, Idaho, is asking bids on 16,000 ft. of sanitary sewer. Mansfield, O., opens proposals Oct. 21 on a sewage disposal plant. Bids are asked for sewer and sewage disposal plant for New York State Training School for Boys at Yorktown Heights, N. Y. Ste. Agathe du Monte, Que., opens tenders Oct. 25 for sewer system and sewage purification works. Vermillion, O., is asking proposals for sanitary sewer system and sewage disposal plant. Mesa, Ariz., awarded $51,000 contract for sewer construction. Visalia, Cal., let contract at $40,500 for sanitary sewer extensions. South Bound Beach, N. J., let a $28,000 sewerage work job. Forest Grove, Ore., awarded $58,000 contract for sanitary sewer system.

Rivers and Harbors.—U. S. Engineer at Cincinnati, O., opens bids Nov. 1 for reconstructing in concrete part of abutment at Dam No. 1, Muskingum River, O. U. S. Engineer at Jacksonville, Fla., is asking bids for dredging work requiring removal of 60,000 cu. yds. of sand and 110,000 cu. yds. of rock. State Board of Engineers, New Orleans, La., awarded contract for 170,000 cu. yds. of levee. Contracts were let to following for levee work in Lower Tensas and Atchafalaya Districts; Gibson, Hamilton Co., Natchez, Miss., 515,000 cu. yds., E. H. Jackson, Natchez, Miss., 102,500 cu. yds.; W. C. Mullen, Vicksburg, Miss., 295,300 cu. yds.; N. C. Williamson, Millikin, La., 91,700 cu. yds.; L. E. Pickett, Natchez, Miss., 87,500 cu. yds.

On the Threshold of Prosperity.

Once again, according to the daily press, this country is on the threshold of the greatest era of prosperity in its history. There is nothing original about this statement. Our best little optimists have been using it for the past 12 months; the newspapers have dragged it out at every opportunity. And yet somehow we never seem to cross that threshold; we are always just on the point of doing so. This time, however, there seems to be some real basis for the widespread belief that better times are waiting right around the corner. There have been many indications of this in the last few weeks. The steel industry is working at capacity; railroad earnings are increasing; trade conditions show unusual betterment; idle investment capital is more abundant. And now comes the Government October crop report showing the greatest harvest yield in the records of the country. Over a billion bushels of wheat, making it the greatest crop in our history, the second greatest corn crop, record crops of barley, hay, oats and rye and better than average yields of fruits and potatoes, are noted in the report. Perhaps now, thanks to nature's bounty, we shall cross the fabulous threshold and enter the land of plenty.

Not a Job to Our Liking.

In these days of construction dullness almost any job will bring out lively competition from contractors. A few days ago the Board of Water Commissioners of Hartford, Conn., took bids on the somewhat grewsome task of transplanting the occupants of two cemeteries. Two contracts were advertised, each of them calling for the removal of about 190 bodies from burial grounds, acquired by the commissioners in connection with the Nepaug Reservoir development. Five bids were received on each job, the prices on one ranging from $3,497 to $5,674 and on the other from $2,712 to $3,346. The specifications required that none of the caskets be broken open during transit to the other cemeteries. It also was specified that after the bodies had been disinterred, the graves should be thoroughly disinfected before being closed again, and that the surface of the cemetery should be leveled off. The contractors also will transfer the grave stones and erect them over the proper graves in the new cemeteries. It is a pretty safe guess that negro labor will not be used on these contracts.

Irrigation System Construction.

An encouraging recent development is the large amount of irrigation work for districts and private companies now apparently nearing the construction stage. Many extensive projects have been ready for some time for the awarding of contracts. All engineering details have been completed and bond issues authorized, but the actual placing of the work with contractors has been deferred because it was not possible to dispose of the securities. In the last few weeks, however, there has been a decided change for the better in the status of these undertakings. Several fair sized contracts already have been placed, and more will come up for letting in the near future. It looks now as though earth moving contractors would find plenty of opportunities in the many irrigation developments projected in California, Oregon and Washington.

FLOOD PREVENTION WORKS FOR ERIE, PA.

Proposed Plan for Improvement of Mill Creek.

Stream to be Carried in Conduit and Concrete Lined Channel.

The construction of flood prevention works to cost nearly $800,000 is recommended for the city of Erie, Pa., by Farley Garnett, Consulting Engineer, Harrisburg, Pa., in a report submitted last month to B. E. Briggs, City Engineer. The carrying out of the project, it is stated, will affectually prevent a recurrence of the disasterous flood in Mill Creek of last August. The plan of development includes the construction of a detention reservoir, and the substitution of a concrete conduit or concrete channel for the present stream bed of Mill Creek. The alignment of the creek also would be changed. The recommended plan proposes the construction of a closed reinforced concrete horse shoe shaped conduit from the Pennsylvania R. R. crossing at the lake front to the Nickel Plate R. R. crossing at 19th St., a distance of about 8,100 ft. All sharp bends in the present channel would be eliminated and about 2,400 ft. relocated to obtain a shorter and straighter course. From the Nickel Plate crossing to the city line the creek would be carried in an open concrete lined channel. The length of this section would be about 4,800 ft. The closed section would be 18 ft. wide by 14 ft. high inside and would have a capacity of 6,000 cu. ft. per second. The open channel would be 25 ft. wide on top and 12 ft. deep.

Wherever possible the present alignment of the creek will be followed. All bends, however, will be eliminated. Below the Pennsylvania R. R. embankment it is proposed to dredge a straight open channel, the excavated material being used to construct dikes along the sides of the channel. From the Pennsylvania R. R. to 8th St. it is proposed to follow closely the present channel, easing off curves and passing through such culverts as can be economically used. It will be necessary to excavate below the present bottom under all such structures in order to get the required depth. Through this portion of the line the average depth of the bottom of the conduit would be about 5 ft. below the present creek level.

At 8th St. a bad angle in the present culvert would be eliminated, by passing to the east thereof, joining the channel between 8th and 9th Sts., to leave it again just north of 9th St. From 9th St. to 14th St., the new line departs from the old alignment, lying to the west of it up to 12th and French Sts., where the present creek is crossed. From this point to 14th St. the new line would lie to the east of the old. The greatest divergence of the revised alignment from the present channel would be from 10th to 12th Sts., where they are approximately 200 ft. apart. The new line traverses a section in which few buildings stand and in which all were either removed or badly damaged by the flood of Aug. 3rd.

From 14th St. to 26th St. the old channel is closely followed. At 26th St. the new line swings on an easy curve to the west of the present creek, crossing it at Hill Road and Moorhead St., eliminating two sharp bends and 1,000 ft. of length, terminating to the west of the old line near the city limits. The improved channel would terminate in an intake, with wing-walls and dikes, designed to throw the water into the concrete channel.

Between the intake and the reservoir it is proposed to remove dead trees, logs and debris and to improve the existing channel in some places. Where the side hills converge, between the brick works and the forks in the creek, 1¼ miles above the city line, a dry, detention reservoir is proposed. This reservoir, formed by a concrete barrier, 60 ft. high, with an opening in its base 7.5 ft. in diameter, would have a capacity of 390,000,000 gals. This structure would be 350 ft. long on top and approximately 40 ft. thick at the base. The reservoir would be one mile long, but the land inundated would be of small value, as most of the 55 acres is stony lowland or steep valley side.

The reservoir would seldom have any water in it, as only at long intervales would a flood come down the creek larger than would be carried by the culvert which would drain it. But at the rare intervals when such a flood did come, the reservoir area would be there to absorb it, letting out just so much water as could be safely carried down through the city. The conduit is so designed as to be capable of carrying the water let through the reservoir plus the maximum run-off from the area north of the reservoir which would enter the creek. The reservoir would catch debris from the 8.5 square miles above it and so prevent its getting into the channel. A drift, or debris catcher or deflector, would also be constructed at the upper end of the concrete channel.

At 20th St. it is proposed to construct a high concrete arch bridge spanning the entire valley with one or two arches.

The entire cost of the project exclusive of land damages is estimated at $798,000. This includes reconnecting all broken sewers with the interceptor in the lower portion of the city and siphoning under the conduit at all sewer crossings. It also includes refilling all street crossings and repaving streets at creek and conduit crossings and replacing curbs and sidewalks.

The city is now considering the matter of issuing bonds to carry out the improvement. It is doubtful, however, if anything further than the making of more detailed designs and estimates will be undertaken this fall.

Naugatuck Valley, Conn., Conservation Project.

One of the largest artificial reservoirs in New England will be created if the plans for water conservation in the Naugatuck Valley, Connecticut, are carried out. A report on this development was submitted recently to a committee representing interested manufacturing corporations, by Charles H. Preston, Jr., Consulting Engineer, Waterbury, Conn. The report recommends the construction of a large dam on Lead Mine Brook and the establishment of a storage reservoir with a capacity of about 3½ billion gallons. This brook has its source near Torrington, Conn., and enters the Naugatuck River near Thomaston.

The tentative designs provide for a dam of the gravity type constructed of cyclopean masonry. It would be 1,300 ft. in length, with a maximum height of 142 ft., 13 ft. wide at the top and 118 ft. wide at the base. It would contain 190,000 cu. yds. of masonry and would be founded on solid ledge rock for its entire length. At the westerly end of the dam there would be a spillway 250 ft. in length with its crest 10 ft. below the finished top of the dam. Through the base of the dam there would be a reinforced concrete wasteway 130 ft. long with a clear inside opening 7x9 ft. The flow through this opening would be controlled by a sluice gate operated by hand labor or an electric motor. The valve stem would be about 145 ft. in length and 5 ins. in diameter.

Preliminary investigations looking to the conservation of water in the Naugatuck River were made in 1913 by Mr. Preston, and his report stated that it was possible to develop three large compensating reservoirs on Lead Mine Brook. In 1914 Mr. Preston was instructed to report on the development of one of these reservoirs. It is stated that the total development of the Lead Brook project would mean a dependable stream flow in the Naugatuck River for the four dry months of each year exceeding 12 ins. in depth. With further developments on the three tributary streams it is the engineer's opinion that this depth of 12 ins. could be increased to 30 ins.

The carrying out of the project would prove of immense benefit not only from an industrial standpoint, but also from a sanitary one. The estimated sewage population on the Naugauck River is 140,000 and the number of manufactories is 130, 80 per cent of which are metal works, discharging chemicals and acids at all periods of the year into the river.

The project is now under consideration by the manufacturers, who are to determine in the near future what further steps will be taken.

THREE LARGE IRRIGATION PROJECTS.

Contracts to be Let Soon for Work in Oregon and Washington.

Expenditure of Over $2,000,000 Proposed.

Three important irrigation projects, two in Oregon and one in Washington, will be placed under construction soon. These developments are to be carried out for the Brewster Irrigation District, the Suttles Lake Irrigation District and the Portland Irrigation Co., controling the Paisley Irrigation Project. O. Laurgaard, Portland, Ore., is the Consulting Engineer for the three projects.

The Brewster project is located in north central Washington in the famous Wenatchee Valley District, so the lands are very well adapted to the raising of fruits and other high class crops, when water is available, and as a rule are sold for very high prices. The project itself contains no especially difficult engineering feature. It involves the construction of a flume, approximately 30 miles in length and the installation of one power plant and three pumping units, in addition to the ordinary work included in a lateral and distribution system for 15,000 acres of irrigable lands. The District contains 20,000 acres of land and also includes the incorporated town of Brewster, which is the headquarters for the District. Bonds have been voted to the extent of $1,250,000, arrangements for the sale of which are being negotiated by the Directors. Arrangements also are now being made with contractors for the construction of the project on the basis of bonds as pay. C. R. McKinley is President and W. R. Hunner is Secretary of the District, Brewster, Wash.

The Suttles Lake Irrigation District is situated on the DesChutes River in Central Oregon, near the town of Culver and embraces an area of 35,000 acres, for which water in sufficient quantity is available to irrigate 12,000 acres. It is intended to pro rate this water among all the land owners of the District. Bonds to the extent of $600,000 have been voted, notices for the sale of which are now being published. The construction of the project includes a 60-ft. earth fill dam with concrete core wall at Suttles Lake, a long canal line of approximately 18 miles in length, principally earth excavation, and the ordinary lateral and ditch construction incident to an ordinary irrigation project. The lands are well adapted for the growing of forage and root crops. After the bids for the sale of the bonds have been opened in November, arrangements will be made for the construction of the project either on a cash basis or on the basis of the bonds as pay, according to whether or not satisfactory arrangements for the sale of the bonds are made. H. J. Chenowith is President and C. I. Henline is Secretary of the Suttles Lake Irrigation District, at Grandview, Ore.

The Paisley Irrigation Project is located in Lake County, Oregon, and will be constructed under the terms of the Carey Act by the Portland Irrigation Co. The project involves the irrigation of 12,000 acres of land, which are well adapted to the growing of forage crops, vegetables, etc. About half of the lands have been sold and the balance will be sold to actual settlers at prices varying from $40 to $75 per acre. In addition a storage reservoir of approximately 50,000 acre feet capacity and a dam 83 ft. in height will be necessary. Advertisements for the construction of the entire project, or separate portions of same, will be sent out in the near future.

County Highway Construction in Florida.

More highway construction probably is at present under way or in contemplation in Florida than in any other southern state. The work is being undertaken by the counties or by county road districts or precincts. The funds are supplied generally by the sale of bond issues authorized by vote of the citizens.

The first county to undertake the improvement of its roads on a large scale was Hillsborough. Three years ago this county authorized a $1,000,000 bond issue for this purpose. Since that time there has been a great increase in interest in better highways, as is shown by the fact that since the first of the present year 12 counties have authorized bond issues aggregating $4,328,500. In addition 7 other counties propose issues amounting to $3,165,000. The following tabulations rearranged from the Manufacturers' Record show the counties and the amount of the bond issues. Table I shows the counties in which bond issues have been authorized since June 1. Table II shows the pending issues:

TABLE I.—BOND ISSUES AUTHORIZED.

County.	County Seat.	Amount.
Clay	Green Cave Springs	$ 150,000
De Soto	Arcadia	760,000
Hernando	Brooksville	150,000
Lake	Tavares	500,000
Lee	Fort Myers	177,000
Leon	Tallahassee	200,000
Orange	Orlando	600,000
Palm Beach	West Palm Beach	800,000
Pasco	Dade City	258,500
Putnam	Palatka	233,000
Seminole	Sanford	450,000
St. Lucie	Fort Pierce	600,000
Total		$4,328,500

TABLE II.—PENDING BOND ISSUES.

County.	County Seat.	Amount.
Columbia	Lake City	$ 350,000
Dade	Miami	275,000
Lafayette	Mayo	300,000
Lee	Fort Myers	125,000
Pinellas	Clearwater	715,000
Polk	Bartow	1,000,000
Taylor	Perry	500,000
Total		$3,165,000

The highway construction in Florida for the most part is carried out under the direction of the County Commissioners who employ an engineer to prepare the plans and specifications and supervise the work. Various types of surfacing are being employed. In southern Florida a considerable amount of brick pavement has been built. In this the brick was laid flat on sand foundation with sand filler and cement curbs. In some of the recent work in Orange County grout filler has been used. Modified asphalt is being constructed in some sections and a New York City contracting firm recently received a large contract for work of this kind. Concrete, rock and shell and asphalt pavements also are being built.

The contracts usually cover long sections of highway. In some instances a single contract has been let for the construction of the entire county system of roads.

Barge Canal Terminal, Syracuse, N. Y.

Bids are now being asked by the State Superintendent of Public Works for the construction of one of the larger of the Barge Canal terminals. The work advertised is Terminal Contract No. 20, and it provides for the channel to Onondaga Lake, piers, dock-walls, a spillway and a highway bridge. The location is Syracuse, N. Y. The terminal will be constructed between Clinton St. and Onondaga Creek. The latter will enter the turning basin at the south side and the present channel of the creek from the new harbor to the lake will be abandoned.

The channel from the lake passes under the tracks of the New York Central & Hudson River R. R. and will be crossed by Hiawatha Ave. It is proposed to extend several streets east of the Oswego Canal to the new harbor. Spencer St. already has been extended west to N. Geddes St. and other approaches will be opened to the harbor from the south and west sides.

The estimated cost of the work now advertised is $665,875. It includes over 1,000,000 cu. yds. of excavation. Bids will be received until noon, Oct. 26, by W. W. Wotherspoon, State Superintendent of Public Works, Albany, N. Y.

New $12,000,000 Water Supply for Providence, R. I.

Engineering work is about to be started on one of the largest water supply developments undertaken in recent years by a New England city. The project provides for a new supply for Providence, R. I., the estimated cost of the improvement being in the neighborhood of $12,000,000. Investigations for this undertaking have been under way for the past two years and at the last session of the state legislature a city water supply board was established to construct the works.

The maximum consumption of the city at present is over 25,000,000 gals. per day, while the average consumption is about 20,000,000 gals. daily. The present supply is obtained from the Pawtucket River, which at low water has a flow of only 12,000,000 gals. per day. This and the increasing pollution of the river has made necessary the securing of a new supply. The present supply is pumped to sand filter beds and the filtered water raised by pumping to a distributing reservoir. To reach elevated portions of the city additional pumping is necessary.

The new supply will be obtained from the north branch of the Pawtucket River, where a storage reservoir covering approximately 6 square miles with a water shed of 92 square miles will be established. The dam for this will be about 80 ft. high. The water will be delivered by gravity to the distributing reservoirs in Providence, thus doing away with all pumping except that for the high service. The aqueduct as proposed will be about 8 ft. in diameter and about 6 miles in length and will be mostly in tunnel. Filter beds and other works also will be constructed.

The works will be carried out under the direction of the Providence Water Supply Board, of which B. T. Potter is Chairman. Frank S. Winsor, Providence, R. I., is Chief Engineer of the Board and Samuel M. Gray is Consulting Engineer.

$400,000 for Water Works Improvements at St. Paul, Minn.

The city of St. Paul, Minn., will expend $400,000 in carrying out certain improvements to its water works recommended by Allen Hazen, Consulting Engineer, New York City, in a report submitted last May. Ordinance authorizing a bond issue for the above amount is now before the Council. The first improvement to be undertaken will be the installation of a new 15,000,000-gal. pumping engine. Plans for this will be ready about the first of next month. Early next year it is expected plans and specifications will be ready for two covered reservoirs, one of 30,000,000 gals. capacity, the other of 7,000,000 gals. capacity. Motor driven revolving screens and Venturi meters also will be installed. Garrett O. House is General Superintendent of Water Works of St. Paul.

Work Started on $3,000,000 Dry Dock.

Actual construction has been started on one of the largest single contracts ever let by the state of Massachusetts. This work calls for the building of a dry dock at Boston for the Directors of the Port of that city. Bids on this development were received some months ago but formal approval of the awarding of the contract was held up until recently. The dry docks will be located in South Boston, in the center of a filled area about 1 mile long. The dock will be a masonry structure about 1,200 ft. in length and will cost about $1,800,000, exclusive of the equipment and machinery. The total cost of the improvement will be about $3,000,000. Holbrook, Cabot & Rollins, Corp., Boston, Mass., is the contractor.

$3,000,000 Recommended for Street Paving at Boston, Mass.

The Finance Commission of Boston, Mass., in a report submitted last week to the Mayor and City Council, expresses the opinion that approximately $2,000,000 will be necessary, in addition to the amount of the uniform yearly appropriation, to place the pavement of the city in proper condition. In addition it is stated that about $1,000,000 should be expended for paving street railway areas. The Commission recommends that the average appropriation for the paving service be increased out of the tax levy by approximately $400,000 a year, commencing with 1916. It is further recommended in the business portion of the city the more recently developed type of smooth granite paving should be used and that the thoroughfares in residential sections be surfaced with some form of asphalt pavement.

NEWS LETTERS

St. Louis Items.

Wm. List and M. D. Bagwell have bought the team outfit of Jack Winter's at Joplin, Mo., and are going to incorporate under the state laws of Missouri under the name of List & Bagwell Co.

The Canal Construction Co. made a start on their drag line work in Southern Illinois last week. Elmer Gant is looking after this job.

The Board of Public Service awarded contracts for the following streets, improvements and reconstructions: Marcus Ave., from Ashland Ave. to Natural Bridge Ave., Skrainka Construction Co.; $7,684. Tower Grove Ave., from Chouteau Ave. to Clayton Ave., Webb-Kunze Construction Co.; $13,433. Spring Ave., from Chippewa St. to Gravois Ave., Eyermann Construction Co.; $10,059. Soulard St., from Broadway to Twelfth St., John McMahon, $22,406. And recommended to the Board of Aldermen ordinances establishing Genevieve Ave. from Florissant Ave. to Prange Ave., Minnesota Ave. from Bates St. to Eichelberger St., Prather Ave. from Manchester Ave. to Mitchell Ave., Bamberger Ave. from Chippewa St. to Gravois Ave., Berlin Ave. from Taylor Ave. to Euclid Ave.

J. W. McMurray and Roger Faubion of the J. W. McMurray Contracting Co., left here for Texas, where they have extensive masonry and concrete contracts on the M., K. & T. and Frisco R. R.s.

An ordinance for the repaving of Broadway, from the viaduct to Fifth St., was passed by the City Council of East St. Louis. The estimated cost will be $26,849. Broadway is the principal thoroughfare between St. Louis and East St. Louis and was paved many years ago with granite blocks. Property owners recently organized the Broadway Improvement Association, which has as its main object the repaving of the street with creosote blocks, in the belief that it will increase property valuations. Work on the improvement will begin immediately.

Cameron & Joyce Bros., of Keokuk, Ia., who were awarded 8 miles of grading, tracklaying and bridging by the Cudahy road at Fowler, Kans., have sublet this work to several outfits. In addition to this, Cameron & Joyce Bros. were awarded 54,000 yds. of road work in Vermillion County near Danville, Ill., which they sublet to A. Lane and Taylor and Early.

Mulvill Bros., of Alton, Ill., can use a few small team outfits for surface ditching and bank widening on the Chicago & Alton R. R. near Mexico, Mo. They also have another small grading job near Alton, Ill., to sublet. In addition to this, Mulvill Bros. last week were awarded the contract for grading the grounds and road ways at the New State Hospital near Alton, Ill.

The appropriation of $20,000, which will be available to St. Clair County, Illinois, next year for hard road purpose, will not be used for constructing permanent roadways, but for grading four principal roadways in St. Clair County. This was decided at the meeting of the Board of Supervisors in Belleville. The highways to be graded are: Belleville, Freeburg, Belleville-Shiloh, East St. Louis-Dupo, and Lincoln trail east and O'Fallon.

The Board of Public Improvements, Room 315, New City Hall, St. Louis, Mo., will receive bids until noon, Oct. 22, for the construction of a re-inforced concrete viaduct on Chouteau Ave. between Vandeventer Ave. and Tiffany St., St. Louis.

Mike Costello spent several days here with us. Mike informs us that the grading on the Southern Railway between Dry Fork and Gretna, Va., that was awarded to Robt. Russell some time ago, is being held up on account of change of line and right of way. As soon as this is arranged Costello Bros. are going to work two steam shovels and a team outfit on one end of the line and Bob Russell is going to start on the other end. There is 11 miles of this work and some of it pretty heavy.

The Bondurant Construction Co., of Hickman, Ky., have sublet their levee work opposite Hannibal, Mo., to John Kenny.

John Gilbert, of the Merritt-Gilbert Contract Co., left here for Lockport, N. Y. Expects to return in a couple of weeks.

C. E. Smith, formerly Engineer of the Missouri Pacific Ry., and now a consulting engineer in the employ of the City of St. Louis, was selected last week to represent the City of St. Louis on a Board of Arbitration to settle labor disputes in connection with the Free Bridge by President Kinsey of the Board of Public Service. The Building Trades Council selected Louis J. Haenni, vice-president and general manager of the Gilsonite Construction Co., a personal friend of Mayor Kiel, as its representative. Under the terms of the agreements, the two members of the Board selected by the labor unions and the city will select the third member of the Board.

Contractors wanting work for their idle outfits, or in need of labor, write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 W. 5th St., Kansas City, Mo. Quite a lot of good laborers and stationmen coming in here from the Northwest now.

Fruin & Colnon Contracting Co. have started a steam-shovel and two machines on the grading for the University Park Realty Co. in the western part of the State. They have sublet 100,000 yds. of this work to Harrington Bros., 100,000 yds. to Frank Grant, 60,000 yds. to Tim Maloney, and still have about 30,000 yds. of short haul work to let, reserving the balance of this work for their own outfit.

A. B. Koenig.

Branding Timber for Guaranteeing Grades.—A step of great importance to the producers and users of lumber has been taken by the Great Southern Lumber Co. of Bogalusa, La. The company announced last week the inauguration of a system of branding select long leaf yellow structural timber as a guaranty for grades. Other mills in the yellow pine producing center are planning similar action.

PERSONALS

Mr. H. Kent McCay has been appointed to the office of Harbor Engineer for the city of Baltimore, Md. Mr. McCay was formerly city engineer of Baltimore and later chief engineer of the Paving Commission for four years, during which time improvements amounting to $2,000,000 per year were carried out by the Commission.

Messrs. James and Cox announce that they have merged with their own the accounting practice of Mr. George V. McLaughlin. Mr. McLaughlin is a certified public accountant and member of the New York Bar. The business will be conducted hereafter at 52 Broadway, New York City, under the firm name of McLaughlin, James & Cox.

Mr. Frank R. Judd has been appointed engineer of buildings for the Illinois Central Railroad, with headquarters at Chicago. Mr. Judd was chief draftsman in the Bridge and Building Department of that system from 1909 to 1913. Since 1913 he has been assistant engineer in charge of construction of the new union depot and of track elevation work at Memphis, Tenn.

Mr. Ray Palmer, formerly Commissioner of Gas and Electricity for the city of Chicago, has opened an office as consulting engineer, specializing in the prevention of electrolysis, expert examinations and valuations of gas and electrical properties. Mr. Palmer, during his service in Chicago, prepared valuable reports on Chicago's electrolysis problems and on power rates, etc.

Mr. H. G. Moulton, 14 Wall St., New York City, has been appointed by the Public Service Commission for the First District, New York City, as an expert in a consulting and inspecting capacity on underpinning work on the subway construction throughout the city. Mr. Moulton has had an extensive experience in connection with mining and railroad timber construction. He will work under Alfred Craven, chief engineer of the Commission.

Mr. Curtis C. Westfall has been appointed engineer of bridges for the Illinois Central Railroad, with headquarters in Chicago. Mr. Westfall entered the service of that company in 1907 as draftsman, and has remained, except for a period of eight months in 1913, when he was chief engineer in charge of construction on 70 miles of railroad in North Dakota. He is now promoted from the position of assistant engineer in the bridge department. Mr. Westfall is a graduate of the University of Illinois, class of 1907.

Mr. P. M. Fogg, formerly engineer in the U. S. Reclamation Service, has entered into partnership with Mr. E. E. Miller, consulting mining engineer, to conduct a mining property sales business in connection with Mr. Miller's professional practice in examining mining properties. The firm will also handle civil engineering work, specializing in irrigation projects. Offices of the firm are at 1136 First National Bank Bldg., Denver, Colo. Mr. Fogg entered upon his professional experience in 1901 as transit man on the filtration works at Philadelphia. Two years later he became connected with the Bureau of Yards & Docks, Navy Department, on construction of a large dry dock and shop buildings at the Philadelphia Navy Yard. He remained in that office until 1906, when he entered the U. S. Reclamation Service, with which he has been identified ever since. During that time he has been engineer on various irrigation projects in Montana, Idaho, Oklahoma, Texas and New Mexico. For three years he was project manager of the Minidoka Project in Idaho, involving large construction and operation of 120,000 acres. Later he was engaged in reconnaissance examinations in the Pecos River Valley in Texas and New Mexico.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces examinations for the following positions:

Surveyor, General Land Office; salary, $100 to $110 per month and subsistence; Dec. 8-9.

Associate Gas Engineer; Bureau of Standards; $2,000 per annum; Nov. 3.

NEW CATALOGUES

Metal Lockers.—Paper, 6x9 ins.; 16 pp. Manufacturing Equipment and Engineering Co., Boston, Mass.

Shows views of several styles of sanitary metal lockers for use in factory, stores, etc.

Oil Tractor.—Paper, 6x9 ins.; 8 pp. Hart-Parr Co., Charles City, Ia.

Describes the Hart-Parr "Little Devil" oil tractor, giving details of construction and operation, some cost data, and views of the tractor at work.

Motor Truck Expense Record.—Paper, 11x16 ins., 26 pp. The B. F. Goodrich Co., Akron, Ohio.

A book for keeping data on motor truck expenses, compiled for free distribution among truck owners. It is conveniently arranged for keeping accurate account of all items of cost in the daily, monthly and yearly upkeep.

Sanitary Equipment.—Paper, 6x9 ins.; 8 pp. Manufacturing Equipment and Engineering Co., Boston, Mass.

Shows various types of sanitary washbowls and bubbling fountains for factories, hospitals, etc. Gives details of design, sizes and price and diagram showing method of installation.

Concrete Arch Bridges.—Paper, 9x6 ins.; 40 pp. Daniel B. Luten, Indianapolis, Ind.

Consists of 18 construction views of Luten Design, reinforced concrete bridges under construction in the early part of 1915, and a number of views of completed bridges, accompanying construction views of the same. Gives data as to length, width, cost, contractor, etc.

Barrett Specification Roofs.—Folder. Barrett Manufacturing Co., 1210 Otis Bldg., Chicago.

A handsomely lithographed folder showing views of the seven large buildings of the National Lamp Works at Nela Park, Cleveland, in all of which Barrett specification roofs and waterproofing and Tar-Rok subfloors are installed.

Concrete Septic Tanks.—Paper, 6x9 ins., 8 pp. Universal Portland Cement Co., Chicago.

Treats of the sanitary disposal of sewage in rural communities and small towns by means of concrete septic tanks in the houses and the construction of these tanks. Illustrated with plans of typical systems and halftones showing types of tanks.

Drills.—Paper, 6x9 ins., 28 pp. Chicago Pneumatic Tool Co., Chicago.

Bulletin No. 216, describing "Hummer" self-rotating hammer drills. The general design and construction and operation details are explained and illustrated with photographs and sectional diagrams. Price lists of repair parts, specifications for the drills, and lists of drill steels are also included.

Centrifugal Pumps.—Paper, 6x9 ins.; 16 pp. A. S. Cameron Steam Pump Works, 11 Broadway, New York City.

Bulletin No. 154, consisting of descriptions, sectional views and illustrations of Cameron single suction, double suction and sump pumps of the vertical centrifugal type. Also gives table of capacities, speeds and horsepowers, and tables of dimensions.

Kahn Building Products.—Paper, 8½x11 ins.; 32 pp. Trussed Concrete Steel Co., Youngstown, Ohio.

Kahn building products for railroad structures are described in this pamphlet. Includes reinforcing steel, hy-rib, Kahn mesh, United Steel sash, waterproofing paste, steel Floretyles, etc. A number of photographs of structures using these products are given.

Compressor and Vacuum Pumps.—Paper, 6x9 ins.; 12 pp. The Gardner Governor Co., Quincy, Ill.

Circular AC-9, describing Gardner vertical air cooled compressors and vacuum pumps. Gives specifications and illustrations. Shows the Gardner "hopper cooled" compressor, Gardner garage set, Gardner "air wagon," a portable pumping unit, electrically driven outfits, one-tool plants and air receivers.

Concrete Culverts.—Paper, 5x7½ ins.; 8 pp. The Security Culvert Co., Minneapolis, Minn.

The "Security Culvert," described in this booklet, is a sectional, reinforced concrete culvert with wing-wall inlet and outlet sections, having also cut-off wall and sloping base. Also provides for steel longitudinal reinforcement to prevent bending. Forms and tools for the manufacture of these culverts are furnished by the company. Illustrated.

RAILWAYS

BIDS ASKED.

California:

San Francisco, Cal.—Until Nov. 10 by Board Public Works for construction of railway from Rosasco into Hetch Hetchey Valley for use in the construction of the new water supply project of the city. The line will be 67 miles long. M. M. O'Shaughnessy is City Engineer.

PROSPECTIVE WORK.

Alaska:

Seward, Alaska.—It is stated that an appropriation of $10,000,000 will be recommended at next session of congress for continuing construction of Government Alaska railroad.

Arizona:

Gilbert, Ariz.—Arizona Eastern Ry. has about 150 men at work widening its roadbed. Work will cover a distance of about 30 miles. Improvement is being done by company's forces.

Illinois:

Moline, Ill.—Project is under consideration for constructing an electric railway from Moline to Coal Valley, six miles. Estimated cost about $60,000.

Maine:

Lisbon, Me.—Lewiston, Augusta & Waterville Street Railway, Lewiston, Me., proposes change of location in town of Lisbon. Work involves 131 ft. of pile trestle and 35 ft. of steel girder bridge over Sabattus river, and 434 ft. of fill.

Skowhegan, Me.—About $80,000 has been subscribed toward construction of electric railway from this place. Only $20,000 more is required. Harvey D. Eaton, Waterville, Maine, is the promoter.

Minnesota:

Duluth, Minn.—Coons Construction Co. has been awarded contract for grading for about one mile extension of Duluth street railway.

Missouri:

Kansas City, Mo.—Kansas City, Mexico & Orient Ry. is reported to be planning to start construction soon on its proposed extension. Extensive improvements along the line south of Wichita, Kas., are also reported under consideration.

St. Louis, Mo.—United Railways Co. proposes an expenditure of about $125,000 for rerouting street car lines in downtown district.

St. Louis, Mo.—Wabash R. R. placed orders for 7,250 tons of 90-lb. rail and will relay about 50 miles of track.

New Mexico:

Gallup, N. Mex.—It is stated Santa Fe system will start work early next month on construction of new shop plant in this city.

North Carolina:

Kinston, N. C.—Kinston Belt Line Ry. has been chartered to secure a connection between logging road already in operation and Atlantic Coast Line R. R. It is doubtful if the line will be built.

Ohio:

Columbus, O.—Chesapeake & Ohio Northern Ry. Co. has been authorized to issue $3,450,000 capital stock and $1,000,000 of bonds. Proceeds of these securities are to be used on new line from Sciotoville to Columbus, now under construction.

Cleveland, O.—Citizens will vote on granting franchise to Cleveland, Akron & Canton Terminal Ry. Co. Company proposes construction of subway and docks for freight purposes, involving an expenditure of $11,000,000 to $15,000,000. O. C. Barber is president.

Oregon:

Portland, Ore.—Oregon, California & Eastern Ry. Co. has been organized and proposes construction of about 400 miles of standard gage lines for Central Oregon and adjacent territory. Reconnaissances and surveys are already under way. Probable expenditure is about $7,000,000. J. C. Ainsworth, H. C. Wortman and H. L. Pittock are interested. Robt. E. Strahorn, formerly connected with various Harriman lines in the northwest, is interested in the new proposition.

Tennessee:

Etowah, Tenn.—Louisville & Nashville R. R. is reported to have made surveys and is said to be planning to begin construction soon of a line from Etowah to Chattanooga.

Shelbyville, Tenn.—Nashville, Chattanooga & St. Louis Ry. will construct spur to Sylvan cotton mills. Work calls for 9,500 yds. of earth excavation, 10,000 cu. yds. of rock excavation, and will be done by company forces.

Texas:

Temple, Tex.—Temple & Marlin Interurban Ry. proposes construction of line between Temple and Marlin, a distance of 35 miles. Estimates are not yet completed, but work will include one bridge over Brazos River 600 ft. in length, 50 ft. bridge, 100 ft. bridge and 100 ft. bridge, also about 500 ft. of trestle. S. D. Hanna, Temple, Tex., is Chief Engineer.

Washington:

Bellingham, Wash. — Bellingham, Mount Baker & Spokane R. R. has completed location surveys for first 16 miles of its line east of Bellingham. Surveys are now under way in the vicinity of Deming. It is stated that company will probably float bond issue in November, so that actual construction be started early in 1916. J. E. Fader, Seattle, Wash., is interested.

West Virginia:

Fairmont, W. Va.—Western Maryland R. R. will construct spur from Monongahela river road of the Baltimore & Ohio to Wyatt, eight miles, to develop coal land owned by Consolidation Coal Co.

BIDS OPENED; CONTRACTS LET

Georgia:

Lula, Ga.—Construction will be started this month on the Lula-Homer R. R. Company proposes line from Belton, Ga., southeast to Homer, and then east to Hartwell and to Anderson, S. C., a distance of eighty-two miles. About three-fourths of the grading work on the section from Lula to Homer, has been completed. The contract for construction and equipment of the line has been let to W. J. Redmond, Atlanta, Ga. D. G. Ziegler, Lula, Ga., is Chief Engineer.

Utah:

Ogden, Utah.—Utah Construction Co., Ogden, has been awarded the contract for new cut-off of the Ogden, Logan & Idaho Ry. from 17th St. & Lincoln Ave. to Harrisville.

ROADS STREETS

BIDS ASKED.

Arizona:

Phoenix, Ariz.—Until 10 a. m., Oct. 22, by Robt. A. Craig, City Manager, for furnishing motor-driven combined street sprinkler and flusher.

Yuma, Ariz.—Until Oct. 25, by County Supervisors for about 32 miles of road construction, oiled macadam and concrete with light surfacing.

California:

Los Angeles, Cal.—Until 2 p. m., Oct. 25, by H. J. Lelande, County Clerk, for oiled macadam in Road Improvement District No. 44.

Connecticut:

New Haven, Conn.—Until 3 p. m., Oct. 28, by Supervising Architect, Washington, D. C., for construction of sidewalks, curbing, etc., at new U. S. post office and court house.

Illinois:

Cicero, Ill.—Until 8 p. m., Oct. 25, by J. S. Rylands, Secretary Board of Local Improvements, for resurfacing south 60th Court with crushed limestone.

Indiana:

Peru, Ind.—Until noon, Nov. 8, by F. K. McElheny, County Auditor, for concrete road in Peru township.

South Bend, Ind.—Until 11 a. m., Nov. 8, by C. Sedgwick, County Auditor, for three gravel roads, Madison township.

Columbus City, Ind.—Until 1 p. m., Nov. 5, by Thomas A. McLaughlin, County Auditor, for road on Whitley-Noble county line.

Evansville, Ind.—Until 10 a. m., Nov. 4, by C. P. Beard, County Auditor, for macadam road in Pigeon township.

Muncie, Ind.—Until 10 a. m., Nov. 3, by F. M. William, County Auditor, for two gravel or macadam roads, Liberty township.

Shelbyville, Ind.—Until 10 a. m., Nov. 3, by F. W. Fagel, County Auditor, for 3 miles of road in Washington township.

Plymouth, Ind.—Until 1:30 p. m., Nov. 2, by Geo. F. McCoy, County Auditor, for three roads, Sherman township.

Martinsville, Ind.—Until noon, Nov. 2, by Sam Watson, County Auditor, for roads in Brown township.

Bloomfield, Ind.—Until 2 p. m., Nov. 2, by G. E. Kill, County Auditor, for macadam road in Fairplay township.

Rensselaer, Ind.—Until 2 p. m., Nov. 2, by J. T. Hammond, County Auditor, for gravel road in Gillan township.

Petersburg, Ind.—Until 2 p. m., Nov. 2, by John P. Gray, County Auditor, for rock roads in several townships.

Noblesville, Ind.—Until 10 a. m., Nov. 2, by W. O. Horton, County Auditor, for roads in Wayne, Washington, Pearl Creek and Noblesville townships.

Bloomington, Ind.—Until 2 p. m., Nov. 2, by W. F. Kinster, County Auditor, for road in Van Buren and Washington townships.

Fowler, Ind.—Until 1 p. m., Nov. 1, by Warren Mankey, County Auditor, for road in Bilboa township.

Greensburg, Ind.—Until 1 p. m., Nov. 1, by L. W. Sands, County Auditor, for road in Washington township.

Shoals, Ind.—Until noon, Nov. 1, by L. T. Haga, County Auditor, for road in Perry township.

Goshen, Ind.—Until 2 p. m., Nov. 1, by J. W. Brown, County Auditor, for concrete road in Harrison township.

Greencastle, Ind.—Until 2 p. m., Nov. 1, by G. L. Airhart, County Auditor, for two miles of macadam road, in Greencastle township.

Kansas:

Marysville, Kan.—Until noon, Nov. 4, by R. F. Gallup, County Engineer, for grading ¾ mile of road. Advertisement in this issue.

Kentucky:

Bellevue, Ky.—Until 8 p. m., Oct. 21, by Edwin Price, Jr., City Clerk, for bituminous macadam on Lafayette Ave.

Louisiana:

Monroe, La.—Until noon, Nov. 5, by H. D. Apgar, Mayor, for 37,000 sq. yds. of gravel surfacing, with Tarvia topping, also 24,800 ft. of combination concrete curb and gutters.

Maryland:

Denton, Md.—Until noon, Nov. 1, by H. Waldorf, County Roads Engineer, for about 1 mile of state aid road.

Massachusetts:

Woburn, Mass.—Until noon, Oct. 26, by State Highway Commission, 15 Ashburton Pl., Boston, for 5,200 ft. of state highway in city of Woburn.

Minnesota:

Crookston, Minn.—Until 2 p. m., Oct. 26, by County Auditor, for improving State Road No. 4.

Mississippi:

Leakesville, Miss.—Until Nov. 3, by S. R. McKay, Clerk County Supervisors, for furnishing tractor truck, also two graders and three way drags.

Columbus, Miss.—Until Nov. 8 (readvertisement) by Highway Commission of Supervisors District No. 17 for 35 miles of macadam road. Gus E. Hauser, Jr., is Engineer.

Missouri:

Sedalia, Mo.—Until Nov. 1, by City Clerk, for 9,200 sq. yds. of vertical fiber brick paving with asphalt filler, 4 in. concrete base 1-3-6

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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The Importance of Knowing How to Act.

In our last issue we published an abstract of a paper, entitled, "The Engineering Contractor," presented by Halbert P. Gillette before the recent convention of American builders, in San Francisco. We wish to give added emphasis to one feature of this paper, both because of its importance and because it has not received due consideration in the past. In speaking of the education of the engineering contractor Mr. Gillette said:

> Educators are almost unanimous in the belief that the chief object of an education is to teach a man how to think. But, I fear, the common conception of "how to think" is so narrow that it fails to embrace "how to deport oneself." How to act is quite as important in the business and professional world as how to think. A salesman may have a very fine thinking mechanism, but he will fill few orders if that be his sole characteristic. Thinking is but half the game of life. Acting is the other and often more important half. Action is both a matter of heredity and a matter of acquired habit. A complete education should give a man habits as well as ideas and training in logic. The habit of going among men, the habit of studying their habits, the habit of being courageous, affable, honorable—these are things certainly not less important than a training in science. I fear they are, however, the very things that few educators have tried to cultivate in their students. The outstanding explanation of the excellence of the engineering training that West Pointers receive is the existence of a training in habits.

The above remarks are particularly applicable to *engineers.* If, in the past, engineers had given proper attention to this important factor in success we would not be so much concerned with the present status of the engineer. In comparison with other professional men the engineer is indeed a "poor actor."

Brick Roads Upon a Sand Base—A New-Old Method of Construction.

Brick roads on a sand base of the present day are subject to the same ills that brick roads constructed on a sand base in previous years have been subject to with the exception, perhaps, that the modern vitrified brick is superior to the old brick and will stand more wear and tear. Such construction has been in the past more or less unsatisfactory, due to uneven surface that the pavement presents after a few years wear.

But there is no logical reason why such a pavement should not be satisfactory if well constructed and not subjected to an unusually heavy traffic. It is a fact of engineering science that sand makes an excellent foundation, unyielding and easily formed. Sand is frequently spoken of as a cushion. There is nothing of the nature of a cushion about sand —no other material of a like nature is as hard. A sand foundation then, if properly prepared, should make an unyielding foundation.

An interesting feature of the brick road construction in Hillsborough County, Florida, described on another page is the method of laying the brick flat. When the loads hauled over the pavement are not unusually heavy brick laid flat should be quite satisfactory. To lay brick flat subjects them to a severe test and unless the brick are well inspected and carefully culled many broken brick will result.

The experience of the engineers in Hillsborough County, Fla., leads them to believe that brick pavement laid upon a sand base should be filled with a portland cement grout. Pitch grouting has been tried in the city of Tampa and the resulting pavement has been found quite satisfactory, especially from a standpoint of noiselessness.

For country roads in sections of the county where frost is not troublesame it seems that there is small need for a concrete base for brick pavements. If the pavement is not apt to be disturbed until worn out, as is the case with counrty roads, a portland cement grouted brick pavement needs no concrete base in sections of the country where there is little danger from frost.

An important advantage of the sand base brick pavement is the facility with which the brick may be taken up, turned and relaid. Many blocks of pavement have been so treated in the city of Tampa the resulting pavement being practically a new one.

What One Bridge Survey Discloses.

Some interesting data on the highway bridges and culverts in Illinois were presented in a paper by Clifford Older, bridge engineer, Illinois State Highway Commission, before the recent meeting of the Northwestern Road Congress. These data were compiled from the results of a bridge survey of this state, which is now under way. At the present time the survey is about half completed, the data covering about one-half of the area of the state and almost exactly one-half of the road mileage.

Of the 48,426 miles of road already surveyed there are 97,963 bridges and culverts, the total length of these structures, measured along the axis of the road, being 770,000 ft., or about 145.9 miles. It is thus seen that the average number of bridges per mile is 2.02, the average length of bridge per mile is 15.9 ft., and the average length of each structure 7.8 ft. Of the total number of bridges 1.8 per cent are over 60 ft. long, 21.8 per cent have a length of from 9 to 60 ft., and 76.4 per cent have a length of less than 9 ft. It should be noted, however, that the 1.8 per cent given for bridges over 60 ft. long comprises about 21.9 per cent of the total bridge length.

An interesting classification is that indicating the types of structure in use and the percentage of each type. This classification is as follows:

	Per cent.
Wooden structure	34.9
Corrugated pipe	18.2
Vitrified tile	13.1
Concrete, reinforced concrete and stone masonry	10.2
Steel superstructures on steel tubes, legs, etc.	8.8
Steel superstructures on masonry foundations	7.4
Plain steel pipe	3.4
Wooden superstructures on masonry foundations	2.4
Cast iron pipe	1.6

At the beginning of the construction season of 1915 it was reported that 9.8 per cent of the bridges were in need of repairs and that 8.7 per cent should be replaced.

Complete data similar to those given above are indispensable if we are to have a correct solution of the bridge problem in any state. With complete data at hand we can expect the development of types of bridges which will be both lasting and economical. The centralization of authority in our state highway commissions offers the means for rapid progress in this direction. If these commissions are given proper support the day is not far distant when the item of "bridge repairs and renewals" will no longer prove such a burden to the community.

Mortar Beds and Brick Laid Flat.

Nine years ago in its issue of Sept 26, 1906, this journal advocated laying brick pavement on a mortar bedding course or cushion and laying the brick flat instead of on edge. At the time it was not contemplated and it was so stated that brick laid flatwise was best for all pavements regardless of the intensity of their traffic but that "for economy's sake" brick "should usually be laid flatwise in residence streets." Since the date of this pronouncement of editorial opinion flat laid brick street pavements and country roads have been constructed in many places as frequently noted in these columns. In this issue there is a description of flat laid brick country road construction in Florida. The construction has its opponents but it has also come to recognition.

Within a year, or perhaps it may be two years, the substitution in brick pavement construction of a mortar bedding course for the sand cushion has gained favor. Editorial writers frequently speak of the idea and of the construction as being new. Neither is new. Brick pavement on a mortar bed was constructed in Baltimore in 1906. In the same year New York city was laying asphalt block on a mortar bed and it was in connection with this work that this journal was prompted to advocate the extension of the method to brick pavement. But while the use of the mortar bed is not new its wide recognition as meritorious construction is recent. It is only in the present year's work that we find many examples. The most familiar of these examples is perhaps the pavement at Paris, Ill., described fully in our issue of Oct. 6, 1915. In another column of this issue Mr. Wm. C. Perkins sums up briefly the arguments on which the advocates of the mortar bedding course or cushion base their belief.

There are objections to laying brick pavements with grouted joints and on a mortar bedding course. One is that the cutting out of the brick for street trenches is difficult and destructive and another is that a strong obstacle is offered to taking up and turning the brick after wear has destroyed the original surface. Other objections have been named. It is not these real demerits but another of far more imaginary character that, curiously enough, has in all very recent discussions of mortar bedding aroused most comment. The "resiliency" of the sand cushion, it is urged, is lost. The phonetic rhythm of the word seems to have lent it magic importance. "A quarter-inch mortar bed instead of a one-inch sand cushion? Why! Your pavement would have no resiliency." It may be so—this journal holds no brief for the mortar bed—but one may justly be skeptical of any great amount of resiliency existing in an inch of sand clamped between 6 ins. of concrete base and 4½ ins. of grouted paving brick surface.

Whether grouted brick or granite block laid in mortar on a concrete base persist or perish as pavement constructions depends upon considerations more important than a decreased resiliency due to lack of sand cushioning which can be demonstrated only by an inward feeling. Is it correct principle of pavement design to make wearing surface and base one piece instead of making them easily separable so that the wearing surface can be removed at will? Some wit once said that "in America pavements are put down only to be taken up." While most engineers would be loth to voice support to the doctrine that a pavement should be designed to be easily taken up, most pavement engineers also design with subconscious recognition of the contingency. The monolithic pavement principle has its drawbacks and must have its worth proved by time before these drawbacks can be dismissed as unimportant.

The fact that this journal almost a decade ago bespoke consideration and favor for pavement brick laid on mortar bed indicates that it has no quarrel with the very recent propaganda in favor of this construction. It may, however, consistently quarrel with the assumption too frequently made that in this new construction is all pavement wisdom. It can conceive of conditions under which cushionless or monolithic brick pavement construction might be far from wise, and it knows of conditions under which it would unhesitatingly employ such pavement in preference to any other. The same opinion holds true of granite block on a mortar bedding course. How little we really know of the new construction is evidenced by the contradictory cost data cited by different writers. Mr. Rodney L. Bell in his article published in our issue of Oct. 6 states that the 2-in. monolithic (brick on mortar on concrete) pavement constructed as in Illinois represents a saving per square yard over the older method of 10 to 12 cts. Mr. D. Moomaw, road engineer, Cuyahoga county, Ohio, in an article in "Engineering Record," states that mortar cushion will increase the cost 15 to 20 cts. per square yard compared with sand cushion. Mr. Wm. C. Perkins in the article quoted in another column considers that a 1 to 5 cement-sand bed will increase the cost about 5 to 6 cts. per square yard compared with a 2-in. sand cushion. And in Baltimore Mr. Compton, chairman of the paving commission, observes no appreciable increase in cost due to use of mortar bed.

Has the Activated Sludge Process of Sewage Treatment Made Good?

According to present indications it may be asserted on safe grounds that the activated sludge process for the treatment of sewage is in a fair way to bear out the hopes of the experimenters who have been testing it out during recent months. Those who have had most to do with this experimental work are now more enthusiastic over the possibilities of the process than ever before. In fact, the engineer who has experimented on the largest scale, Mr. T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission, has reached this conclusion: "The activated sludge process is the best and cheapest process for treating sewage where a high standard of effluent is required, and, as it becomes better developed, it will supplant sedimentation and sprinkling filters."

So successful were the Milwaukee experiments that a normal size unit is now being constructed in that city to treat 1,600,000 gals. of sewage daily. The cost of the plant will be about $65,000. Certainly no better evidence of confidence in the method could be desired than the making of an investment of this magnitude. Incidentally it is gratifying in this case, as always, to see an engineer confident enough of the soundness of his judgment to recommend a radical departure from the fairly well established order of things when his judgment dictates that the time and means for making such a departure are at hand. In this issue we devote considerable space to the results of the Milwaukee experiments and to a description of the works now under construction for the utilization of the process on a large scale. Every engineer should read this article. It contains much specific information.

In our issue of April 7, 1915, we published an article and an editorial on the activated sludge process. In the editorial we referred to the process as "exceptionally promising" but intimated that its merits would have to be shown before we unleashed our enthusiasm. We have been "shown" and now find pleasure in bringing to the attention of our readers the most complete article yet published on the subject. While our conservatism is thus modified we desire to lay emphasis on Mr. Hatton's advice to young engineers to "stick to the old processes until the problems connected with this new one are pretty well solved by those who have the facilities for conducting experiments." We do not believe that engineers in general practice can again afford to take the public in on their enthusiasm over partially developed processes of sewage treatment. The art is still developing rapidly and this should steadily be kept in mind. So, while the time has arrived when the general practicing engineer can safely invest time in reading of the development of this process at Milwaukee and elsewhere, the general adoption of it would now be premature and would lay the engineer liable to the charge of seizing upon the fad of the hour in this particular field. Milwaukee has an ideal combination of engineers and chemists with which to study this problem and it may safely be assumed that the merits and defects of the process will be determined in due season. Meanwhile, let us "stick to the old processes."

What is the activated sludge process? The engineering definition which suggests the vital points in design is formulated by Mr. Hatton as follows:

> The activated sludge process is the scrubbing of sewage liquor by means of artificial air injected throughout its mass at low pressure and of sufficient volume to separate suspended matters and colloids, which form a sludge kept in constant and thorough agitation throughout the body of the liquor. The sludge, thus kept in contact with the liquor, must contain sufficient reducing and nitrifying organisms, and adequate food and lodging therefor, to break down the organic nitrogen into free ammonia and nitrogen, and to oxidize these to nitrates.

The foregoing engineer's definition is amplified by the following chemist's definition, formulated by Mr. William R. Copeland, the Chief Chemist of the Milwaukee Sewerage Commission:

> The sludge contained in sewage and consisting for the most part of organic matter, when agitated with air for a sufficient period, assumes a flocculent appearance very similar to little pieces of sponge. Bacteria gather in these flocculi in immense numbers, some of them having been strained out of the sewage and others developed by natural growth. Among the latter are species which possess the power of decomposing organic matter, especially of an albuminoid or nitrogeneous nature, setting the nitrogen free, and others absorbing this nitrogen converting it into nitrites and nitrates. These biological processes require time, air and a favorable environment, such as suitable temperature, food supply and sufficient agitation to distribute them through all parts of the sewage.

The process is singularly free from nuisance, a tremendous advantage, assuredly; one which the public will appreciate above all others. The bacterial removal and the degree of clarification effected are high. The process is exceedingly flexible. For warm weather conditions the cost of the process is less than that of any other for like character of final effluent. Winter conditions of operation are yet to be studied with special reference to cost—this is the largest remaining obstacle. If this is successfully surmounted the process will be established. Already its value in warm climates appears to have been demonstrated. These outstanding considerations are enumerated to aid the reader in reaching a conclusion as to whether the process has made good.

An activated sludge plant is a busy place requiring intelligent handling. We are inclined to consider this an advantage rather than otherwise, since plants which are supposed to operate without constant supervision usually fail from total neglect.

Finally, the recovery of commercially valuable fertilizing elements from the sludge is sure to make a strong appeal to the popular imagination which has deplored the waste of the manurial value in city sewage ever since Victor Hugo called general attention to this subject in "Les Miserables."

SEWERAGE AND SANITATION

The World's First Full-Scale Plant for the Treatment of Sewage by the Activated Sludge Process.

(Staff Abstract.)

The world's first full-scale plant for the treatment of sewage by the activated sludge process is under construction on Jones Island in the city of Milwaukee. The design features of this plant to treat 1,600,000 gals. of sewage per day are here illustrated and described. The present article also contains many operating and cost data on the activated sludge method of sewage treatment as observed in and based upon experimental work at Milwaukee. The article is by far the most complete yet published on this subject. Pertinent editorial comment appears elsewhere in this issue.

EXPERIMENTAL WORK.

After the city of Milwaukee undertook the task of designing works for the collection and disposal of its sewage an elaborate experimental plant was constructed on Jones Island. In this plant about 25 processes of sewage treatment were tested out to determine their worth under Milwaukee conditions. All of these processes first tried out, save Imhoff tank sedimentation, sprinkling filter oxidation and chlorine sterilization, have been abandoned as inapplicable under Milwaukee conditions.

Later in the summer of 1914 the attention of Mr. T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission, was called to the laboratory results being obtained in England by the activated sludge process. After correspondence with Prof. Gilbert J. Fowler of Manchester University, discoverer of the process, and after learning from him the great possibilities of the process, we decided to conduct experiments, under his direction, of greater magnitude than had theretofore been undertaken.

To that end we improvised one of the tanks which had been used for testing chemical precipitation into a tank for trying the activated sludge process by the "fill and draw" method. This was placed in operation sometime in March of the present year, and has been operating under varied conditions up to the present time. The operation of this tank, together with two smaller experimental tanks being operated at the same time, clearly demonstrated that it was possible to treat the sewage of Milwaukee by the activated sludge process on the "fill and draw" method, when the temperature of the sewage was 50° F. or over, at less cost than by any other process with which we had been experimenting, taking into consideration the character of effluent obtained.

Having determined the availability of the "fill and draw" method, we determined to try the "continuous flow" method. To that end the other chemical precipitation tank which stands alongside of the "fill and draw" tank, and of the same dimensions, was revised and put in operation.

Activated sludge was obtained for seeding this tank partially from the Imhoff tank and from fresh sewage. The Imhoff tank sludge, which is anaerobic, and which must be converted into aerobic sludge before activated sludge is produced, was run into the new tank; to this was added fresh sewage every eight or ten hours, and the mixture aerated by blowing air through it under about 5 lbs. pressure. At the end of six or eight hours the air was turned off; sludge allowed to settle, the supernatant liquor drawn off, fresh sewage added to the capacity of the tank and the aeration repeated.

This process was continued until the tank contained about 30 per cent of its capacity of good activated sludge. It required about 33 days to seed this tank in the manner described, whereupon it was started upon the "continuous flow" method. This was begun during the first week in July of this year and has been continued without material interruptions since.

From the beginning of the tests remarkable results were secured. With a rough screened sewage containing from one to seven millions bacteria per c.c., 250 p. p. m. of suspended matter, 30 p. p. m. organic nitrogen and 120 p. p. m. oxygen consumed, an effluent was produced containing a 99 per cent removal of bacteria and suspended matters, 12 to 14 p. p. m. nitrates, stable after 5 days and clear as the lake water, leaving a sludge containing 5.45 per cent of ammonia, 1.34 per cent of available phosphoric acid and 0.23 per cent of potash, worth as a fertilizer $9 a ton based on dry weight.

This was accomplished with 1.77 cu. ft. of air per gallon of sewage treated, costing $4.43 per 1,000,000 gals., based on air at $2.50 per 1,000,000 cu. ft. compressed to 5 lbs. pressure, which is our guaranteed cost where large units are used, and includes all overhead charges and boiler room labor, but not outside plant or engine room labor. Experiments now under way indicate that the volume of air can be very much reduced.

In considering the cost of this process the character of effluent obtained must not be lost sight of. The effluent above described is of far higher standard than any yet obtained from any of the processes with which experiments have been conducted at the Milwaukee testing station, and much higher than is ordinarily required. If the standard is reduced the cost will be reduced in direct ratio.

In view of the foregoing record of results obtained by this process, either by the "fill and draw" or "continuous flow" method it is not surprising that the Sewerage Commission felt warranted in expending $65,000 trying out the process on the large size unit herein described, before adopting it as a plant which would ultimately cost in the neighborhood of $3,000,000.

One of the principal reasons for building the large unit was to determine how much low temperatures of the winter would affect the process, what methods would have to be used to overcome this effect and what they would cost. The foregoing results have all been obtained with sewages varying in temperatures from 50° F. to 70° F., whereas the winter sewages run down to 42° F. for short periods. It is well known that low temperatures seriously affect the efficiency of nitrifying organisms, but to what extent cannot be determined until a fair trial is made, and our contemplated plant may show that some artificial heat will have to be applied to some portion of the process during the extreme low temperature periods.

DESCRIPTION OF BIG PLANT UNDER CONSTRUCTION.

Figure 1 is a plan of the general layout of the plant, which consists of eleven circular reinforced concrete tanks 30 ft. inside diameter by 13 ft. maximum depth, supported upon a pile foundation due to the instability of the soil. Tanks 1 to 6, inclusive, are the aerating tanks in which the sewage mixed with the activated sludge is aerated by means of air forced in under 5 lbs. pressure. Tank 9 is the sedimentation tank, and tanks 10 and 11 are the activated sludge tanks.

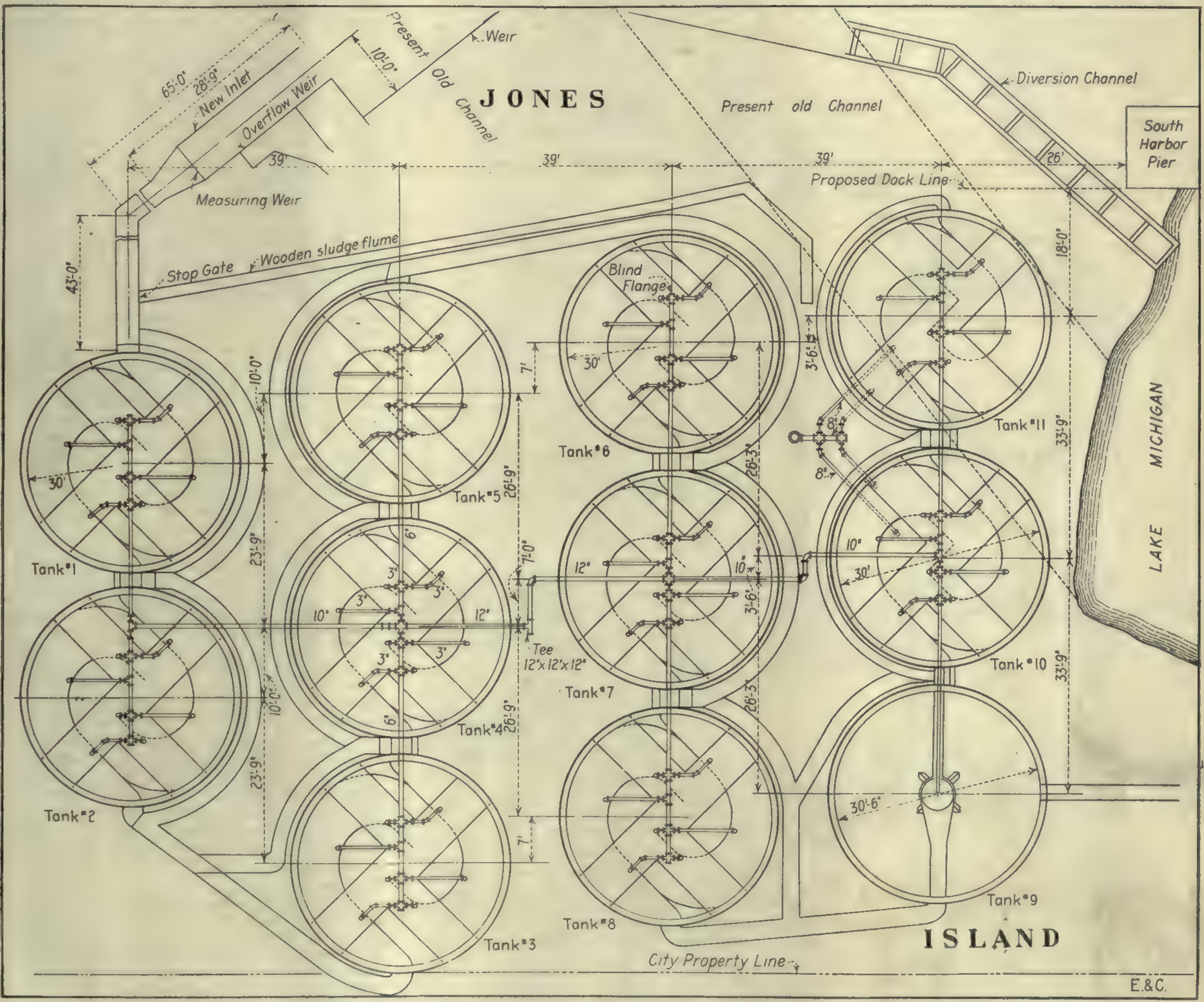

Fig. 1. General Layout of the Activated Sludge Sewage Treatment Plant at Milwaukee, Wis.

Figure 2 is a detail of the aerating tanks showing the curved baffles, the manner of sloping the bottom of the running through channels so as to avoid the deposition of sludge and the manner of placing the air diffusers, details of the castings in which the diffusers are set, and the manner of connecting the air pipes with these castings.

Figure 3 shows the details of the sedimentation tank, which is the only tank to be roofed over. The roof is necessary to prevent ice forming about the edges of the circular weir, which would set up uneven currents. This tank has a radial flow, and is designed for a 25-minute sedimentation period at 2,000,000-gal. rate.

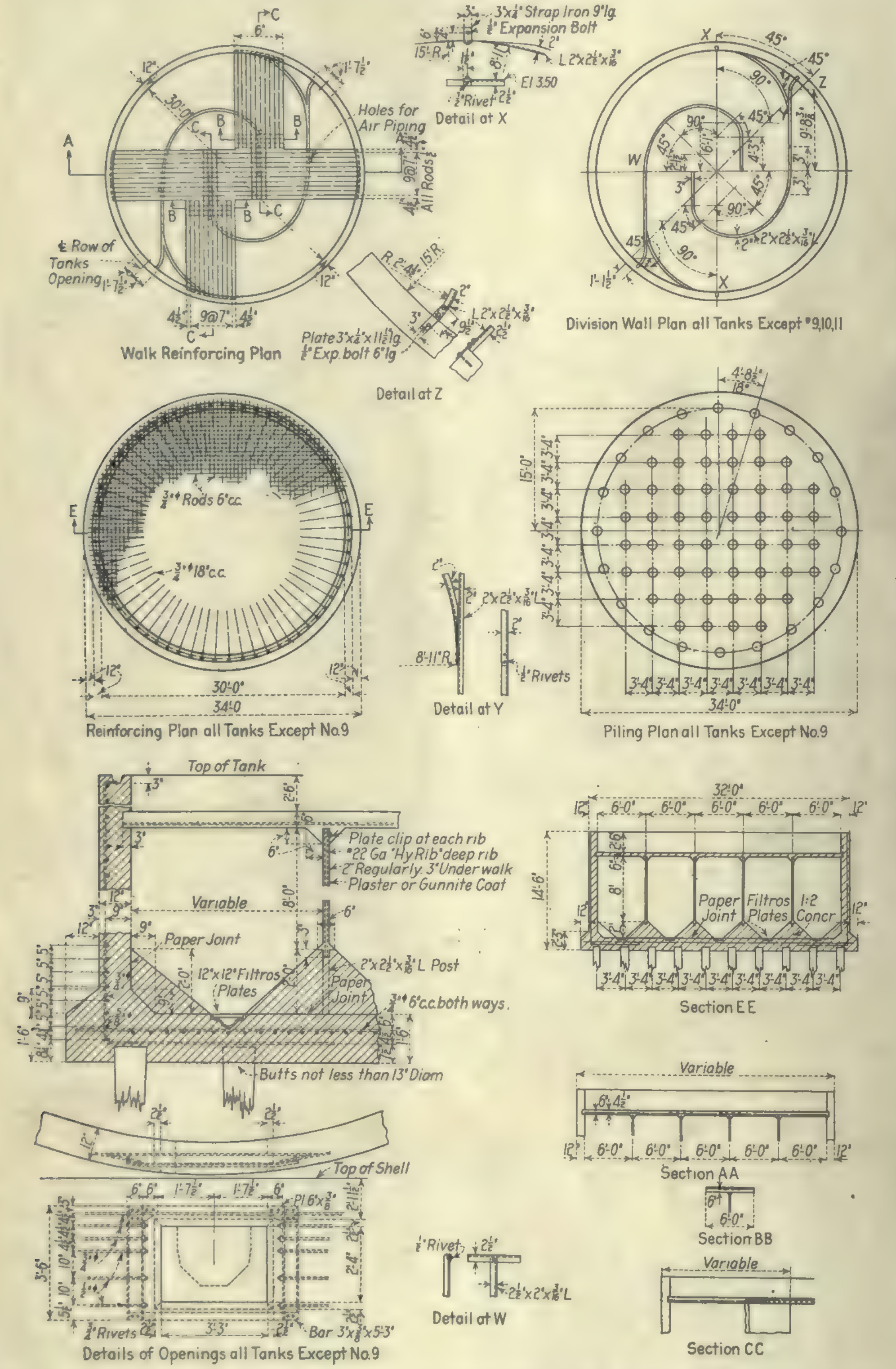

Fig. 2. Details of the Aerating Tanks of the Milwaukee Plant for the Treatment of Sewage by the Activated Sludge Process.

The two sludge tanks are similar to the aerating tanks except that they are each made into two separate compartments by stop planks connecting the two ends of the baffle walls. The air pipes and diffusers are placed in the same number and manner as in the aerating tanks.

Wooden rectangular troughs are built part way around each tank to control the direction of the flow of liquor, and stop planks are arranged so that any one or series of tanks can be cut out. The sewage from 250,000 people, to which is added the sewage from the packing house district, tanning factories, and many other large industrial establishments, passes out to the lake through a 20-ft. wide open channel alongside of the proposed plant.

In this channel a weir is constructed 20.35 ft. long, which maintains a depth of about 3 ft. of liquor for 40 ft. back of the weir. This is the grit chamber in which the heavier solids from the street washings are deposited, as the sewers connected with this large intercepting sewer are of the combined type.

Above the weir, just mentioned, the liquor for the plant is taken off through a wooden rectangular channel, in which a weir is built, having the same elevation as the long weir, and an overflow weir to regulate the head over the plant weir. A liquid recording gage will be placed back of the plant weir to measure the flow of liquor through the plant.

The weirs have been so arranged as to provide a flow through the plant to correspond with the fluctuations of flow through the main sewer, and the air applied to the sewage will be automatically regulated to correspond with this flow. Self-recording air meters will be installed to determine the volume and pressure of air used.

The sewage, after passing the plant weir, enters tank No. 1, where it comes into immediate contact with the air and the activated sludge, with which the tank has been originally seeded. It is designed to use 25 per cent of this activated sludge at first and to increase or diminish it as the operation shows necessary to get the most economical results.

Passing through tank No. 1 the liquor, mixed with the sludge, enters tank No. 2, when it is again aerated and further mixed with sludge contained in that tank, and so continues until it passes, with the sludge mixed with it, into the center of channel of tank No. 9. Here the sludge settles out to the bottom of the tank, the clear liquor passing over the circumferential weir to the lake.

The sludge settles to a deep well built in the bottom of the settling tank, and is discharged by gravity into sludge tank No. 10 or 11 where it is aerated for such a period as may be necessary to maintain the nitrogen cycle. From these sludge tanks the sludge passes to an 18-in. cast iron pipe sunk vertically in the ground with its base about 28 ft. below the height of the liquid in the sludge tank, and from this pipe it is pumped by air into the fresh liquor trough, entering No. 1 tank with the raw sewage and again passing through the process.

That portion of the activated sludge in excess of what is necessary to maintain the proper percentage in the aerating tanks is pumped out of the sludge tanks from time to time and dewatered and will be used as a fertilizer. The method of dewatering has not yet been decided upon, but will probably be by means of the sludge press or vacuum wheel.

The deep chambers connected with the settling tank and sludge tanks are for the purpose of dewatering the sludge as much as possible by weight, and thus avoiding the pumping of unnecessary liquor through the process.

It has been found by the experiments conducted that the success of the "continuous flow" method depends upon maintaining good activated sludge at all times in the tanks treating the fresh liquor. By aerating the sludge to a higher degree than the whole body of the liquor, air is saved, because only 25 per cent of the entire mixture is thus given additional aeration.

The plant, as designed, can treat 1,600,000 gals. of sewage per day with a four hours' period of aeration and with 25 per cent activated sludge content. From present indications it will be able to treat the sewage satisfactorily, when the temperature is 50° F. or over, at a much higher rate, but this is yet to be determined on the large scale.

In order to overcome some of the effects of low temperature it is designed to pass the condensing water from the present sewage station adjacent to the new plant through coils of pipe hung to the inside perimeter of the two sludge tanks, inducing circulation by a circulating pump built in the condenser discharge line. This water is now discharged into the river at a temperature of about 100° F.

The power plant for producing the air necessary for operating the plant consists of two positive pressure rotary blowers each having a capacity of 2,400 cu. ft. of free air per minute compressed to 6 lbs. of pressure, and belt driven from two A. C. variable speed motors each of 75 b. h. p. equipped with a drum controller and totally enclosed three-pole oil switch with inverse coils and a low voltage release attachment.

Only one unit will be required for operating the plant. Two are provided to avoid possible interruptions. The current will be secured from the local company.

One of the questions which would immediately arise in the mind of the engineer is why tanks were designed circular in preference to rectangular. These tanks were designed before any results had been obtained from the "continuous flow" method, and the writer felt there were only two processes available for satisfactorily treating the sewage of Milwaukee; the activated sludge process with "continuous flow," or fine screening followed by Imhoff tank sedimentation followed by chlorination. If the former process proved a failure the latter would have to be adopted. The tanks were, therefore, designed so that they could be used as the digestion chambers for an Imhoff tank installation by removing the sloping bottoms and baffle walls. By referring to detail of bottom of tank in Fig. 2 it will be seen that provision has been made for removing this concrete slope without disturbing the balance of the concrete bottom, by placing a paper joint between the two layers of concrete.

It is quite probable that rectangular tanks will better fit the conditions required successfully to carry on the process, for several reasons. One is that the air diffusers can be placed across such a tank at right angles to the direction of flow, thus avoiding possible short circuiting of the liquor, another is the better convenience of placing the air piping system and avoiding placing any pipes in concrete, and another is cheaper forms for construction. But whatever form of tank designed the width of the running through channel should not exceed 6 to 8 ft. to get the most economical disposition of the air.

Many experiments have been conducted with a view of determining the best form of air diffuser, and others are now being carried on. So far the "Filtros" plate seems to give the best result. This is a composition of quartz sand and some character of cement to bind it together. The sand is ground to a uniform coefficient to give any desired porosity and, after adding the cement, is burned in a furnace. The plates come any size or shape desired and at any thickness. In the Milwaukee plant a plate 12 ins. square by 1⅛ ins. thick is being used and known as type 5-3 which has a capacity for passing 2 cu. ft. of air per square foot at 2 ins. water pressure, the porosity being 33.27 per cent by voids. This material is manufactured by the General Filtration Co., Inc., of Rochester, N. Y.

It has been found very important to maintain as far as possible an even diffusion of air throughout the body of the liquor. That is, every square foot of plate should contribute its share of free air. To this end orifices are provided to be set in the casting under each Filtros plate. Each orifice is designed to pass the required volume of air under a predetermined pressure.

COST.

Of course, one of the most important factors to be determined in treating sewage by the activated sludge process is the cost, and the writer presents herewith an estimate of the cost so far as it has been determined from the experiments so far conducted.

In considering this phase of the question it should be first realized that such effects upon cost as low temperatures might have has not been determined; that, with this exception, sufficient data have been secured accurately to determine how much air is required to treat the sewage and sludge to produce a certain standard effluent from the Milwaukee sewage, and guarantees from well known manufacturers of blowers, engines, turbines and motors have been secured as to the efficiency of the several apparatus they will undertake to furnish for the final treatment plant.

General dimensions of aerating, sludge and settling tanks have been determined with reasonable accuracy based upon the vari

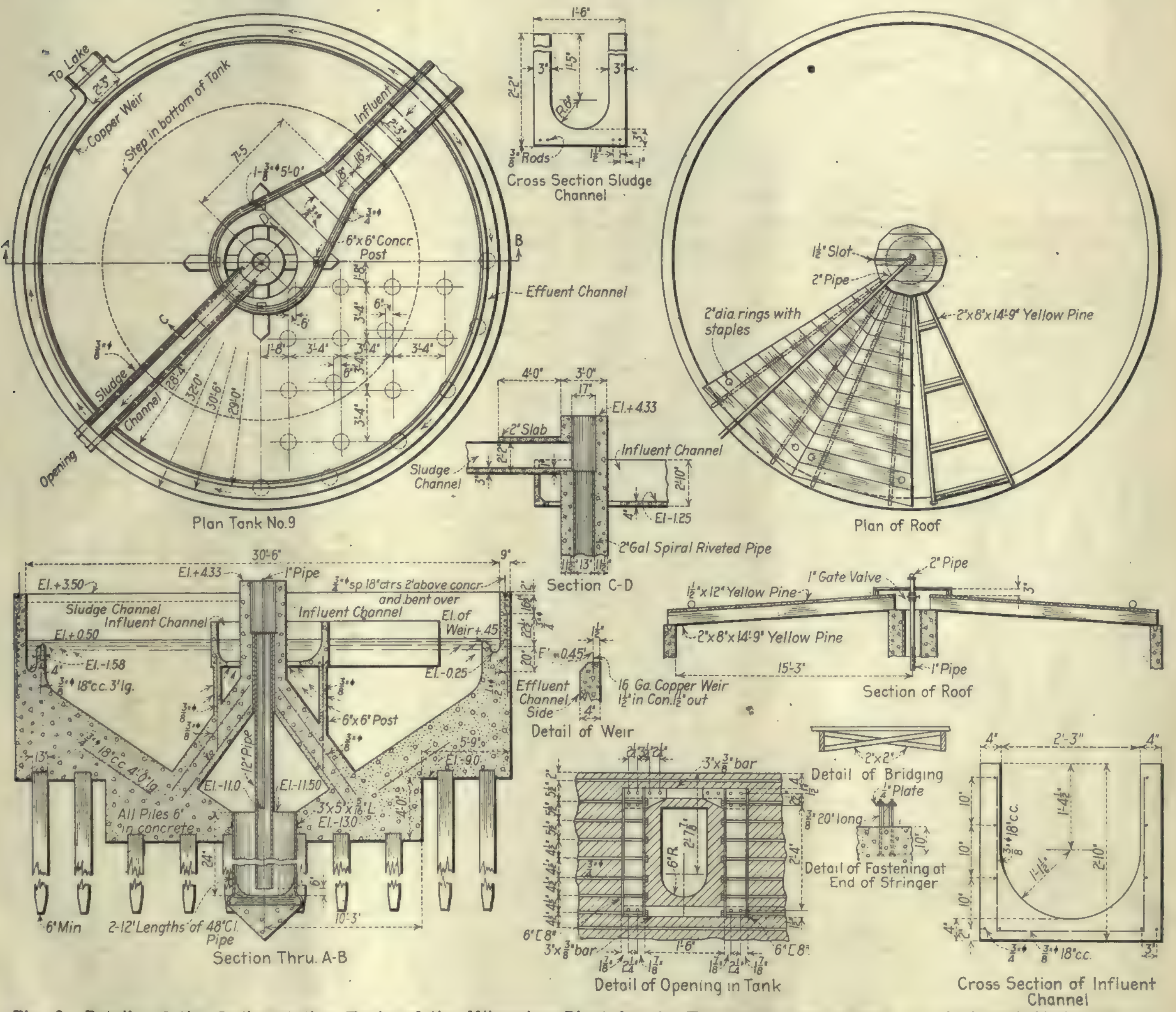

Fig. 3. Details of the Sedimentation Tanks of the Milwaukee Plant for the Treatment of Sewage by the Activated Sludge Process.

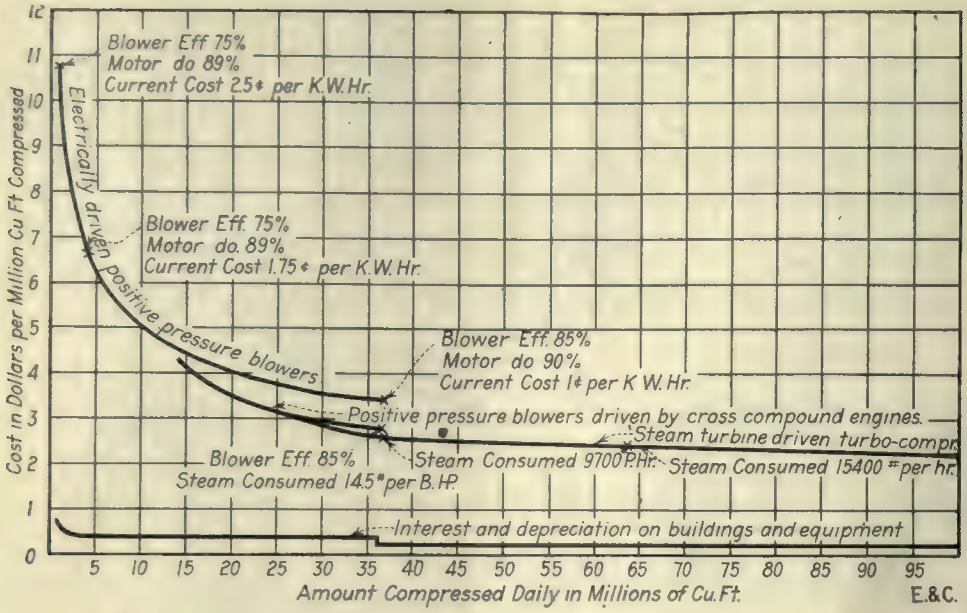

Fig. 4. Diagram Giving Cost of Air Per 1,000,000 Cu. Ft. Compressed to 5 lbs. Pressure, Including Interest and Depreciation on Equipment, by Electric Motor, Corliss Compound Engine or Steam Turbine.

To approximate the cost of air at other pressures find the equivalent volume of air at 5 lbs. by multiplying the required volume by P/5 where P is the new pressure. The cost of the equivalent volume at 5 lbs. as shown by the curves is approximately the cost of the required volume. Steam consumption is figured at 175 lbs. pressure, 100° superheat and 28½ ins. vacuum. Cost of steam is taken at 38 cts. per 1,000 lbs., including all boiler room labor and overheads on boilers and condensers. Fuel, 82,000 B. T. U. for 1 ct.

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periods of aeration and sludge content shown upon the following diagrams. These diagrams have all been prepared for determining the cost of treating a daily average of 50,000,000 gals. of sewage at Milwaukee, with coal worth 1 ct. per 82,000 B. t. u., the price now being paid by the City's Water Department, but from the diagrams the cost for other rates of flow can be determined.

It is clearly demonstrated, however, that the smaller the plant the higher the cost for treatment due to the less efficiency in operating small size blowers, and reciprocating engines and small motors, instead of large size blowers, steam turbines or large motors. It may be that this cost can be considerably reduced by using oil or gas engines in driving the smaller units.

Figure 4 is a diagram showing the cost of producing air compressed to 5 lbs. pressure by either an electric motor, Corliss compound engine or steam turbine. The cost of the electric current is based upon the costs for which the local company has agreed to furnish the required service.

Figure 5 is a diagram showing the cost of producing the air per 1,000,000 gals. treated per day under varied conditions as to period of aeration, rate of air application per square foot of tank surface and percentage of activated sludge maintained in the tanks. This cost is taken from Fig. 4 and includes all boiler room labor and all overhead charges such as interest, sinking fund and depreciation.

Figure 6 is a combination of the data contained in Figs. 4 and 5, and also includes the cost of the plant for treating the sewage, which cost includes all overhead charges such as interest, sinking fund and depreciation. The only labor cost included is boiler room labor, the engine room and plant labor not being included for want of sufficient information.

These diagrams are based upon rectangular tanks holding an average depth of 9 ft. of liquor, the depth which has so far seemed most applicable to the Milwaukee situation.

In Milwaukee so far the most satisfactory results have been obtained by using 0.25 cu. ft. of air per minute per square foot of tank surface, a period of 4 hours' aeration with a sludge content of 25 per cent. By referring to Fig. 6 it will be seen that this treatment will cost $5.30 per 1,000,000 gals. treated, exclusive of engine room and plant labor, and the disposal of the sludge.

If a lower standard of effluent is required and a 3-hour period of aeration only is required, with 20 per cent sludge content and the same rate of air supply, the cost will be seen to be $3.95 per 1,000,000 gals. treated.

The writer believes he is warranted in the statement that the above costs are much below the cost of producing an equal standard of effluent from any other process of sewage treatment applicable to a large United States municipality.

Considerable attention has been given to the sludge disposal problem and the question has been taken up with two firms who are in the business of producing fertilizers from by-products. One of these firms gives the following analysis of a representative sample of the sludge:

	Per cent.
Nitrogen	4.48
Fat	7.60
Total phosphoric acid	1.84
Insoluble phosphoric acid	0.50
Available phosphoric acid	1.34
Ammonia	5.45
Potash	0.23

It gives the present value of this sludge as a fertilizer the sum of $9 per ton based upon its dry content, and states that it is the only sewage sludge with which it has had any ac-

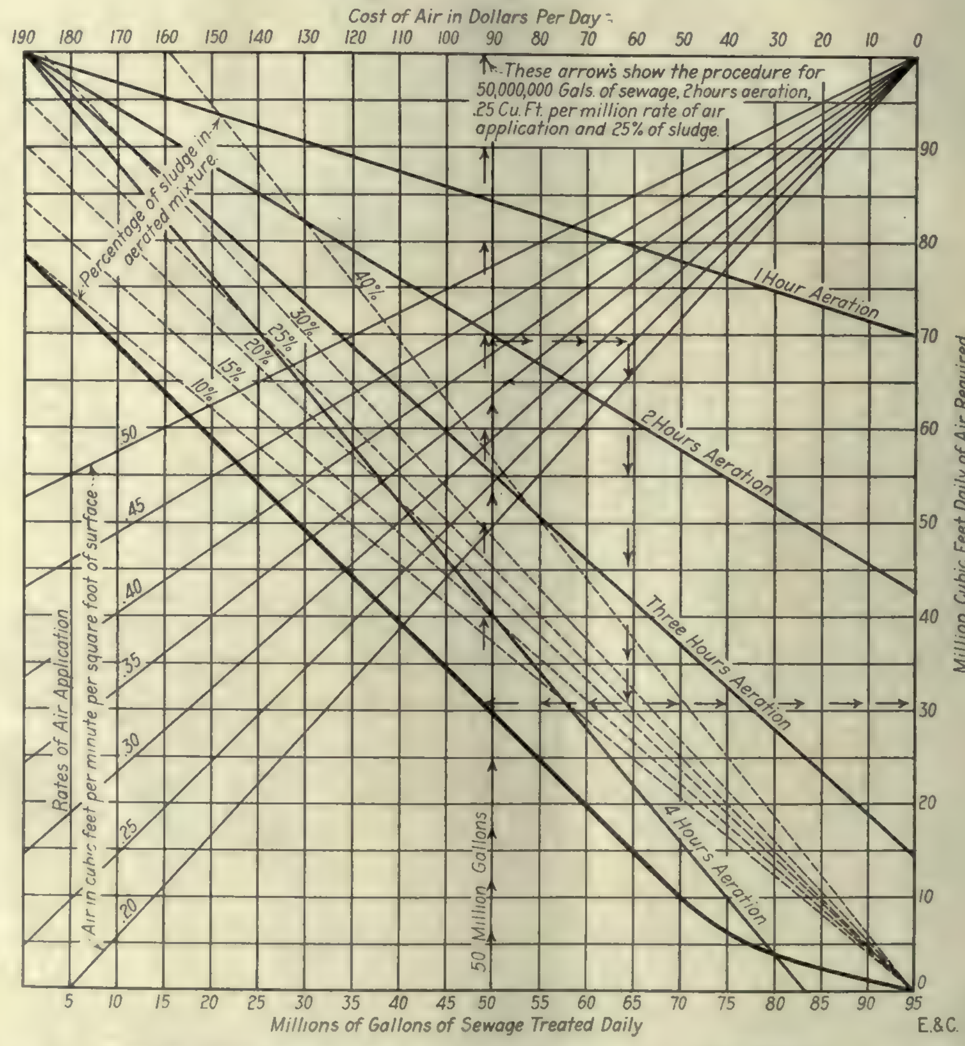


Fig. 5. Diagram Showing the Cost of Producing Air Per 1,000,000 Gals. of Sewage Treated Per Day, Under Varied Conditions as to Period of Aeration, Rate of Air Application Per Square Foot of Tank Surface and Percentage of Activated Sludge Maintained in the Tanks.

Costs include all boiler room labor and all overhead charges, such as interest, sinking fund and depreciation. The amount of air used per 1,000,000 gals. of sewage is based upon the use of a tank of 9 ft. average depth. The final cost of aeration is, however, nearly independent of the depth of tank if the rate of aeration per square foot of tank surface remains constant, as if the depth were doubled the volume of air per gallon of sewage would be halved but its pressure doubled.

Instructions:—Begin at the bottom of the diagram with the number of gallons of sewage treated daily. Run vertically to the selected period of aeration, then horizontally to the selected rate of air application, then vertically to the percentage of sludge, then horizontally to the heavy curve and thence vertically to the cost in dollars per day. To find the amount of air in millions of cubic feet per day run horizontally to the left instead of to the heavy curve.

quaintance that gives sufficient value to warrant handling. It further estimates the cost of recovering the sludge, that is dewatering and drying, as $3 per dry ton. From all the information so far available, which is far from being reliable, about one ton of dry sludge will result from treating 1,000,000 gals. of Milwaukee sewage.

At any rate it seems quite within the bounds of reason to anticipate that there will be sufficient recoverable value in the sludge to pay for its final disposition at least, so that the cost of this portion of the process need not be taken into consideration when comparing it with the cost of treating sewage by any other process.

It might be stated that the companies have declared their willingness to take all the sludge, corresponding to the sample submitted, which could be furnished them, and that they would be quite willing to take it either with 50 to 60 per cent moisture or less and pay us upon the basis of the dry content, charging us for the cost of drying.

The sludge is far easier dewatered than is the Imhoff tank sludge, and is free of odor as is the entire process of treatment.

To show the bacterial efficiency of the process Table I is given, showing several representative samples taken from the day's run of the "fill and draw" tank over a period of two months. This particular table is here inserted to bring out clearly the remarkable effect on the bacteria for the different periods of aeration. The tank was working with an activated sludge content of from 12 to 14 per cent.

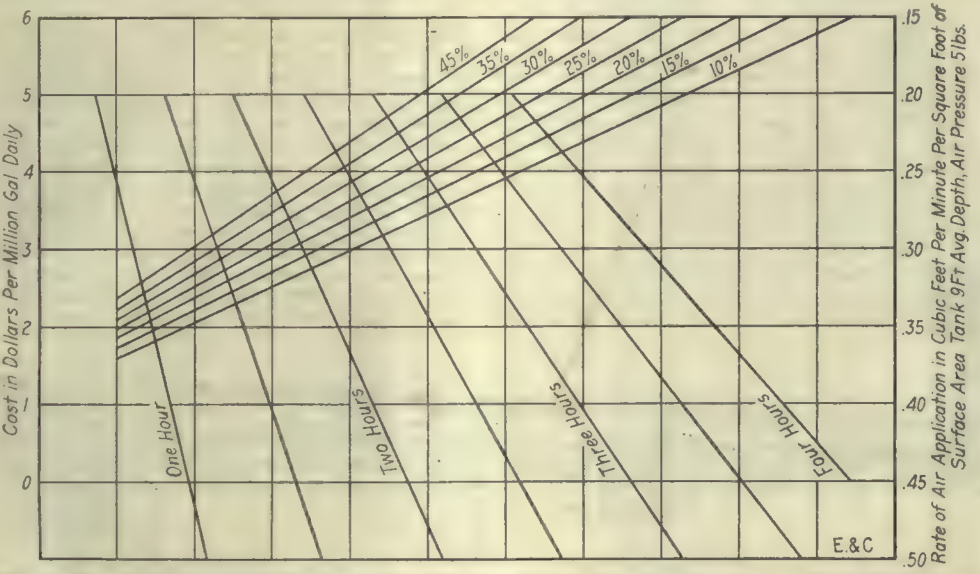


Fig. 6. Cost of Sewage Treatment by the Activated Sludge Process for 50,000,000 Gals.

This diagram combines the data given in Figs. 4 and 5; it also includes the cost of the plant for treating the sewage, which includes all overhead charges. Only labor cost included is that for boiler room. Engine room and plant labor not included.

Tankage is provided for 1½ times the average daily flow and the sedimentation period is ½ hour. Pumping of sludge is figured in as 30 cts. per 1,000,000 gals. of sludge pumped on the basis of 10 cts. per 1,000,000 gals. 1 ft. high.

Instructions:—Select the required rate of air application on vertical line to the extreme right. Run from this point horizontally to the left to the required period of aeration, then run vertically to the required percentage of sludge in the mixed liquor, and then horizontally to the left for the cost in dollars per 1,000,000 gals. of sewage treated.

The results in Table I indicate that most of the work is done in 1½ to 2½ hours so far as the removal of the bacteria is concerned, although a longer period of aeration is required to secure a stable effluent. An 1½ hours' aeration gives, in every case, a clear effluent providing the liquor comes in contact, during the period, with 12 per cent or more of activated sludge, but, so far, it has not been possible to maintain the sludge in an activated condition with only 1½ hours' aeration.

IN GENERAL.

Before satisfactory results can be obtained by the process the sludge must be activated. That is, the free ammonia nitrogen must be changed to nitrate nitrogen, or as we briefly term it, the nitrogen cycle must be established. This requires continuously aerating the sludge, while intermittently adding fresh sewage, for several days until it becomes quite brown in color and from which a clear limpid liquor can be drawn.

It has been found in our experiments that a clear effluent, with a 90 per cent, or over, reduction of bacteria, can be secured without establishing the nitrogen cycle, but such an effluent is not stable for five days without dilution.

TABLE I.—BACTERIAL EFFICIENCY OF THE ACTIVATED SLUDGE PROCESS AT MILWAUKEE AS OBSERVED OVER A PERIOD OF TWO MONTHS WITH THE "FILL AND DRAW" TANK.

Date.	No. of days stable after 4½ hours aeration.	No. of cubic feet of air per sq. ft. of tank surface.	No. of cubic feet of air per gallon of sewage treated.	Hours of aeration. 0 — No. of bacteria per C.C. at 37° C. Raw sewage activated sludge tank.	1½	2½	3½	4½	Percentage of removal of 37° C. bacteria.
May 11	5—	0.30	1.47	160,000	1,000	1,000	1,000	1,000	99—
June 2	5—	0.28	1.41	230,000	1,000	1,000	1,000	1,000	99—
June 8	5—	0.39	1.90	240,000	12,000	5,000	3,000	1,000	99—
June 12	5—	0.30	1.49	110,000	6,000	5,000	1,000	1,000	99—
July 22	5—	0.35	1.72	300,000	15,000	9,000	3,000	2,000	99—

It is surprising how rapidly this process of sewage treatment has been taken up in an experimental way both in England and the United States. Within the last nine months ten experimental stations in the United States and one in Canada have been studying the process.

Prof. Edward Bartow, Director of the Illinois State Water Survey, has conducted a very interesting series of experiments at the University of Illinois. His paper appearing in Engineering and Contracting of April 7, 1915, is one of the best descriptions of the process and the results obtained which has come to the notice of the writer.

Mr. Leslie C. Frank of the United States Public Health Service, has secured letters patent covering the process, and has dedicated the patent to the citizens of the United States, thus protecting our municipalities against royalties. Mr. Frank is to be congratulated for this act, which will prevent a repetition of the litigation experienced by many American municipalities who adopted septic tank treatment.

In conclusion the writer believes the activated sludge process is the best and cheapest process for treating sewage where a high standard of effluent is required, and that, as it becomes better developed, it will supplant sedimentation and sprinkling filters.

Its adaptability for treating sewage to any required standard makes it particularly attractive. The cost being in direct proportion to the standard required makes it come within the means of many of the smaller municipalities which would not be able to meet the first cost of sprinkling filters. The fact that the sludge is valuable as a fertilizer meets the popular conservation propaganda, and helps pay the operating charges.

It might not be out of place here to warn the young practicing engineer against advising his clients to adopt this process and then designing a plant before he becomes thoroughly acquainted with the principles involved. Such a procedure will result in probable failure and chagrin to him and an unwarranted reflection upon the ability and judgment of his profession. He would better stick to the old processes until the problems connected with this new one are pretty well solved by those who have the facilities for conducting experiments.

ACKNOWLEDGMENT.

The foregoing matter is the major portion of a paper before the recent annual meeting of the American Society of Municipal Engineers by Mr. T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission. The copy for the illustrations shown was courteously furnished Engineering and Contracting by Mr. John H. Fowles, Secretary of the Milwaukee Sewerage Commission.

Surface Drainage a Controlling Factor in Stream Pollution.

(Staff Abstract.)

It is often asserted that cities should cease contributing to the general polluted condition of surface waters, and this can be accomplished at great cost, but little consideration has been given to the general surface contamination due to the run-off from agricultural lands and villages. The latter phase of the general subject is here considered.

Upon the fertile smaller tributary drainage areas will be found the farms and hamlets where the usual sanitary accommodations are those of privies from which the excrement flows away or is periodically spread upon the land. Throughout much of the year these are undoubtedly oxidized by natural processes and do not concern this discussion. Small villages, having commercial water supplies, drain into streams of sufficient size to prevent serious physical nuisance, but partially digested sludge is accumulated in mill-ponds and pools. In the northern climates, however, the winter period of three or four months makes dormant the natural aids, to be followed immediately by the greatest flood discharges cleaning the whole surface of its accumulations. These discharges often reach the equivalent of 2 ins. or more of water over the entire drainage area. For purposes of illustration, assume that this flushing by spring freshets may bring down one-fourth of the year's accumulated filth of the drainage area or that one-fourth of 365 days, or 91 days, accumulation is brought down and that this occurs within a period of 15 days, then there would be one-fifteenth of 91 days accumulation passing down each day or six days' accumulation of filth from this drainage area to pass into the great waters each day during the flood periods from sources outside the great cities situated upon them.

To apply this to a specific example, the Niagara River has upon its course an urban population of about 600,000. There enter it from the east two minor tributaries having a population upon their drainage areas of about 100,000. From the above reasoning there would enter from these tributaries during each of 15 days a year, from flood discharge, a pollution equal to that normally entering from the cities along its course.

The fallacy of purification of this stream by exclusion of city sewage alone is apparent if, during 15 days of each year, the condition remains substantially that of normal pollution.

There must be added to this the surface washings of the urban areas which, at present, seem entirely beyond reasonable limits of purification.

Another consideration pertaining to the general condition of these waters is that of the accumulated flood discharges as affecting the whole body of lake waters.

A rise of 1½ ft. has occurred in a month in Lake Erie from spring flood discharges, representing an addition of one to two per cent of the whole contents in polluted surface drainage. This does not thoroughly admix, but remains somewhat adjacent to the shores and there represents a greater proportionate pollution.

This condition may be of utmost importance to several of the Lake cities situated at the mouths of comparatively small streams. Due cognizance is taken of the highly polluted condition of these small streams, and water intakes are located at a distance along the shore such that the dilution, perhaps supplemented by sewage treatment, will apparently ensure a safe supply and yet the accumulated discharge of some near small stream may, at times, produce a body of water which, under usual conditions of wind and current, may be brought to the intake. This possibility may well indicate the advisability of more thorough water treatment at a less expensive location or a lessened sewage treatment for the city with the same factor of safety secured.

It may be argued that this surface drainage has lost most of its pathogenic bacteria, and is, therefore, comparatively innocuous, but the medical profession is not yet prepared to say that this organic refuse, even without pathogenic bacteria, may not be a marked source of digestive ills.

Under the above assumptions and arguments the conclusion must be reached that any endeavor to improve these waters to a safe potable standard by removal of urban sewage alone, will be futile. Nor can it be assumed, within fair reason, that this effect of surface drainage can be eliminated as a practical or immediate probability. Until sanitary science and sentiment have made great strides, surface contamination must continue as a potent factor demanding treatment of potable water supplies and with such requirement the logical corollary is that only such treatment of municipal sewage is required as may prevent undue burden upon a water plant designed to meet the conditions of surface pollution.

Until sanitary science and education have made greater advance in the rural and suburban territories, the inherent menace of this drainage must be a limiting and controlling factor in any endeavor to render pure the larger bodies of water and to make them potably safe by remedies applied solely by the great municipal bodies along their borders.

ACKNOWLEDGMENT.

From paper by George. H. Norton, Buffalo, New York, before American Society of Municipal Improvements.

BRIDGES

Construction of the Twelfth St. Trafficway Viaduct, Kansas City, Mo.

(Staff Abstract.)

The Twelfth St. Trafficway Viaduct forms the principal part of a trafficway designed to facilitate the usual street traffic between sections of Kansas City, Mo., which are separated topographically. Twelfth St. is the principal east-and-west thoroughfare of the city, and is the central axis, both with respect to the up-town part of the city and the industries in the Bottoms of the level valley of the Kaw River. About 30 years ago a steel viaduct for cable cars was built on this street with a grade of about 13 per cent, and car service was maintained until the present construction was commenced. The present trafficway extends from Liberty St. to Broadway, a distance of ¾ mile, of which the viaduct occupies about 2,300 ft. The remaining portion consists of earth embankments and cuts. A 60-ft. street is thus provided on a continuous grade of about 5.5 per cent for a distance of 3,500 ft., or substantially from end to end of the improvement. To accommodate traffic desiring a less steep grade, and willing to travel by a less direct route, a roadway on a lower deck is provided, with a grade of 2.5 per cent. This lower roadway begins one block east of the upper one and extends to the bluff, a distance of 1,800 ft. Preliminary studies and estimates were made for viaducts of steel and of reinforced concrete; in the latter case structures of arch spans and also of girder spans were considered. The girder type of structure was finally selected, a general elevation of which is shown in Fig. 1.

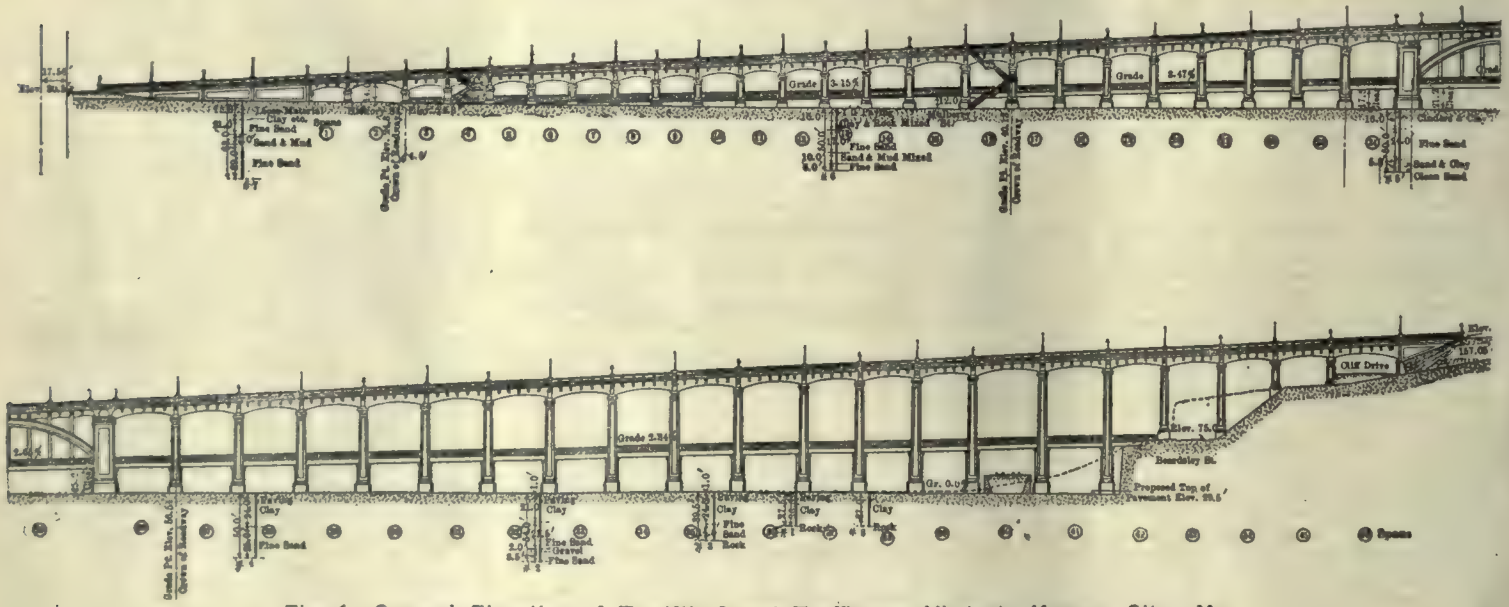


Fig. 1. General Elevation of Twelfth Street Trafficway Viaduct, Kansas City, Mo.

GENERAL FEATURES OF STRUCTURE.

The structure is of concrete construction, and consists of girder spans supported by columns founded in part on rock, in part on soil, and in the main part on concrete piles. Over the eight railway tracks in Santa Fe St. a long span is provided by the construction of an arch. The viaduct is about 2,300 ft. long, 60 ft. wide, and 120 ft. high at its highest point. The columns are in pairs transversely, and are so placed that the upper deck cantilevers beyond the columns on each side, and the lower deck roadway passes between them. The upper deck provides a roadway 30 ft. wide, paved with creosoted blocks, a sidewalk 5 ft. wide, and a street car space 22 ft. wide. The roadway is separated from the street car space by a concrete curb, and on each side of the structure there is a concrete hand-rail. The two street car tracks are built with the usual wooden cross-ties set in ballast, so that no other traffic can use the area which they occupy. This arrangement, somewhat uneconomical from a highway standpoint, was specified by the city authorities. Iron trolley poles on each side of the street car space support the usual overhead trolleys. Stairways are provided at Hickory and Mulberry Sts. to give access for pedestrians to the roadway from the ground surface. The lower deck, beginning at Hickory St. and ending at Beardsley St., provides a single roadway, 30 ft. wide, paved with creosoted blocks. The longitudinal girders supporting this deck extend far enough above the roadway to form side barriers.

The upper deck comprises 45 deck girder spans of two girders each, varying in length from 33 to about 56 ft., the arch span, and two earth-filled approaches. The lower deck comprises 27 through girder spans of two girders each, supported on the same columns that carry the upper deck, the suspended deck of the arch span, and the earth-filled approaches. The floor slabs are supported on cross girders and cantilever beams. For the crossings of both decks over the streets, near the west end, very shallow floors are necessary, and concrete-encased steel beams in the floors, and concrete-covered steel girders, are used instead of the ordinary reinforcement. Both upper and lower roadways are lighted with incandescent electric lights, placed above the hand-rail for the upper deck, and on brackets on columns for the lower deck.

Careful attention was given to the architectural treatment in an effort to secure something more than a plain series of posts and columns. This treatment considers the columns, not merely as posts, but as columns with plinths and capitals. The bottoms of the upper decks are curved to give an arched or high cambered appearance. The lower deck girders are straight and in effect are supported by secondary pilasters set out from the main columns. In general the span lengths are made smaller near the lower end of the structure, affording uniformity of appearance and preserving the unity of effect, notwithstanding the great variation in height of the different columns. The large arch at Santa Fe St. provides a central feature for the structure, and was thus developed. The piers are carried up to the upper roadway and there support, on cantilevers, bays which project beyond the usual hand-rail line. The capitals, plinths, moldings, the projecting panels, and such features, are bold and heavy, in keeping with the general dimension of the viaduct.

CONSTRUCTION PLANT.

Yard Space.—The contractor's plant was at the west, or low, end of the viaduct, where storage space, switch tracks, sidings, and facilities for handling materials were most easily available. The working space comprised an area of about 35,000 sq. ft. Figure 2 shows the layout of the construction plant.

Three standard gage spur tracks were provided, one track parallel to Twelfth St., in the alley south of it—used for the delivery of timber; and two tracks crossing Twelfth St. at right angles—one for the delivery of sand, stone and steel and the other for cement.

Concrete Plant.—The mixing plant, placed on the line of the viaduct, consisted of elevated bins for sand and broken stone, arranged to discharge into measuring hoppers, below which a 33-cu. ft. "Chicago" cube mixer was installed. The mixer dumped the concrete into hopper cars operating on a 30-in. gage track passing underneath. Stone and sand were delivered in bottom-dump cars and unloaded into a receiving pit alongside the bunkers. A 22-in. "Jeffery" belt-bucket elevator, of a total height of 70 ft., raised the stone and the sand from the pit to the top of the bins, where a baffle-board directed each to a proper bin. One elevator thus handled both sand and stone, unloading first one and then the other. The cement was hauled up an inclined track from the cement storage shed on a car, self-dumping at the top, to a platform under the sand bin, where it was filled into a sheet-iron tube with a bottom gate, and so discharged into the mixer. The tube was of just the proper dimensions to hold six sacks of cement, the normal charge. Figure 3 shows side and end elevations of the concrete mixing plant. The limited room for tracks made necessary considerable shifting of the cars, as only the first car of a train could be placed over the pit. The operations of unloading and mixing were not always simultaneous, but when all operations were going forward, there were required, severally, 2 men for unloading and handling the elevator, 3 men for unloading cement from cars, 1 in the storage shed, 2 opening sacks and feeding to the mixer, and 1 man attending to charging and operating the mixer. Thus, the services of 9 men were needed for the unloading and mixing of concrete ingredients.

During severe weather, the stone, sand, and water for the concrete were heated by passing steam from a 60-hp. boiler into the bottoms of the sand and stone bins, and into the water, thus thoroughly and satisfactorily heating all the materials.

Equipment for Steel and Timber Reinforcing.—The steel storage yard was adjacent to one of the switch tracks, and was equipped with a working platform and a power bar-bender of ingenious design. This bender was devised on the job, and included a motor connected by a worm gear to a vertical shaft which had at its upper end a clutch with a jaw to engage the bars to be bent, thus bending the bars in a horizontal plane on a protractor plate to any desired angle. The lumber storage yard was beside the third siding. From this lumber yard, the material was passed into a wood-saw shop, thence into the carpenter shops, and then forward to the structure. The wood shop was equipped with a circular rip saw, a "Hall and Brown" rip saw No. 131, a "Crescent" 36-in. band saw, a "Crescent" swing cut-off with 18-in. saw, and a universal edger and planer known as "Hall and Brown New Model Single Sticker No. 30."

There was also a well equipped blacksmith shop.

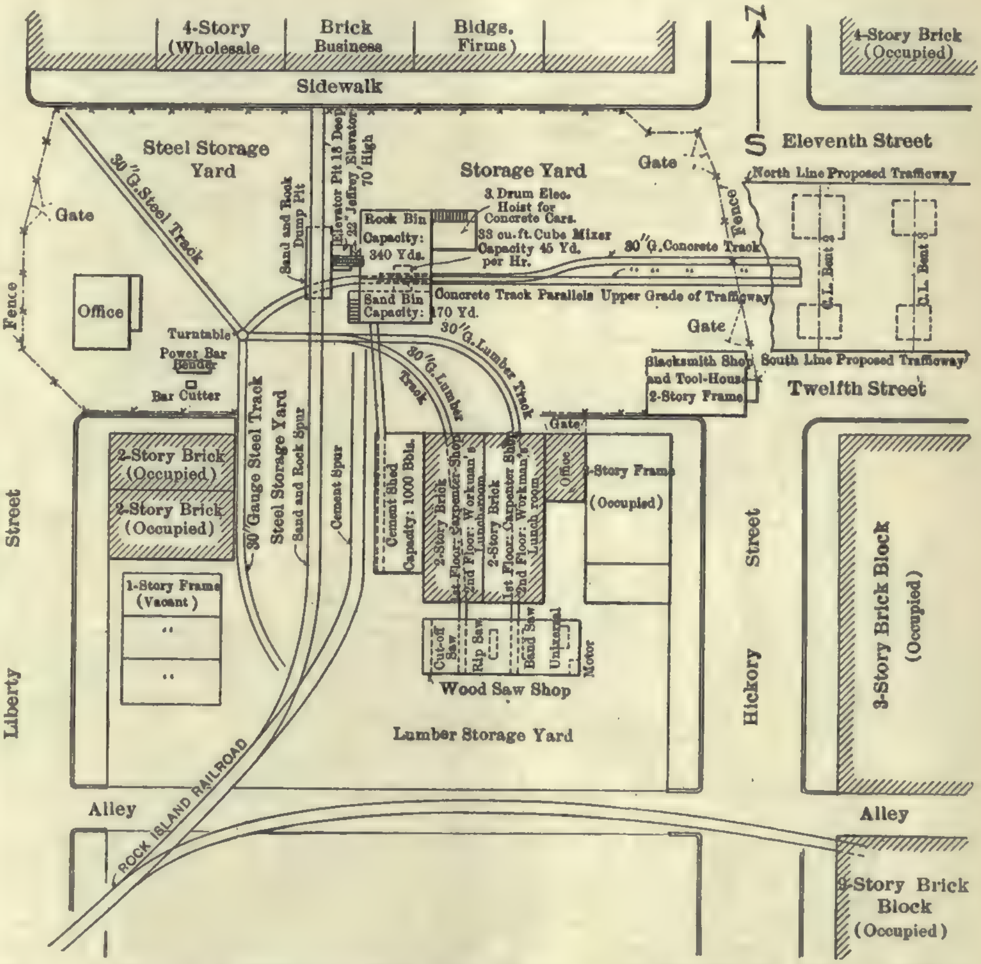


Fig. 2. Layout of Construction Plant and Storage Yard for Twelfth Street Trafficway Viaduct.

Transportation.—All materials were put in form as nearly as possible ready for erection in this yard. All were conveyed out to place on a double narrow-gage, industrial track carried on a tramway trestle some 8 ft. above the finished roadway surface, on the falsework, or on the partly finished structure. As construction proceeded, the tram tracks were placed on the upper roadway. The cars operating on this track were hauled forward and backward in pairs by a cable operating on two drums of a hoist placed on the mixing plant; the empty car being returned as the loaded car was hauled out.

For conveying concrete, four 2-cu. yd. side, bottom-dump cars were used; and about six sets of trucks provided cars of various length for handling forms, steel, etc. Two light traveling derricks of about two tons capacity, one on the lower deck and the other on the upper tramway on top of the upper deck, were each equipped with electric hoists.

The entire equipment, including elevators, concrete mixer, wood-working machinery, blacksmiths' tools, bar-bender, etc., was operated by electricity, alternating-current, 220-volt, 3-phase, 25-cycle being available, and individual motors being attached to the various units.

Pile-Driving Equipment.—The piles were driven with a steel frame, turntable driver with 56-ft. steel leads, equipped with a 42-hp. hoisting engine and a No. 1 "Vulcan" steam hammer weighing five tons, resting on rollers supported on wooden sills laid on the ground. Timber cribbing was used to support the sills across the excavations. There were, of course, the usual collapsible pile cores and other special equipment required in the construction of "Raymond" piles.

With the exception of the pile-driving outfit, practically the entire equipment was purchased new for this work and was carefully selected, in order to fit exactly the service needed. The orderly progress of the work is a testimonial of the adequacy and suitability of the plant.

Procedure of Sub-Surface Work.—The excavations, for the most part, were very simple, not very deep, on account of the concrete piles, and in a sandy loam, easily dug, and standing without much shoring or sheeting. Near the east end of the viaduct there was considerable old, filled material; and rock was encountered at various elevations. The east abutment rests in part on clay and shale with front toe-walls, 5 ft. thick, carried to rock at about 10 ft. lower elevation. The work was simple, open excavation.

After excavations were made, the concrete piles were driven to the refusal the apparatus would stand. The engineers required that all the steel shells for a group of piles be driven and then the concrete for all be placed at one time. This was to prevent any possible damage to the unset concrete of one pile by the driving of another near it. No particular difficulty resulted, except that the shells would sometimes partly fill with water or with sand and silt, which had to be pumped out before depositing the concrete. The shells stood open without collapse, except where water-bearing, so-called quicksand was encountered, and there it was found necessary to fill each shell as driven. In the main, the concrete for the piles was mixed in the general mixing plant, but, in some instances, for convenience, small quantities were mixed by hand.

Forms and Falsework.—The forms and falsework merit special attention, for their construction, erection, and removal formed the principal items of labor cost of the whole structure, and the efficiency with which the work was carried forward was dependent in no small degree on the thoroughness and care the contractor used in their design and construction. Figure 4 shows a cross section of the falsework and forms for the girder spans, and Fig. 5 shows the falsework used for the arch span.

Plans and sketches were prepared dimensioning all special parts of all forms, and, as far as possible, controlling portions were constructed in the carpenter shops and taken out complete for erection; only the principal portion of the sheathing was put on in place in the usual manner. Though the structure has an effect of duplication, there is, in reality, very considerable variation of dimensions within small limits, so that there were few parts of forms removable and replacable without alteration. For instance, there are no two columns of the entire structure alike.

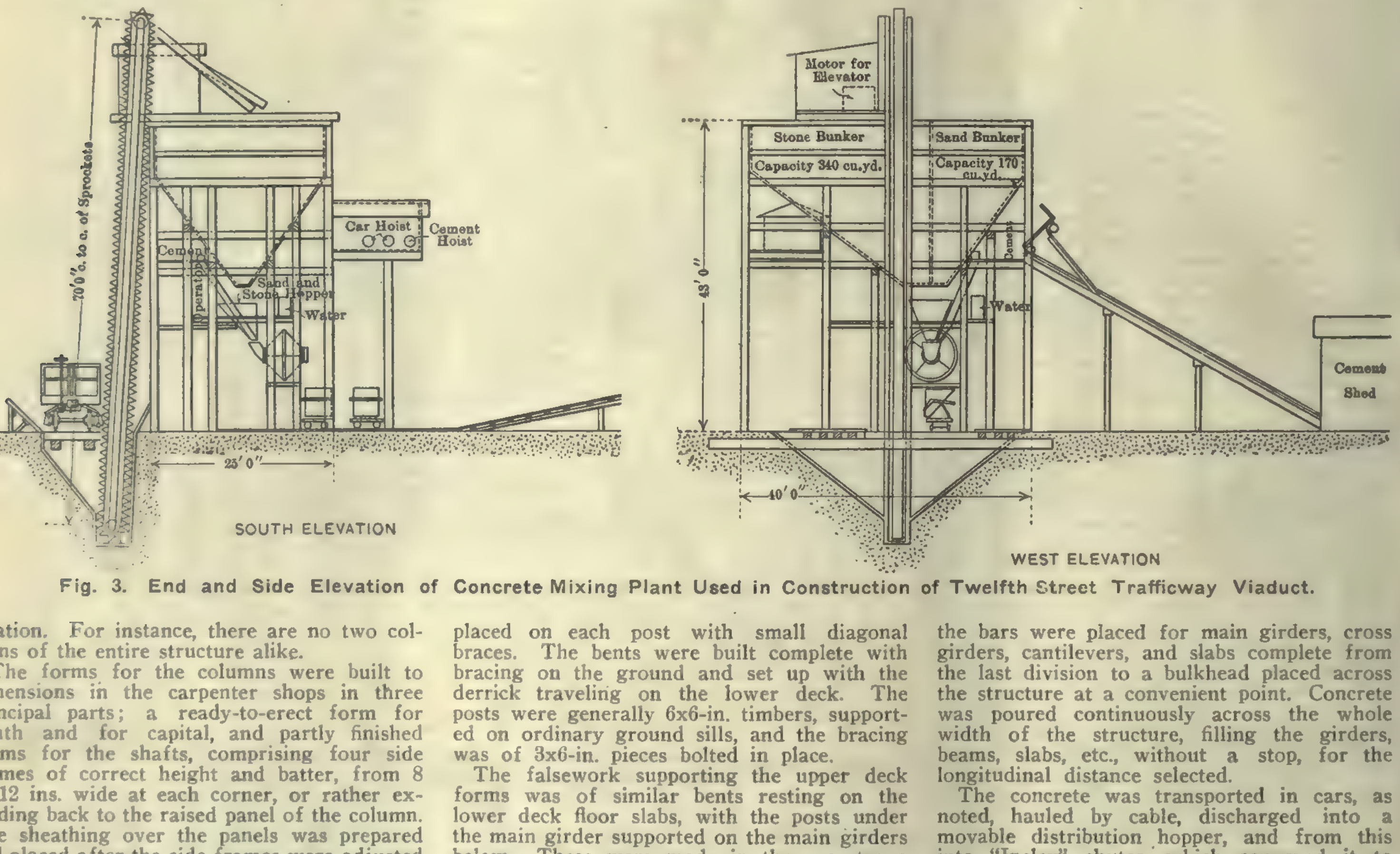


Fig. 3. End and Side Elevation of Concrete Mixing Plant Used in Construction of Twelfth Street Trafficway Viaduct.

The forms for the columns were built to dimensions in the carpenter shops in three principal parts; a ready-to-erect form for plinth and for capital, and partly finished forms for the shafts, comprising four side frames of correct height and batter, from 8 to 12 ins. wide at each corner, or rather extending back to the raised panel of the column. The sheathing over the panels was prepared and placed after the side frames were adjusted to position. Yokes surrounding the column of the usual four timbers, bolted at the corners, and tied across with a central bolt surrounded by a tin tube, were placed at intervals and given bearing by wooden wedges.

For the upper deck longitudinal girders and for the cross girders between columns, which had curved bottoms, the forms were built in place by the usual building-construction methods. The curved joists under these girder forms were framed and bolted together full length, carried out, and placed as a unit; and short lagging boards, the length of the girder width, were nailed on. The side lagging was placed longitudinally on a 2x6-in. studding, placed in pairs at suitable intervals and tied across by bolts. The lower bolts passed through below the bottom sheathing, and were not encased by the concrete.

The forms for the intermediate cross-beams were of the same general design, except that the sides were made of a series of panels about 2 ft. wide with a vertical stud at each side. After the bottom forms had been prepared these panels were easily and rapidly set up alongside each other and supported by bolts passing across between the pairs of studs. The erection, removal, and re-erection of these panels were simple and easy, and their use effected considerable economies.

The cantilever beams on each side of the structure were also duplicated forms, and were built in two unit-sides ready to be placed on a bottom form and bolted together. The bottom joists were sawed to correct form in the shop and sheeted after being placed. The cracks between the sheeting on all these curved surfaces were filled, or pointed up, with clay just before placing the concrete.

The decking between beams and girders was supported on joists resting on stringpieces fastened to the vertical studs of the beams and girders, as is customary in building construction. Forms for abutments and retaining walls were built in the usual manner. Portions of the hand-rails, stairways, etc., were built of units cast in wooden forms generally lined with sheet steel.

The falsework supporting the lower deck forms consisted of bents of posts under each cross girder, braced together transversely and longitudinally. A short longitudinal cap was placed on each post with small diagonal braces. The bents were built complete with bracing on the ground and set up with the derrick traveling on the lower deck. The posts were generally 6x6-in. timbers, supported on ordinary ground sills, and the bracing was of 3x6-in. pieces bolted in place.

The falsework supporting the upper deck forms was of similar bents resting on the lower deck floor slabs, with the posts under the main girder supported on the main girders below. These were made in three parts; a central bent of three posts and bracing supporting the central portion of the cross beam, and two side bents of three posts each with a cap cantilevered to each side, one end of the cap supporting the cantilever beam and the other extending far enough under the cross beam to carry a corresponding load, balancing the entire cap load over the posts. These three ports of each bent were prepared on the lower deck near position, or were carted out to position on wagon trucks and raised by the derrick on the upper deck.

The requirements of horizontal clearance for the railroad tracks on Santa Fe St. made necessary the use of three pairs of small wooden truss spans to support the forms for the arch ribs. These trusses rested on bents of posts set in available spaces between the tracks. The arch centering was placed on top of them, and the lower deck forms were suspended from them.

Falsework and forms for about seven girder spans were provided and carried forward as it was removed, the posts of the falsework being spliced as the height increased.

CONSTRUCTION PROCEDURE.

The falsework, forms, and pouring were each, relatively, on the lower deck about two span lengths ahead of the upper deck, as the falsework for the upper deck could not be placed on the lower deck concrete until it had hardened somewhat. The whole construction thus moved forward in sequence, maintaining about the same relation of lower deck advance.

The reinforcing bars were delivered, as far as possible, in lengths correct for use. Diagrams were prepared showing the shape and dimensions for bending each bar and assigning a mark to it. The bars were bent in the yard, and each special bar was tagged with its erection mark on a linen tag. Groups of plain bars, etc., were not tagged individually.

As the forms neared completion, the prepared bars were carried out on the tram cars and set in place. Metal clips, separators, and wire ties at the crossing of every two bars, supported them in place. Use was made of small cement briquettes or blocks in some cases to hold the bars up from the forms.

The placing of bars and depositing of concrete in the columns was carried forward in customary routine. For the upper deck, all the bars were placed for main girders, cross girders, cantilevers, and slabs complete from the last division to a bulkhead placed across the structure at a convenient point. Concrete was poured continuously across the whole width of the structure, filling the girders, beams, slabs, etc., without a stop, for the longitudinal distance selected.

The concrete was transported in cars, as noted, hauled by cable, discharged into a movable distribution hopper, and from this into "Insley" chutes, which conveyed it to final position in the forms. A trussed steel chute about 80 ft. long carried the concrete from the receiving hopper on the upper deck forward to position in the lower portions of the structure. The concrete was mixed to a soft consistency so that it flowed readily, but it was not so wet as to have water standing on its surface. It was spaded and sliced at the forms and around the reinforcing bars to insure complete contact, and to work forward the mortar.

The maximum capacity of the concrete plant delivering 1,300 ft.—or, say, to the mid-point of the structure—was about 30 cu. yds. per hour. The largest quantity placed in continuous run was about 450 cu. yds. in 15 hours. A trip one way, from the plant to the east abutment, required 3½ minutes.

The hand-rail units were cast on the deck in metal-lined wooden forms, near the place where they were to be used. The lower rail was cast in place, the separately cast balusters were set in it in rows, and the pre-cast top rail was set on them, extending into the posts. The forms for the posts, except for the capital, were clamped on, and the posts were cast in place. The stairs were cast in units of one riser and one tread. These were supported on falsework and projected into the forms for the supporting girders, which were built in place.

Materials, Prices and Wages.—The total quantity of timber used on the job was about 1,500,000 ft. B. M. This may be roughly divided into 600,000 ft. of form lumber, 850,000 ft. of falsework, and 50,000 ft. in general use, including bins and mixing plant. The average cost of this material was about $20 per thousand or about $1 per cubic yard applied to the whole concrete, or $1.25 per cubic yard applied to concrete above the bases.

There was some difficulty in securing stone as clean as desired, for the limestone strata in this region are overlaid with clay and other objectionable materials; and, especially during a rainy season, it is impossible to prevent some clay and soft shale from mingling with the stone in the crusher bins. In fact, the more careful crushers shut down during rainy weather to avoid this difficulty. The stone cost $1.15 per cubic yard delivered in cars at the site. The sand supply from the Kaw River is clean, sharp, and well graded, testing about 52 per cent retained on a No. 30 sieve. Its cost delivered in cars at the site was about $0.65 per cubic yard. The cement was "Kansas City," Portland, manufactured in a mill about 15 miles from the site, and costing, delivered in cars at the site, $1.20 per barrel (plus sack loss). These delivered prices include somewhat complex switching charges. Reinforcing steel delivered cost about 1.75 cts. per pound.

The number of men employed varied from 150 to about 325, an average of about 200 men, of whom about 150 were carpenters and helpers. The wages prevailing were: For common labor, $2; for carpenters' helpers, $2.50; for carpenters, $3.50; for finishers, $3.50; and for derrick and hoist operators, $4; all for 9 hours per day.

GENERAL COMMENT.

The conduct and execution of the work merit special comment. The viaduct was built substantially in the allowed time of 15 months, moving forward in logical and orderly manner, largely due to systematic handling of labor and materials. On the first day of every week a schedule of work to be accomplished each day of that week was prepared in writing, and the foremen were instructed, not only what to do each day, but also how much had to be done. If the amount assigned was not completed at the usual stopping time the men kept at work until it was done. This applied particularly to placing concrete, the day's run being completed more than once after midnight. The conditions surrounding the work permitted it to be handled as a manufacturing proposition, and with factory-like precision and system.

QUANTITIES AND COSTS.

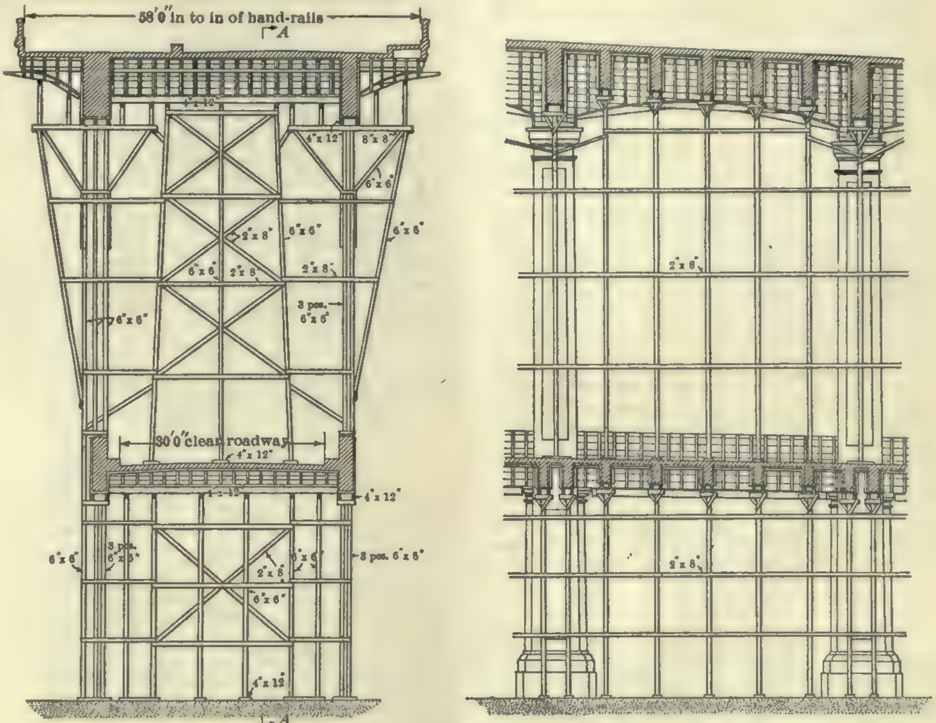
The contract assigns unit prices for 40 classified items, including many classifications of concrete with regard to location in the structure. The following summarized figures were prepared from such classifications, and an attempt has been made to give the salient features of the final quantities of the structure, as built. These costs are the amounts paid by the city, and include the contractor's profit.

There are about 32,500 cu. yds. of concrete, distributed about as follows:

Item.	Cu. yds.
Concrete piles	1,360
Columns, piers at Santa Fe St., and footings	11,300
Upper deck, including girders, cross girders, cantilevers, floor slabs, etc.	11,300
Lower deck, including girders, cross girders, floor slabs, etc.	3,600
Retaining walls and abutments	3,000
Ribs of arch at Santa Fe St.	600
Hand-rails	500
Stairways, sidewalks, curbs, paving base on fills, and miscellaneous	800

No special payment was made for excavation, but the amount paid for concrete included its cost. The total excavation was about 10,000 cu. yds. The amounts paid for concrete in place varied from about $8 to $13.50 per cubic yard for different classifications, averaging $9.45 for the whole structure, omitting only the piles and the hand-rails, as both of these were paid for at linear foot prices.

There were driven 2,610 piles, having a total length below bottoms of footings of about 47,000 lin. ft., and an average length each of 18 ft., costing in place $1.20 per linear foot



CROSS-SECTION SHOWING FALSEWORK

LONGITUDINAL SECTION *A-A*

Fig. 4.

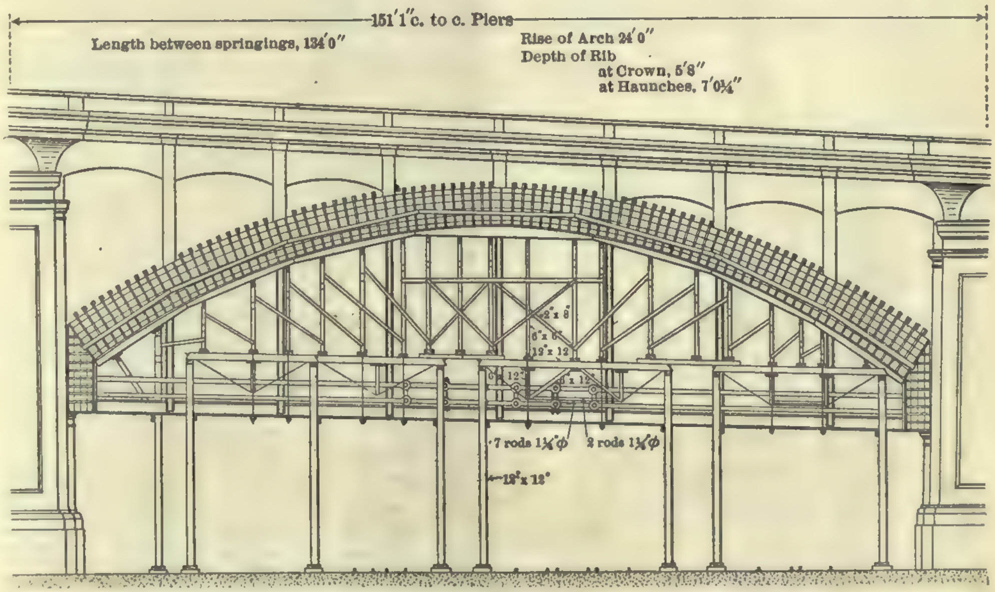


Fig. 5.

Fig. 4. Cross Section and Longitudinal Section of Twelfth Street Trafficway Viaduct Showing Arrangement of Forms and Falsework. Fig. 5. Elevation of Arch Span Showing Arrangement of Falsework.

The approximate quantities of metal, and the prices paid for them in place are as follows:

Item.	Lbs.	Cost, cts. per lb.
Reinforcing steel, ¾ in. in diameter and greater	2,900,000	2.95
Reinforcing steel, less than ¾ in. in diameter	1,000,000	3.25
Unfabricated metal, such as bed and bearing plates, guard angles, etc.	100,000	4.40
Fabricated structural metal	620,000	4.60
Cast iron lamp posts and brackets	25,000	5

Omitting the fabricated structural metal and the lamp posts gives a total of 4,000,000 lbs. of metal, or, considering 30,600 cu. yds. of concrete, an average of 130 lbs. of metal per cubic yard, at an average price of 3.06 cts. per pound.

The lighting system cost $9,500.

The double street car tracks, including ballast, cross-ties, track rails, inner steel guard rails, bonding, and trolley poles, cost, in place, a total of $18,000 for a length of 2,600 ft. of double track, or, say, $3.50 per linear foot for single track.

There are 14,500 sq. yds. of wood block paving, which cost $2.25 per square yard. The waterproofing under the ballast comprised about 5,000 sq. yds., costing $1.71 per square yard, and that under the pavement included 11,500 sq. yds., at a cost of 58.5 cts. per square yard—a total cost of $15,000.

There were about 40,000 cu. yds. of earth filling, costing 28 cts. per cubic yard.

There were other miscellaneous items, such as catchbasins, drainage pipes, sewer connections, etc., bringing the total cost of the structure to the city to about $600,000, to which should be added about $40,000 for engineering.

The following is a summary of quantities and costs:

Concrete piles, 2,610	$ 60,000
Excavation, about 10,000 cu. yds.	no price
Concrete, 30,600 cu. yds.	290,000
Reinforcing metal, 4,000,000 lbs.	122,000
Structural metal and castings, 645,000 lbs.	30,000
Lighting system	10,000
Street car tracks, etc	18,000
Waterproofing	15,000
Block pavement	33,000
Hand rails	8,000
Earth filling and miscellaneous	14,000
	$600,000

PERSONNEL AND ACKNOWLEDGMENT.

The viaduct was built for the city of Kansas City, Mo., under the control of the Board of Public Works. It was constructed under one general contract by the Graff Construction Co. of Seattle and Kansas City. The plans were made, and the construction supervised, by Waddell & Harrington, Consulting Engineers, Kansas City, Mo., the preliminary studies and estimates, the specifications and the direction of the design being in charge of E. E. Howard; and the construction was directed by L. R. Ash. M. J. Maher was resident engineer in charge of the entire construction work. The foregoing data were abstracted from a paper by E. E. Howard, in Proceedings American Society of Civil Engineers, Vol. XLI, p. 1019.

Concrete Highway Bridges: Some Data on Highway Bridges in Illinois.

(Staff Abstract.)

Data collected by the Illinois Highway Department show that reinforced concrete is as cheap as steel for about 85 per cent of all bridges now being built in Illinois. This fact has been determined by carefully prepared cost curves, and has been confirmed in many cases by proposals received on both steel and concrete designs prepared for the same bridge sites.

MAINTENANCE COST OF CONCRETE BRIDGES IN ILLINOIS.

The maintenance cost of bridges naturally depends largely upon the durability of the materials of which they are constructed, particularly when renewal expense is classed as a maintenance charge. About 1,700 reinforced concrete bridges have been built in Illinois under the general supervision of the State Highway Department. The oldest of these structures was built nine years ago; about 75 per cent, however, are less than four years old. On these 1,700 bridges the following repairs and replacements have been made since they were placed in service:

(1) Replacement of a 12-ft. slab, necessitated by the use of unsatisfactory materials in the original construction, at a cost of $150.

(2) Strengthening the foundation of a 40-ft. girder span, which had settled due to the flow of a stratum of soft material underlying a 4-ft. layer of hard material on which the abutments rested, at a cost of $1,600.

(3) Repairing one abutment of a slab bridge, which was partly undermined by an excessive flood, at a cost of $50.

(4) Jacking up one end of the superstructure of a 45-ft. girder bridge and constructing new bridge seats on one abutment, the settlement of which was caused by mining operations 200 ft. under ground, at a cost of $125.

This gives a total expenditure of $1,925 on the 1,700 bridges—about 0.1 per cent of their first cost.

ADAPTABILITY OF CONCRETE BRIDGES.

The adaptability of reinforced concrete for highway bridge purposes covers nearly as broad a field as does structural steel. It is, of course, not suited for movable spans; and where very long spans are required the cost of concrete bridges may be much greater than that of steel structures. In fact, very favorable natural conditions may render the use of such structures impracticable and their cost prohibitive.

The fact that only a very small percentage of the highway bridges in Illinois require spans of more than 60 ft. is largely responsible for the construction of about 85 per cent of all bridges of reinforced concrete, at no greater cost than steel structures designed for the same locations. Although concrete is more expensive than steel for about 15 per cent of all bridges constructed in Illinois, only 3.9 per cent, including movable bridges, are being built of steel.

RESULTS OF BRIDGE SURVEY.

The adaptability of reinforced concrete for the vast majority of highway drainage structures may be appreciated by an examination of the results of an extensive bridge survey made by the county superintendents of highways in Illinois, under the direction of the Illinois Highway Department. This survey covers about one-half of the area of the state and includes counties and townships in all districts. The data given in Table I cover all bridges and culverts on 48,426 miles of road, the total road mileage in Illinois being almost exactly double this figure.

TABLE I. — DATA ON BRIDGES AND CULVERTS ON 48,426 MILES OF ROAD IN ILLINOIS.

Type of bridge or culvert.	Number of bridges over 60 ft. long.	Number of bridges 9 to 60 ft. long, inclusive.	Number of culverts less than 9 ft. long.	Totals.
Concrete or stone	51	2,379	7,570	10,000
Steel on masonry foundations	775	5,076	1,372	7,223
Steel leg and tube bridges	697	6,329	1,632	8,658
Wood on masonry foundations	73	1,139	1,101	2,313
Wood throughout	118	6,424	27,692	34,234
Corrugated pipe	......	....	17,811	17,811
Plain steel pipe	......	....	3,308	3,308
Cast iron pipe	......	....	1,603	1,603
Vitrified tile pipe	......	....	12,813	12,813
Total number	1,714	21,347	74,902	97,963
Total length in feet	168,328	396,639	205,038	770,005 (145.9 miles)

DISCUSSION OF RESULTS OF BRIDGE SURVEY.

From Table I it will be seen that the average number of bridges and culverts per mile is 2.02; the average length of bridge per mile is 15.9 ft.; and the average length of each bridge, measured along the axis of the road, is 7.8 ft.

Of the total number of bridges 1.8 per cent are over 60 ft. long, 21.8 per cent are between 9 and 60 ft. in length, and 76.4 per cent are under 9 ft. in length.

The following classification is made with reference to the materials used in the construction of these bridges:

Type.	Per cent of total.
Steel on masonry foundations	7.4
Concrete or stone	10.2
Steel tube or leg bridges	8.8
Wood on masonry foundations	2.4
Wood throughout	34.9
Corrugated pipe	18.2
Steel pipe	3.4
Cast iron pipe	1.6
Tile pipe	13.1

At the beginning of the construction season 9.8 per cent of these bridges were reported as needing repairs, and 8.7 per cent as needing replacement.

It is to be noted that 98.2 per cent of all the bridges are less than 60 ft. long, and for these reinforced concrete is eminently suited. However, the fact that the remaining 1.8 per cent comprises 21.9 per cent of the total length of bridge (see Table I) should not be overlooked. In many cases, however, a series of spans of less than 60 ft. may be used for these longer bridges.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by Clifford Older, bridge engineer, Illinois Highway Commission, presented before the annual meeting of the Northwestern Road Congress, at Cedar Rapids, Iowa, Oct. 4-7, 1915.

The Use of Explosives in Driving Concrete Piles for a Bridge Foundation.

(Staff Abstract.)

In constructing the Cabugao Bridge, in the province of Ilicos Sur, Philippine Islands, explosives were used to loosen the subsoil (which consisted of gravel, sand, clay and boulders up to 10 ins. in diameter), preliminary to the driving of the reinforced concrete foundation piles.

It was desired to secure a penetration to elevation —6.8 meters, the elevation of the surface of the ground being approximately +0.2 meters. It was planned to explode the charges at elevation —6.0 meters, thus leaving 0.8 meter of penetration to be secured by driving the tapered points of the piles into the loosened material. Judson powder R. R. P. was used, as it was thought that would have a greater range horizontally and also a greater upward force than any other available explosive.

After the piledriver was moved into place for driving a pile, a 6-meter length of 3-in. galvanized iron pile was hoisted in the leads. To protect the threads during driving a pipe coupling was screwed onto the top of the pipe, and a steel cap, made of a ½-in. plate 7 ins. square, notched on the four sides about 2 ins., was attached. The corners of the plate were bent up at right angles to form a circle with a diameter practically equal to the outside diameter of the pipe. A piece of ¾-in. steel, 2 ins. long, was driven, while hot, through a hole in the center of the plate, a driven fit being secured. The cap was fitted over the end of the pipe, at the ground level, the protruding point serving as a guide to keep the cap and pipe going straight. Although the cap did not keep water out of the pipe it did prevent earth from entering and filling the pipe. While the driver was being made ready for driving, the charge of explosive was simultaneously prepared. The pipe was then driven to a depth of about 6 meters by light blows of the hammer.

The charge, which was made in the form of a long cartridge enclosed in a tin tube 2½ ins. in diameter and 1 meter long, was then lowered into the pipe and tamped to within 75 cm. of the top of the tube. Two sticks of dynamite, each equipped with a 6-meter fuse and cap, were then placed on top of the powder. Another stick of dynamite was broken into four pieces and tamped in around these two sticks, together with additional Judson powder, up to within 4 cm. of the top of the tube. On top of this there was rammed some thin paper in which the fuses were packed, and the tubes were sealed with asphalt or white lead, the end of the tube being crimped slightly.

After the bottom of the tube was down to the bottom of the pipe and was resting on the cap, a 6-meter length of 1-in. pipe was run down on top of the cartridge and held there by two laborers on the piledriver. The cable was then hitched to a rope fastened around the top of the 3-in. pipe, and the pipe was gradually withdrawn by the use of the engine, leaving the cap and tube in the ground. The 1-in. pipe was withdrawn after the 3-in. pipe had been lifted about 2 meters.

As soon as both pipes had been pulled out of the ground the fuses were lighted and the charge exploded. The piledriver was then moved into place for the next pile except one, and the operation repeated, and then to the second pile beyond that. This gave three explosions for a bent of five piles, the piles being spaced about 1 meter apart. The concrete piles were then driven with very satisfactory results as to grade and bearing power.

The following facts should be noted in performing work of this character:

1. There must be a steel cap on the penetrat-

ing end of the pipe, as a wooden plug splinters and forces itself up into the pipe.

2. There must be a coupling on the driving end of the pipe, as the metal at the base of the threads is too thin to permit of hammering without crimping the edges. The coupling also serves as a collar with which to grip the pipe with a rope when withdrawing it from the ground.

3. A block, preferably of hardwood, should be used on top of the coupling as a further protection for the end of the pipe.

4. The 3-in. pipe should not be driven until the cartridge is all ready, because once in a while the cap slides off the end of the pipe when down at a considerable depth, and the charge must be put in immediately before the earth works itself into the pipe.

5. Dynamite is absolutely necessary to explode Judson powder R. R. P. The manufacturer's handbook states the size and number of sticks to be used for different sized charges. The charge used was about 6 lbs. and required two ⅞-in. sticks.

6. In every charge of dynamite there should be two fuses and two caps as a minimum. One fuse and one cap are not enough, as oftentimes a fuse that burns well for half its length or more dies before reaching the cap, if the latter has been crimped too much or improperly. Using two fuses and two caps lessens the chances of failure to explode. One of the fuses should be a foot or more longer than the other, and the longer one be lighted first, to insure reasonable safety to the man doing the igniting. This must be done quickly; hence a torch or other large flame is best.

ACKNOWLEDGMENT.

The data given in this article were abstracted from a paper by Frank T. James, in the Quarterly Bulletin of the Bureau of Public Works, Philippine Islands.

ROADS AND STREETS

Brick Road Construction Upon a Sand Base in Hillsborough County, Florida.

(Staff Article.)

A bond issue of $1,000,000 was voted in Hillsborough County, Florida, in July, 1913, for the improvement of country roads. Vitrified paving brick laid upon a sand base was adopted as the type of construction to be used. This article describes the organization for the work, the method of selecting the roads to be improved, the widths and cross sections adopted and the contractors' organization, and the methods employed in construction. At the present time all of the roads to be improved are either completed or under contract and the whole work is about two-thirds finished.

COUNTY ORGANIZATION.

All matters pertaining to county roads are administered in the state of Florida by a board of County Commissioners composed of five members. This board employs necessary assistants and lets all contracts. Each member of the board receives a salary of $1,500 a year.

The organization for carrying out this work is shown in Fig. 1. This organization existed prior to the bond issue with the exception of the engineering force. For the special work a road engineer and assistants were employed. Ordinarily the County Engineer supervised road construction work.

The work was to be accomplished by a combination of contract, day labor and convict work. Contracts were to be let for the brick paving, the drainage structures and a portion of the grading, the contractor grading only between the curb lines. Earth grading beyond the curb lines and the paving of the shoulders with shell or other material were to be accomplished by the county road force except in those cases where brick paving was to be placed on a road already paved with shell, in which case the contractor was to place the shell excavated from the roadbed upon the shoulders.

METHOD OF SELECTING ROADS TO BE IMPROVED.

Hillsborough County, Florida, has a population of 100,000, of which 70,000 live in Tampa, the county seat, and the small towns of the county, and 30,000 live in the country upon farms. Lumber and turpentine, the growing of citrus fruit and the growing of vegetables for early northern markets, are the principal rural industries. A primary object in the construction of paved roads was to connect the outlying towns with the port of Tampa and to provide a means of rapid transport to a shipping point for small truck growers. The valuation of property in the county is approximately $21,000,000.

The roads to be improved were selected by the County Commissioners and a committee of the Tampa Board of Trade meeting in joint session in June, 1913, prior to the vote of the people upon the bond issue. As a result of this meeting the following resolution was adopted by the Board of County Commissioners and entered upon the minutes:

Be it resolved by the board of county commissioners of Hillsborough County that in the event that the voters of said county ratify at an election called for that purpose the issuance of $1,000,000 bonds for said county for building paved, macadamized, or hard surfaced roads in the said county, the county commissioners shall and will construct and build the following described roads:

Then followed a list stating the roads to be improved, the type of paving, the length to be improved and the width to be paved.

WIDTHS AND CROSS SECTIONS.

Three widths of pavement have been used, 9-ft., 15-ft. and 24-ft. One road was laid 16-ft. wide. The cross sections adopted for use with these widths are as shown in Fig. 2. The crown on the 9-ft. roads was reduced from 3 ins. to 2 ins. after construction began. Some of the 9-ft. road was constructed with a 3-in. crown. Wooden curbs were used only on the 9-ft. roads, all other widths having a granite curb.

As construction progressed it was found best not to excavate any great depth of shell when the construction was over an existing shell road, but merely to true up the shell foundation by hand picking disturbing the old roadbed as little as possible. Some difficulty was experienced in placing the shell shoulder in a satisfactory manner prior to laying the paving.

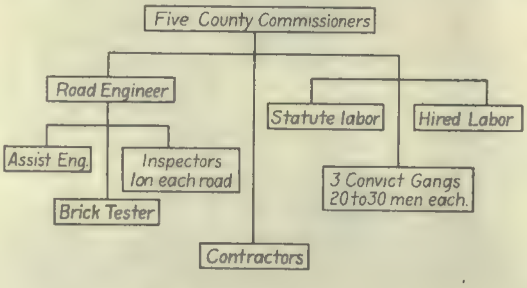

Five County Commissioners
Road Engineer
Statute labor
Hired Labor
Assist Eng.
Inspectors 1 on each road
Brick Tester
3 Convict Gangs 20 to 30 men each.
Contractors

Fig I

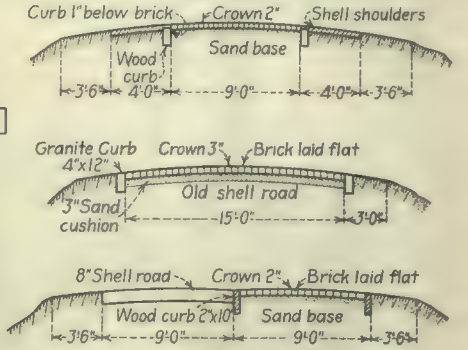


Fig.2

Fig. 1. Organization Chart of Road Work in Hillsborough County, Fla. Fig. 2. Brick Road Cross Sections.

Figure 3 shows the finished surface of the type of construction in which a 9-ft. brick road is placed on one side of the road and a shell road on the other side. A completed 24-ft. road is shown in Fig. 4.

MATERIALS.

Due to the fact that a large part of the paving was to be laid flat and with a sand filler unusual care was necessary in the testing and inspection of paving materials. An inspector was placed at one plant and all brick were subjected to a rattler test before unloading from the cars. The brick were further inspected after placing in the road.

Rattler test inspection reports were made in duplicate upon the form shown in Fig. 9. The following specifications were used for the brick:

Vitrified Brick.

In case the paving is to be of No. 1 block:

All blocks must be strictly No. 1 pavers, of the size commercially known as "Vitrified Block." They must be thoroughly annealed, tough and durable, regular in size, shape, and evenly burned. When broken, the blocks shall show a dense, stone-like body, free from lime, air pockets, cracks or marked laminations. Kiln marks must not exceed 3/16 of an inch, and one edge at least shall show but slight kiln marks. All blocks so distorted in burning as to lay unevenly in the pavement shall be rejected. The standard size of blocks shall not be less than 3 ins. wide by 4 ins. deep by 8 ins. long, nor greater than 3¾ ins. wide by 4 ins. deep by 9½ ins. in length. They shall not vary in depth to exceed ⅛ in. If the edges of the brick are rounded, the radius shall not exceed 3/16 of an inch. No block with a groove will be accepted for the pavement of roads where it is specified that the blocks shall be laid flat.

In case No. 2 blocks are used:

The blocks shall be what is commercially known as "No. 2 Vitrified Paving Blocks." No blocks will be accepted less than 8 ins. long by 3 ins. wide by 4 ins. deep, nor more than 9½ ins. long, 3¾ ins. wide by 4 ins. deep. They shall not vary in depth to exceed ⅛ of an inch; of sound, hard, burned, machine pressed vitrified paving block made for street paving purposes only. By a No. 2 block, it will be understood to mean hard durable blocks well suited for a roadway where durability is a desired feature. The blocks shall be machine pressed, slight imperfections such as kiln marks will be accepted, provided they are not warped and have the necessary toughness to insure wear in a roadway. Bricks that are not of such a quality or of a character that will cause them to disintegrate or go to pieces under traffic will not be accepted, and furthermore they shall not lose more than 28 per cent under the rattler test.

Rattler Test for No. 1 Blocks.

All blocks shall be tested for abrasion in the rattler of the following dimensions: The rattler shall be 28 ins. in diameter and 20 ins. in length measured inside the rattling chamber, a cross-section of which shall be a regular polygon of 14 sides. There shall be a space of ¼ of an inch between the staves to provide for the escape of dust and chips.

CHARGE: The standard charge shall consist of approximately 1,000 cu. ins. of brick to be tested, together with 225 pounds of cast iron 1½-in. cubes with slightly rounded edges and 10 cast iron blocks 2½ ins. square and 4½ ins. long, with slightly rounded edges, weighing approximately 7½ pounds each. When the small cubes shall be reduced by wear to a weight of 360 grams and the large blocks to 3,065 grams, they shall be discarded and replaced by new cubes.

REVOLUTIONS: The standard test shall consist of 1,800 revolutions of a standard rattler with a standard charge as above. The speed of the rattler shall not be more than 30 nor less than 28 revolutions per minute. The blocks shall not lose of their weight more than 25 per cent after being submitted to the rattler test described above.

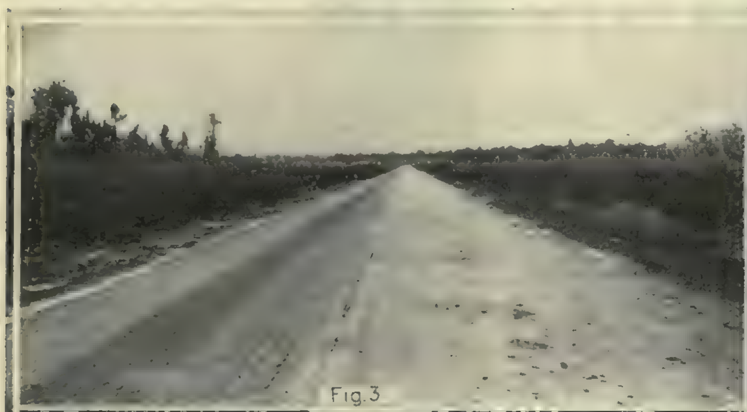


Fig. 3

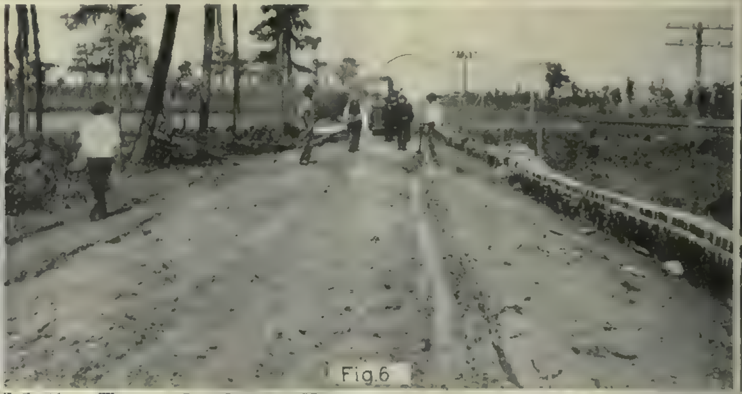


Fig. 6

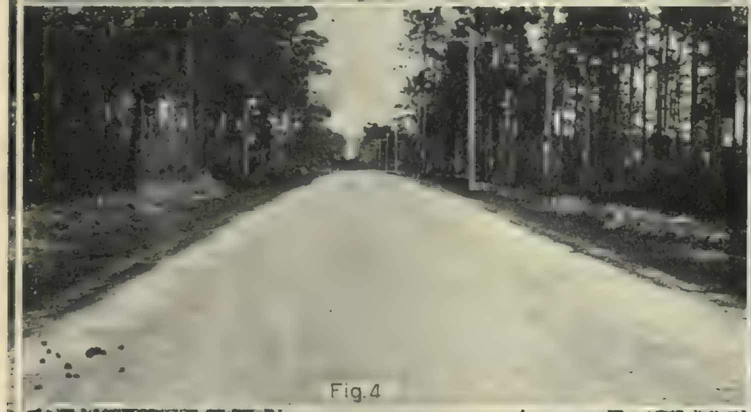


Fig. 4

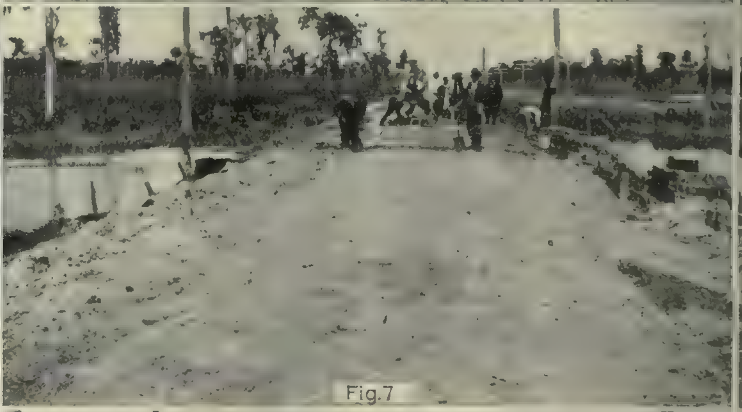


Fig. 7

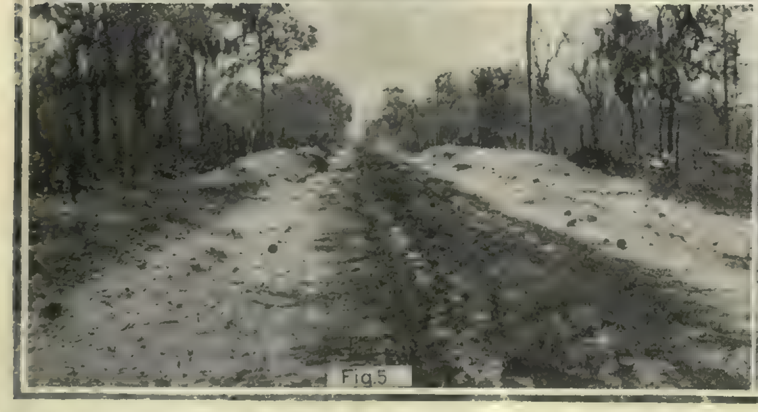


Fig. 5

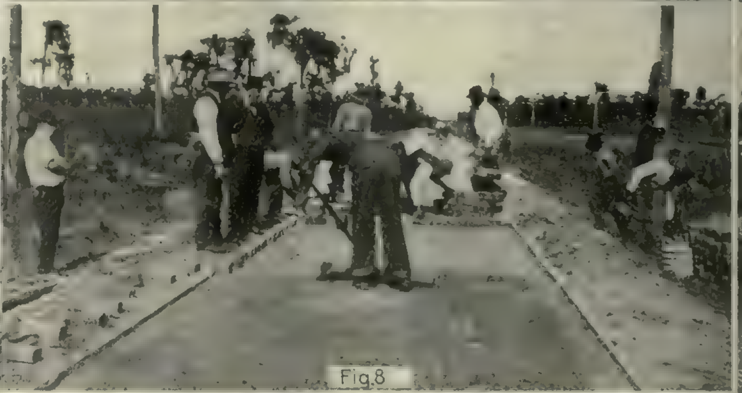


Fig. 8

Fig. 3. One Side of the Roadway Paved with Brick and the Other Side with Shell. Fig. 4. Finished Surface of 24-ft. Roadway. Note the Type of Ditches. Fig. 5. Temporary Road of Straw. Figs. 6, 7 and 8. Three Stages in the Construction of a 9-ft. Road.

Granite curb was specified 4 ins. thick, from 10 to 14 ins. in depth and not less than 4 ft. in length. The top of the curb and 4 ins. on one face was dressed, the dressed surfaces being at right angles. Wood curb was formed from 1½x10-in. pine or cypress 12 ft. long. The wood curb was held in place by pointed stakes of 2x4-in. lumber 18 ins. long, spaced 4 ft. apart and securely nailed to the curb.

CONTRACTORS' ORGANIZATION.

The novel feature of the contractors' organization on the Riverview road, 10 miles in length, was the inauguration and use of a task system of laying brick. A gang consisted of a sandbed smoother, a paver and two carriers. The task assigned the gang was 400 sq. yds. of pavement per 10-hour day. This system was used with a view of reducing the cost of supervision and has proved effective. The expense of a foreman has been eliminated and the contractor states that the men work with a vim to finish the day's work. Negro labor is used except for foremen and rollermen.

Practically all grading work was done with wheelbarrows and pick and shovel, the remainder with wagons, hence it was unnecessary to have many teams in the organization. Ordinarily the organization consisted of a foreman, roller man and from 15 to 30 men, and from 3 to 6 teams. Hauling material was generally accomplished by farm teams hauling at a given price per trip. Numerous teams were available for this work and this method of handling material proved satisfactory.

Ordinary labor is paid from $1.25 to $1.50 per 10-hour day; teams are paid from $4.50 to $5.

METHODS OF CONSTRUCTION

On some roads it was necessary to transport the brick by rail, barge and wagon to get them to the site of the work.

Where roads paralleled railroads switches were put in at intervals of 2 miles and materials were delivered to the nearest switch. Brick hauling was largely done by farm teams on a load basis. As a rule $1.50 a thousand brick was paid for hauling. The average team load was from 300 to 500 brick. Mules and slat-bottomed wagons were generally used.

At times difficulty was experienced in hauling over the road grades which was frequently deep sand. Temporary roads were constructed under these conditions by placing straw or pine needles in the wheel tracks. The cost of building such straw roads was approximately $40 a mile. The general appearance of a straw road is shown by Fig. 5.

Grading.—Grading was nearly all accomplished with wheelbarrows, picks and shovels. Upon a majority of the roads improved a shell road already existed. In the early stages of construction an attempt was made to make the finished grade of the new brick road conform to the old grade of the shell road. Grading then consisted of excavating approximately 6 ins. of the old shell road, just sufficient to allow for the thickness of a sand cushion and the paving brick. This procedure was abandoned finally for the following reasons: If any grade revision was attempted trouble was encountered due to the feathering out of the shell base. Difficulty was experienced in building shell shoulders of the excavated material before the brick were in place. And finally it was thought better construction to leave the old shell base in a cemented and undisturbed condition.

The type of sand grading encountered at some points is shown in Fig. 10. Scrapers and wagons were used in grading this road.

Curb Setting.—After the rough grading is completed curb stakes are set and the elevation of the curbs is transferred from the tops of the curb stakes by means of a straightedge and level.

The following method of setting curb is employed by one contractor: Stout iron bars 1 in. square and about 4 ft. long are lined and driven into the ground so that one edge will line with the outside edge of the wooden curb. These bars are driven at intervals of about 20 ft. Grades are transferred from the station stakes to the bar opposite and the elevation of the top of the curb indicated by a chalk mark on the bar. The bases between the stations are similarly marked, the grades being sighted by means of tees or crossheads. The trench for the curb is then excavated and the curb accurately set and tamped in place.

Name of Firm Furnishing Sample............
No. of Car in Which Bricks Shipped or Received ....
No. of Bricks Tested.........................
Date of Test...................................
Size of Bricks:
Length ......Breadth......Thickness......
Beginning of Test:
Hrs..........Min..........
Ending of Test:
Hrs..........Min..........
Length of Test:
Hrs..........Min. ....
Total No. of Revolutions......................
Initial Weight of Brick.......................
Final Weight of Brick.........................
Loss of Weight....... Per Cent Loss........
No. Broken Bricks.............................
I certify that the foregoing test was made under the specifications and is a true test.
Date...................191....
.......................Inspector.

Fig. 9. Blank Report of Ratler Test.

Wooden curbs are set with the top about 1 in. below the top of the brick in order to prevent undue wear of the curb. Granite curbs are set flush with the pavement.

The approximate cost of the labor in excavating the trench and setting wooden curbs as given by one contractor is 2 cts. a linear foot.

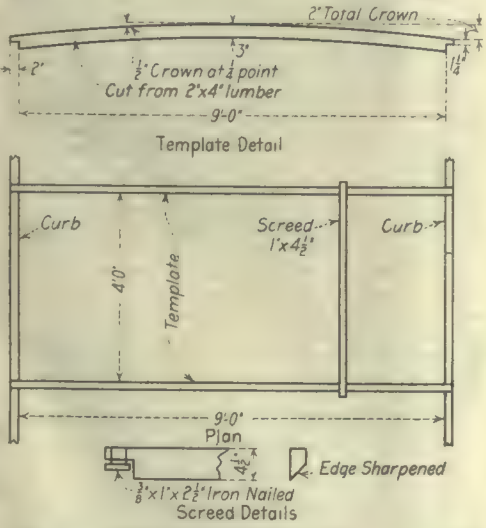


Fig. 11. Striking Template Used on a 9-ft. Road.

Subgrade or Sand Base.—Two types of base are employed: that constructed on an old shell road and that constructed of the natural earth where no shell road exists. Methods of construction differ for the two cases.

In preparing the base on an old shell road it was the practice in the construction of the first roads built under the bond issues to loosen the shell by hand picking and shovel the loosened material into wagons which hauled it to the desired points and dumped the shell upon the shoulders. When the haul on this material exceeds 2,000 ft. the contractor is allowed 50 cts. a cubic yard for hauling and filling in.

The sand used for cushion is generally the fine-grained, sandy soil that exists throughout the state of Florida. The sand is of a powdery nature and contains some loam. It packs well when wet and the thorough wetting of the base prior to sticking and laying bricks is thought by many engineers to be an essential element of satisfactory work in construction where it is used as a base.

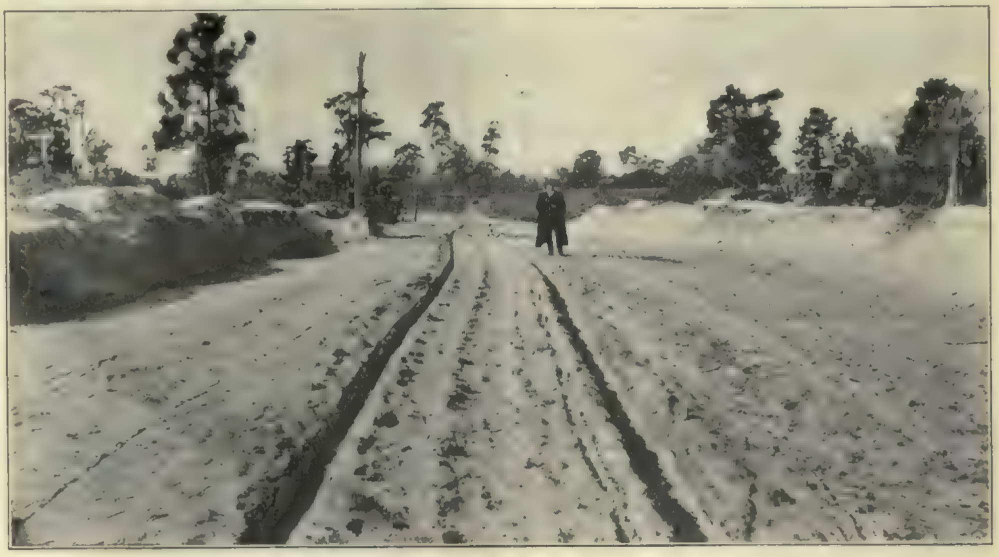


Fig. 10. Heavy Grading Through Sand.

The shell base was then rolled with a 5-ton tandem roller and a bed of natural sand placed upon the prepared subgrade to serve as a cushion for the brick.

In preparing a base of natural sandy soil the base is first wet and thoroughly rolled with a tandem roller. It is then thoroughly raked over with a garden rake to remove any foreign matter and smoothed with a strike board or sand lute.

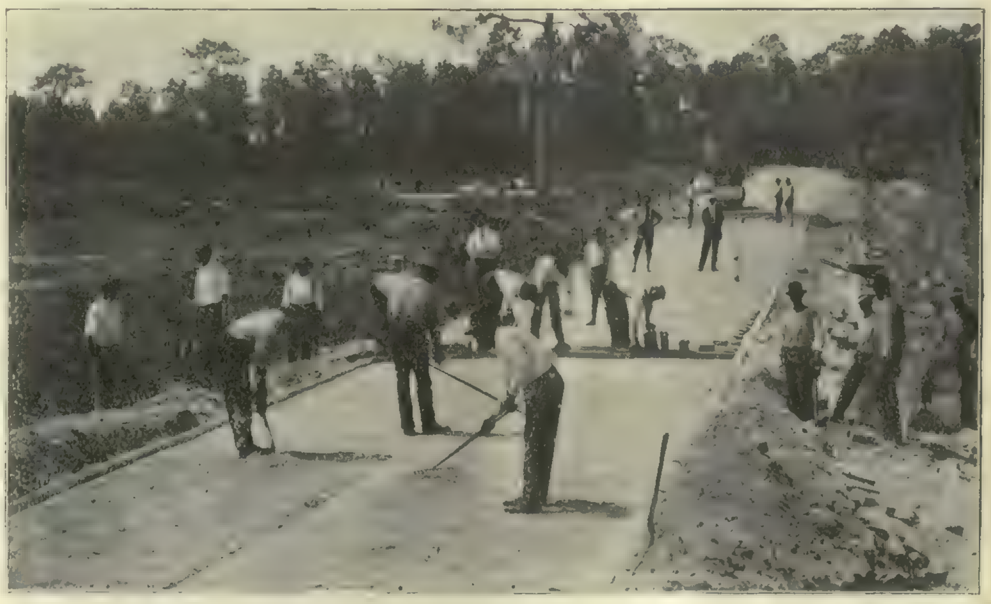


Fig. 12. Brick Road Under Construction on Nebraska Avenue.

The striking template shown in Fig. 11 has been used with success on a 9-ft. road. The templates are cut from 2-in. by 4-in. lumber, using care to have the top and bottom of the template parallel. The end of the screed is metal shod to reduce wear. The striking edge of the screed is sharpened and any wear on this edge does not reduce the efficiency of the template. With this tool an unskilled laborer can accomplish an excellent job of striking with but little instruction.

On a wide road a similar striking device may be used, a plank or two stakes at the center of the road being used to support one end of the template. In this case the template is cut for a half width of roadway.

Brick Laying.—For a 9-ft. road the brick are generally stacked three deep along the side of the road, allowing about 3,400 brick to 100 ft. of road. The brick are laid flat on most of the roads, about 36 bricks being used to the square yard. The following requirements are followed in laying. Brick are laid close together in straight lines at right angle to curb, joists being broken by a lap of at least 3 ins. Joints were avoided on flat curves by spacing the brick wider on the outside of the curve. On a sharp curve a bias joint is unavoidable, but it is formed at right angle to the center line. Before batting out each row is forced with a crowbar to close the joints. No bats less than 3 ins. long are used at intersections.

After laying, brick are culled and turned by the contractor and later by the county inspector. When the pavement has been passed for rolling by the inspector it is swept clean and rolled with a 5-ton roller. The rolled pavement surface must nowhere vary more than 3/16 in. from a template or straightedge.

The surface is thus covered with ½ in. of sand and thrown open to traffic.

Prices.—The following prices are a fair average of those paid contractors for work in Hillsborough County:

Item.	Unit price.
Granite curbing in place, lin. ft.	$ 0.30
Wood curbing in place, lin. ft.	.06
Excavation and extra sand base, cu. yd.	.25
Brick paving laid flat, complete, sq. yd.	1.53
Dry bridge excavation, cu. yd.	.25
Wet bridge excavation, cu. yd.	.50
Bridge concrete, reinforced:	
Abutments, cu. yd.	15.00
Superstructure, cu. yd.	22.50

PERSONNEL.

Jas. Riddle was the engineer in charge up to November, 1914. Since that time George Fuchs of Tampa has been in charge of the engineering and inspection work. The contractors employed on this work at the present time are the Edwards Construction Co. of Tampa and Kendrick, Davis, Webb and McNeil of Tampa.

Bedding Courses for Brick Pavement.

(Staff Abstract.)

The value of the plain sand cushion is being questioned by paving engineers. Many failures occur in brick pavements which can be traced to the non-uniformity of the sand cushion or to a cushion not properly compacted. Many engineers take the ground that the only function of the sand cushion is to provide a uniform bearing for the brick wearing surface—the smooth compacted sand taking care of any inequalities of brick or any variation of the foundation. We believe that the thickness of the bed of sand should be as small as possible, never over 1 in.

It is claimed that a grouted brick pavement should have a cushion so as to give it "resiliency" under traffic. We question if sand confined between a concrete foundation and a brick wearing surface has any real elasticity. We grant it may yield, shift or be compacted by traffic weight on the wearing surface of the pavement and that the cement grouted wearing surface will of itself spring back; but the sand will not follow, and we have a small air space between the sand and the grouted brick wearing surface. This can be easily demonstrated by a hammer survey of any cement grouted brick street laid on a sand cushion. The hollow spaces are readily located. These areas may be separated by solid areas where as yet the cushion has not left the pavement. The bond at these hollow spots may be intact and show no distress, but these areas become weak spots in an otherwise good pavement and eventually there may be a settling or a breaking of the cement bond.

It has also been claimed that a sand cushion prevents the crushing of the brick wearing surface under the weight of traffic. Mere weight does not crush a grouted brick pavement laid on a solid foundation, provided it has a firm bearing or bed for the brick. If paving brick manufacturers cannot make a paving brick that will bear the crushing force of street and highway traffic, they had better stop making brick.

Again, in actual construction, while we may give elaborate directions as to how the sand cushion is to be rolled and struck with a template, we find that to obtain good results in the field is almost impossible, and we have an unstable layer of sand varying in compactness and thickness between a solid foundation and a solid wearing surface. There is also the hazard of the sand working up between the joints of the brick and thus weakening the bond when the pavement is grouted.

Again, a rolled wet sand cushion, if it dries out after the bricks have been laid, will undoubtedly shrink and then leave hollow spots under the wearing surface.

In view of all the hazards of using sand for the bedding course, engineers are beginning to turn to the use of a mixture of cement and sand. Mr. Compton, Chairman and Consulting Engineer of the Baltimore Paving Commission, last year made laboratory tests of a cushion mixed 1 to 3, 1 to 5, 1 to 8, and 1 to 10, cement and sand, and adopted for all brick paving work this year in Baltimore a cement sand bed mixed 1 cement to 5 sand. The sand and cement are thoroughly mixed dry and then handled the same as an ordinary sand cushion. The bricks are then laid, rolled and inspected, and the pavement wet down for grouting. This adds moisture to the cement sand bed and eventually the cement sand bed becomes hard and practically joints the brick wearing surface to the foundation. The rolling of the brick wearing surface is kept up even with the paver. This is an advantage, for if with a cement sand bed the paving is rolled and not grouted and we have rain, no harm is done; in fact the rain will set up the cement sand bed. On the other hand, there is always a hazard when it rains on brick laid on sand cushion and not grouted, as the sand is apt to come up in the joints from the wash, necessitating the relaying of sections of the paving. In Baltimore, Lexington St., from Calvert St. to Liberty St., was paved with brick in 1906, on a 4-in. concrete base, using a ½-in. mortar cushion, mixed 1 to 3. Mr. Compton states that this street stood up splendidly and that no complaint has ever been made as to noise. During the last three years the street has been all "shot" to pieces by sewers, gas, water, steam heating lines, etc., so that at present it is in bad shape from "cuts," but there were absolutely no failures caused by the original construction.

Another example of the durability of a grouted brick pavement laid on a cement sand bed is furnished by the paved approaches to the Pennsylvania Railroad Terminal in New York City. These approaches were paved in 1910, the bricks being laid on a cement sand bed mixed 1 to 3. The pavement today shows no signs of deterioration except along the curbs where the wheels of heavy loaded wagons skidding down the inclines have cut into the bricks.

The theoretical type of construction is that developed by Mr. W. T. Blackburn, of Paris, Ill., Consulting Engineer of the Dunn Wire-Cut Lug Brick Co., who assisted by Mr. Parrish, a local contractor, is laying the brick wearing surface direct on the freshly laid concrete foundation. This form of construction is attracting considerable attention from paving engineers and considerable mileage has been specified for roads in Indiana and Illinois, and has been thoroughly explained in the various engineering journals (E. & C., Oct. 6, 1915.) Mr. Blackburn's specifications for road work in Edgar County, Illinois, using this form of construction are as follows:

> The foundation shall be four (4) inches in thickness with its upper surface finished to four (4) inches below the grade of finished pavement, and covered over with a thin coating of sand and cement, after they have been first mixed dry, to the depth of three-sixteenths (3/16) of one inch. In placing the concrete the operators shall be guided by a light wood template resting on side forms so made as to leave the concrete a little in excess of depth required. Over this shall be drawn a steel template consisting of a six (6) inch I-beam in front and six (6) inch channel iron to the rear, placed in a frame two (2) feet on centers, supported by two (2) rollers at either end resting on the steel forms; the first section, or I-beam, should be three-sixteenths (3/16) inches lower than the channel iron, and cut the concrete base practically to a true surface four (4) inches below grade. In between these forms must be kept a sufficient amount of sand and cement thoroughly mixed dry. This rear template distributes this thin film of dry mortar over the surface of the base, leaving the surface entirely smooth. The template is one of the essentials of this type of pavement.

Upon this foundation and bedding course the bricks are laid in the usual method and are rolled with a hand roller weighing not less than 20 lbs. per inch of length. The rolling should be kept close to the laying and continued until the surface is smooth. At the end of the working period the brick laying, inspection, and rolling shall be completed with the limit of the finished base.

The advantages claimed in using the cement sand bed or the new type of construction as developed by Mr. Blackburn are:

Elimination of the hazard of the sand cushion, as the pavement will not be injured at any time by rain, the wearing surface, with the exception of the filler, being completed each day. If a rainstorm intervenes no damage is done, as there is no sand cushion to become saturated and cause worry about rolling the brick surface.

Each brick in the wearing surface will be assured a cement bond its entire depth, for if the cement sand should work up in the joints, it will set up and prevent the shearing action which tends to crush the top of the brick.

There is no chance for the bed to shrink or shift away from the bottom of the brick wearing surface, as the brick is firmly bedded in the cement sand or held in the mortar of the concrete base.

Where these pavements have been laid there seems to be a total absence of any rumble under traffic.

Slight settlements and breaking of bond due to non-uniformity of sand csuhion are eliminated.

In reference to the use of cement sand bed mixed 1 to 5, the increase in cost over a 2-in. sand cushion will be from 5 to 6 cts. per square yard, but Mr. Compton states that in Baltimore there has been no appreciable increase in cost due to its use in that city.

In county road work this type of construction eliminates the necessity of an edging, thus reducing the cost of the roadway.

ACKNOWLEDGMENT.

Extract from a paper by Wm. C. Perkins, Chief Engineer, Dunn Wire-Cut-Lug Brick Co., Conneaut, O., read before the American Society of Municipal Improvements.

A System of Highway Accounting.

(Staff Abstract.)

Highway accounting is so different from the ordinary business accounting that the system available for the latter cannot be made adaptable for highway purposes. The difficulty lies in the fact that highway accounting has to do entirely with the disbursement of money. This disbursement, if properly analyzed, builds up a source of highway data which is invaluable.

The system that I shall outline is one which is in use in the State Department of Highways of New York, which pays out directly or indirectly more than $20,000,000 a year for highway purposes. This system has been built up and made adaptable to the needs of the department during the past six years since the department was organized, and has proved itself in both the pleasant and stormy weather, which the department has experienced, by furnishing financial data promptly and accurately under sometimes unusual and trying conditions.

There can be no formal rule for highway accounting, but system there must always be. A system of accounting, which may be adaptable to the department of one state, may be absolutely useless to the department of another state, for the reason that the conditions under which departments are organized and obliged to work are different in every state in the Union, occasioned by the differences in the law to which any system must be made amenable. I believe one of the most important questions for the consideration of states spending large amounts for highway purposes is that of a practical uniformity of legislative enactments governing such work and creating the departments under which it is being done. By combining the valuable experience of every state into a comprehensive statute, the benefit of a wider experience in organization would be obtained, and those states just beginning highway work would have the advantage of this. Such uniformity in organization would bring every department into closer relation, and the results would be most beneficial. The collection of national highway data would also be much simplified and made more efficient by such a statute.

A system of practical highway accounting is of much more importance than is generally conceded, for the reason that highway accounting is nothing more nor less than the building of the backbone of highway history.

Highway history must have for its foundation highway cost, and every department of highway construction or maintenance is intimately related to it, so that if the accounting is given in such detail and with such a broad view of what is desired to be accomplished, not simply for the present, but for the future, highway history is written each day and may be returned to in the future with the sure knowledge that it will give accurate information with reference to a particular highway long after other incidents of its construction or repair may have been forgotten. There is also the mistake to be avoided, and which is often made, of carrying too much detail in an accounting system, so that it loses flexibility and becomes cumbersome, delaying payments and thereby causing serious and unnecessary criticism to a department. I believe that it is the universal conclusion that where payments are to be made by a municipal or state government, it is expected that they will be long delayed, and yet with the proper system I know of no reason why a municipal or state government may not make its disbursements as promptly as the most efficient business organization.

The first essential in building up a system of highway accounting is a thorough and comprehensive knowledge of what is to be accomplished, together with a complete understanding of the laws governing the work and its adaptability to them. The assistance of expert accounting knowledge to build the framework of such a system may be used to advantage, but as the system is applied to the work in its operation, if it is to be practical and produce the best results, it must be made adaptable by actual application, and unless it is, it is not possible to estimate the disadvantage. The system must not only meet the requirements of the department, but also must be in unity and work smoothly with the accounting department of the State Comptroller, where the final audit is had. Every department will have a large number of live appropriations at one time, from which expenditures are being made, and unless the accounting system of the department is in close relation to that of the comptroller, confusion and error are bound to follow.

The individual highway account should begin with the initial survey and should show the identity of the highway by name or number, preferably both; the county and town wherein located; its length; the type of construction; the date of the contract, the amount, and the contractor's name; if a county road, the percentage to be paid by the state and by the county. As the account progresses it should show the cost of engineering and advertising; amounts paid to the contractor and from what source or appropriation; and when finished, the final distribution of cost between the state, county, town or city. On account of construction being carried on under contract in most cases, the construction accounting cannot give as much detail of the highway history as the maintenance and repair accounting. The original specification of the highway and the monthly estimates which are paid on it, however, will furnish the information in the detail necessary to complete the construction history.

In maintenance and repair accounting, greater detail can be had and should be required, for the reason that this work is not as uniform as construction and shows a wide variation both as to cost and as to type of work from year to year, so that this branch of accounting should give every possible detail of maintenance work on a highway in order to provide intelligent information in the future. This, of course, must necessarily be based upon the requirements of the department. Some of the subdivisions which should appear in the maintenance accounting of a highway, which are descriptive of the work done, are the following:

Whether the highway is a state or county highway; its name and number; the county and town within which it is located; a subdivision of disbursements under the headings; improvements; resurfacing; engineering and inspection; ordinary repairs to highway surface; labor or material; cleaning macadam; trimming shoulders; opening ditches; repairs to paving; oil—cost of spreading and applying—material for covering; repairs to guard rail; repairs to concrete; tools and plant; patrol, if a patrol system is employed; extraordinary repairs.

To these suggested subdivisions others could be added as found necessary, which will give the desired detail as to the important items of cost, with the result that from year to year a comprehensive analysis of maintenance and repair work is being constructed that not only applies to the whole system, but to the individual highway, which is most important.

All construction eventually resolves itself into maintenance and repair, and unless a state continues to make appropriations for construction, construction accounting gradually disappears, and with its disappearance, maintenance and repair accounting increases in proportion and remains, as it is not conceivable that a state will abandon its investment in good roads, and it therefore must continue to make appropriations for their mantenance and repair. In order that this maintenance and repair may be carried on economically and intelligently, the work of previous years must be thoroughly reviewed as to the type of work which was done and its cost as related to the individual road, so that the type of work may either be continued from year to year, or changed according to its efficiency. In no other way can this information be obtained except from a properly analyzed and accurately prepared accounting which will give the intelligent information necessary, and which, if it is available, will result in saving the state large amounts of money by avoiding those types of work which have proved themselves inefficient and expensive.

It is extremely easy to get information from the usual accounting as regards the whole situation of disbursements. It could easily be shown that the maintenance and repair of a certain highway for a certain year cost a certain amount of money, but unless the account has been built up from day to day in the manner suggested above, it will be very difficult at some time in the future to find out just what kind of work was done on the individual highway, what the analysis of its cost is, and whether from this analysis the service received from the type of work indicated warrants its continuation.

It is my experience that the most adaptable method of supporting this suggested accounting is that of voucher payments, so that the voucher representing each individual payment will show the complete distribution of that payment to the different items entering into the account. When the voucher is entered, the distribution is made, and it is completely absorbed, with the result that the account shows the analysis of the disbursements and is supported directly by the voucher in the file.

By using the voucher system a great deal of detail is avoided, and I would strongly advise that the keeping of personal and merchandise accounts should be omitted, as in highway accounting it is not imperative as to how much material has been purchased from a firm or individual, but it is important as to how much the material cost on a certain highway. If the total purchased is desired at any time, it can easily be arrived at from the vouchers in the files, which show all individual payments. By doing this a large amount of useless bookkeeping can be avoided and better results obtained.

In devising a system of accounting it is impossible to foresee the demands which will be made upon it in the future for information, and the tests to which it will be put. The only protection, which a department can have, is that the accounting system should be built up from the first with the view of giving the public as complete information as possible and in as great detail as is practical for the purpose. If this is done, when the test comes, it can be met promptly and accurately.

No system can be outlined completely at the beginning, for the reason that the details of the work constantly change, and the system in order to be practical and up to date must change with it and adapt itself to it. By all means avoid ruts. Because certain features of the system were adaptable last year, it does not necessarily follow that they will be this year. Anticipate what the work requires and meet these requirements promptly.

ACKNOWLEDGEMENT.

Reprint of paper by S. D. Gilbert Auditor New York State Department of Highways, read before the Pan-American Road Congress.

WATER WORKS

The Development of Rapid Sand Filters in Ohio.

(Staff Abstract.)

More has been done to develop the art of rapid sand water purification in Ohio than in any other state. A review of the development of this type of filter in Ohio is of value as it epitomizes the development of the art of water filtration for the turbid waters west of the Allegheny Mountains. In Ohio are to be found plants which represent practically all stages of advance in the design and construction of rapid sand fillers.

A patent for the use of a coagulent in connection with the filtration of water was granted to J. L. Hyatt in 1884. In view of the fact that a satisfactory treatment of water by rapid sand filters requires the application of a coagulant, the beginning of the development of the rapid sand filter plants for the treatment of municipal water supplies naturally followed the above date and the first of such plants was constructed in the United States at Sommerville, N. J., in 1885. Of course, during the early history of the art, there was no assurance to the public that a rapid sand filter plant would produce satisfactory results and would render municipal water supplies of satisfactory quality for domestic use, so that nearly all such early municipal filter plants were constructed under guarantees of efficiency of results to be accomplished.

The first rapid sand filter plant in the United States which provided for the purification of a municipal water supply and constructed under a guarantee of efficiency was contracted for by the city of Lorain, O., in May, 1896, with the O. H. Jewell Filter Co. The first rapid sand filter plant constructed in the state of Ohio was built at Warren in 1895, and was of the type covered by letters patent issued to J. E. Warren in 1889. The first municipal water softening plant constructed in the United States was built at Oberlin, O., in 1903, and rapid sand filters of the pressure type were used to filter the softened water. The largest municipal water softening plant in the world and the second largest rapid sand filter plant in the world, is constructed at Cleveland, O., and has a capacity of 144,000,000 gals. daily.

The third largest rapid sand filter plant in the world also is in Ohio, at Cincinnati, and has a capacity of 112,000,000 gals. daily. Moreover, the Cincinnati filters were the first municipal filters designed for the application of wash water at high rates without any other means of agitation for cleaning the sand. In building the Cincinnati filters, a brass wire screen was placed over the gravel to keep it in place during washing. The first municipal rapid sand filter plant designed for high rates of washing, and constructed with deep, coarse gravel layers over the strainer systems without superimposed screens for holding down the gravel during washing was constructed at Niles, O., in 1910.

The first filter plant at which alum has been manufactured for use as a coagulant is at Columbus, O. The first municipal rapid sand filter plant at which the disinfectant qualities of common lime have been intelligently and knowingly utilized is at Cleveland, O.

The first systematic investigation by a state board to determine the efficiencies of the filtration plants in a state was made by the Ohio State Board of Health in the years 1906-8.

Just as it is true, as indicated above, that the state of Ohio has done more to develop the art of rapid sand water purification than any other state, so is it true that the citizens of the state are now enjoying the use of larger rapid sand filter capacities than any other state. This is well indicated in Tables I and II wherein are shown the filter capacities and the populations served by rapid sand filters constructed in Ohio during the several periods indicated.

TABLE I.—PROGRESS IN CONSTRUCTION OF RAPID SAND FILTER PLANTS IN OHIO.

Period.	Population served by new plants at end of period.	Daily capacity of new plants. Gals.
1895	7,900	1,450,000
1896-1900	25,371	7,870,000
1901-1905	123,284	24,520,000
1906-1910	777,293	179,650,000
1911-1915	930,674	236,200,000
Total present daily filter capacity...		449,690,000
Total population served in 1915.....		1,940,000

TABLE II.—PERCENTAGE OF POPULATION OF STATE OF OHIO SERVED BY RAPID SAND FILTERS.

Year—	Total population of state.	Population served.	Per cent.
1900.....	4,157,545	43,900	1.1
1905.....	4,462,333	185,486	4.2
1910.....	4,767,121	945,819	20.7
1915.....	5,071,909	1,940,000	38.3

From Table I it is shown that the first rapid sand filter plant was constructed in 1895 and had a capacity of 1,500,000 gals. daily. It served a population of 7,900. At the present time the total filtering capacity of rapid sand filter plants in operation or under construction in Ohio is 450,000,000 gals. daily and the filters serve a population of nearly 2,000,000. It is of interest to note that the total nominal capacity of filters now in operation or under construction in the state is sufficient to provide nearly 90 gals. of filtered water daily for every resident in the state.

Possibly the most interesting feature in connection with the construction of rapid sand filter plants in Ohio is the development which has been accomplished in the design and construction of the plants. As would be expected in the interval of time that has elapsed from the construction of the first plants to the present time, there has been a marked improvement in the design and arrangement of the units especially in regard to the treatment of the water before it is passed through the sand filters, and in regard to the size, form and construction of the filter tanks.

As previously stated, the first plant constructed in Ohio is of the Warren type and consists of units containing sand filtering beds supported on perforated metal plates. Beneath the filter bed bottom of each unit is a chamber into which the filtered water pours on its way to the main filtered water outlet. During washing, water is turned under pressure into the clear water compartment beneath the sand and forced upward through the perforated plates and into the sand. Such a strainer system may be classed as an "open type strainer." The disadvantage of such a system is that it is difficult to get a uniform distribution of wash water throughout the entire area, especially in large units. The design is satisfactory for small units, but is not entirely satisfactory for larger units on account of its excessive expense and because of the difficulty of obtaining a uniform distribution of the wash water over the filter bottoms, as they were originally constructed. This was especially true in the old units wherein the sand was supported on brass wire screens, having comparatively large aggregate openings.

The filters constructed at Lorain were of the Jewell type. The essential features of these filters were that the strainer systems were composed of perforated pipes containing sand valves placed at uniform intervals covering the filter bottom. Filtered water was collected in the strainer pipes and carried to a main storage reservoir. No filtered water compartment for collecting the effluent was provided beneath the sand. It is significant that many modern plants still are constructed using strainer systems of this type.

The advantages of this system are that the wash water can be applied at higher rates under greater pressure without danger of damaging the filters. Moreover, the design permits the construction of a second compartment beneath the filter to store the water for sedimentation and coagulation on its way to the filter. The disadvantage of this strainer system, which is of the "closed type," is that it sometimes clogs by growths or other foreign matter and that there is then considerable difficulty in properly cleaning the strainer systems.

A modification of this closed type of strainer is to be found in the Hyatt cone valves, such as are used in the filters at Geneva and Newark, O. These valves comprise cast-iron cones about 6 ins. high and 6 ins. in diameter at the top, covered with brass, perforated hemispherical plates, and filled with shot or fine gravel. The principal advantage of these units is that they can be taken apart and cleaned without damaging the strainer system.

As shown above, the old Warren filters contained no provision whatever for treating the water before it was applied to the filters, so that the only opportunity permitted for coagulation and sedimentation was as the water stood above the sand in the filters or by providing outside settling tanks. The period of coagulation provided in the filters was about 15 minutes. Approximately the same period of time for coagulation was permitted in the compartment provided beneath the Jewell filters of the Lorain type.

Probably the greatest development in the art of water purification has been an appreciation of the fact that the burden to be placed upon filters should be made as small as possible in order to accomplish the most satisfactory results at the least expense. Within reasonable limits, it is true that the percentage removal of bacteria and impurities by the filters themselves is limited, so that, of course, the best results are accomplished by removing all possible impurities by preliminary treatment before filtration. This has been appreciated in the design of modern plants wherein the period provided for coagulation and sedimentation previous to filtration is frequently from 3 to 6 hours.

In the same way, there has been a marked development in the design of the filter tanks themselves. The phrase "mechanical filter" frequently applied to rapid sand filters, was derived from the fact that a stirring device, or mechanical agitator, was provided to stir the sand in the filters and thus to assist in the removal of impurities during washing. It is obvious that such a device required a circular filter tank. As early as 1899 it was recognized that air under pressure could be used to agitate the filter sand during washing and the application of this principle, of course, permitted the use of rectangular tanks in place of the circular tanks as previously required with mechanical agitators or rakes. This principle has proven of great value in reducing the construction cost of the larger mechanical or rapid sand filters, because it has permitted the use of reinforced concrete, rectangular units occupying very much less area than is required for circular tanks of the same capacity.

It is significant of the development of the art of water purification that the last wooden sand filters now operating in Ohio and provided with mechanical agitators very soon will be removed and replaced by rectangular concrete tanks. The old filter plant at Lorain already has been replaced some years ago by a modern concrete filter plant, and it is of interest to note that the results accomplished by the modern plant today are no more satisfactory than the results which were accomplished by the old plant, before its capacity was exceeded. Moreover, the cost of operation of the new plant is considerably in excess of that of the old plant.

In view of the disadvantages apparent in the closed type of strainer system comprising perforated pipes equipped with sand screens, or valves, engineers have endeavored to develop a strainer system of the closed type in which all parts would be accessible. The first strainer system to be developed along these lines in Ohio was used at Cincinnati and comprised lateral concrete channels covered with perforated brass plates. The design permits the removal of the plates and inspection and cleaning of all parts of the strainer system. Owing to construction imperfections, especially at the shoulders where the brass plates are supported, some engineers have reverted to the original form of closed or pipe strainer system. Possibly this action has been taken, in part, because of patents covering the use of depressed channels in filter bottoms.

A further important modification in the design of rapid sand filters was developed at Cincinnati and comprised the use of wash water without either air or mechanical agitation for cleaning the sand. Experiments conducted by Mr. J. W. Ellms indicated that when the wash water was applied at rates greater than 18 ins. vertical rise per minute, the entire sand body was thoroughly agitated and moved by the wash water, so that further agitation by mechanical means or by air under pressure was not required. It was thought at that time that the high velocity of the incoming wash water would require that the filter gravel, placed above the strainer system, be restrained in place by brass screens. Subsequent developments, however, have shown that the screens are unnecessary and during the past two years they have been removed and the gravel layers deepened.

This fact was appreciated in the design of the rapid sand filter plant constructed at Niles in 1910, under the direction of the speaker, where wash water is applied at a rate of about 24 ins. rise per minute without any disturbance of the filter gravel, which consists of coarse, deep layers not fastened down by screens.

In this connection, it may be noted that not the least important development in the design of rapid sand filters has been in connection with the use of larger and deeper gravel layers. In the old Warren and Jewell type filters, such as were built at Warren and Lorain, O., no gravel whatever was placed between the strainer systems and filter sand. This method of construction in fact was continued for a number of years, and until 1910 some filter plants were constructed without any filter gravel. The speaker has known instances where the construction of old filters has been modified by placing gravel above the strainers with the result that much more efficient washing of the filters has been accomplished by the use of very much less wash water. It is undoubtedly true that the gravel layers play an important part in distributing the wash water throughout the filter area as well as in keeping the sand from passing through the strainer system, so that the successful washing of filters, especially under high rates, may largely be attributed to the use of coarse, deep gravel layers.

A considerable part of the expense of operating a rapid sand filter plant is incurred by the cost of the necessary coagulant, and any development which tends to reduce the cost of the chemical is, of course, an important advance in the art of water purification. The coagulant most commonly used is filter alum, or aluminum sulphate, which generally is purchased in crystalline form at a cost of about

0.9 ct. per pound. To Mr. Hoover, chemist in charge of the Columbus, O., softening and rapid sand filter plant, belongs the credit for introducing the manufacture of the filter alum directly at the plant. The alum manufactured at the Columbus plant is not filtered or crystallized, but is applied in the crude liquid form. It is obtained at less than one-half the cost of the finished manufactured product and, on account of the fine clay contained in the liquid, has proven even more efficient than the clear crystallized chemical.

Another notable development in the art of water purification has been accomplished by the introduction of disinfectants or sterilizing agents. The three disinfecting agents which have been used on a large scale to sterilize municipal water supplies are hypochlorite of lime, liquid chlorine, and quick-lime or calcium oxide, and the use of these germicides has become so universal that it is the exception where a filter plant effluent is not treated in this manner. The most common treatment is with hypochlorite of lime, or with liquid chlorine gas.

The municipal softening plant at Columbus, O., has offered unusual opportunities to study the germicidal effect of quick lime, which is used primarily to soften the hard water of the Scioto River, but which is found also to destroy bacterial life in the treated water by eliminating the carbonic acid which appears to be necessary for sustaining such life. Dr. A. C. Houston, chemist of the Metropolitan Water Board of London, England, probably is the first observer to note such germicidal action of lime. He recommended the application of lime to river water in excess of the amount required to soften the water, thus causing a caustic alkalinity of the treated water, a feature which he considered to be necessary to obtain any sterilizing action by lime treatment.

In ENGINEERING & CONTRACTING of May 12, 1913, is an article by Mr. Hoover, chemist in charge of the water purification works at Columbus, Ohio, showing the results of his experiences and experiments on the germicidal action of lime. Mr. Hoover's conclusions, as stated in the article, are thought to be of general interest, and are as follows:

CONCLUSIONS BASED ON EXPERIMENTS.

1. When enough lime is added to water to absorb the free and half bound carbonic acid and to precipitate the magnesium content, the bacteria of the colon and typhoid group are killed in 48 hours after being so treated, provided the water does not contain large quantities of organic matter.
2. The germicidal action is effective in from 5 to 24 hours when an excess of ½ to 1 grain per gallon is added beyond that needed to reduce the temporary hardness to the lowest possible figure.
3. Intestinal organisms will not live in water containing no free or half bound carbonic acid.
4. Lime softened water inoculated with typhoid organisms or with crude sewage soon becomes free from them.
5. The action is selective in that certain harmless bacteria grow but the disease producing germs do not.

The sterilizing action persists indefinitely.

In a recent paper on water disinfection by chemical methods, Mr. Samuel Rideal states the advantages of using chemicals that persist in their disinfecting action in the following words:

> It is at the same time a disadvantage, if a disinfectant however powerful in its first onset, is very evanescent, as many disease germs are strongly resistant and we know that the time factor is of extreme importance in sterilization.

It is apparent that quick lime has a great advantage over hypochlorite of lime or liquid chlorine as a germicide because its action continues indefinitely so long as the lime-treated water contains no carbonic acid, whereas on the contrary the germicidal action of the hypochlorite continues but a short time after the application of the chemical.

The germicidal action of quick lime, together with the appreciation of the value of softened water, has been utilized in the design and construction of the new water purification plant or the rapid sand filter type recently constructed for the city of Cleveland, O. The use of lime to treat and soften Lake Erie water, which has an average total hardness of not more than 115 parts per million, is a radical departure from former current practice because such a water, especially in the Middle West where hard waters prevail, would be considered of satisfactory quality for domestic use without softening. It is reasoned, however, that owing to the considerable difference in cost per ton of quick lime and of alum, it is possible to use about four times as much lime as alum at the same expense. The lime, however, has a continued germicidal action, especially on intestinal bacteria contained in the water, and moreover, the lime will soften the supply, which will thus be made more desirable at but slightly more expense than would be entailed by the usual methods of filtration, using a coagulant such as filter alum.

It is, of course, difficult to state where further developments in the art of water purification may be accomplished, but it is very apparent that the present stage of development is such that it is possible to treat even a badly polluted river water by rapid sand filters and, in conjunction with a sterilizing process, to produce a water very satisfactory in all respects for domestic use.

ACKNOWLEDGMENT.

From paper before Central States Water Works Association by Mr. Philip Burgess, Consulting Hydraulic and Chemical Engineer, Columbus, Ohio.

Some Refinements in Water Meter Testing in New York City.

(Staff Abstract.)

One or two features of meter testing procedure which may be improved in fairness to consumer, utility, and meter manufacturer are considered in the present article. Meter testing with reference to curves of accuracy and friction is discussed.

The New York City water department is now making investigations looking toward more scientific and definite requirements in regard to meters, including the practicability of specifications on material and design; the establishment of a definite rate basis for testing meters to replace the present vague size-of-stream method, with such an adjustment of the rates as will properly and fairly define the accuracy curve of the individual meter for comparison with that representing reasonable requirements; and the inclusion in approval tests of the determination of the curve of pressure loss at varying rates of flow as having an important bearing on the general efficiency and service durability of the design.

The matter of specifications for meters is one which, if taken up at all, requires long and careful study in order to write specifications which will definitely "specify" without interfering with a desirable exercise of resourcefulness in design by the meter companies, backed by their experience in meeting and covering difficulties. A rate schedule should be made up with reference to the characteristic accuracy curve of the individual size and type of meter. Such a curve for disc meters rises abruptly from a low registration at the minimum operating flow to a maximum at low flow. From this point the per cent of registration for nearly all makes of meters decreases slightly as the rate increases to a point of maximum rate, which may be 1 or 2 per cent below the maximum registration.

The accuracy curve of a meter may be defined by a test that includes the two rates—one at the point of maximum registration and the other at full flow. There should then be included in the test a third rate—constituting a test of sensitiveness—at which a meter in proper condition should operate.

When a rate schedule is established it is proposed to control the rate on field tests by means of an apparatus including in general a set of calibrated orifices through which the water may be discharged under a difference of pressure shown by attached gages and regulated by a throttle valve; the size of orifice being selected by the operator with reference to the rate desired, the plotted or tabulated discharge of the orifices at varying pressure, and the available static pressure. With the rate thus adjusted, a test would be started and stopped with a cut-off valve in the ordinary way.

The question of pressure loss in a meter is one which is ordinarily considered as of secondary importance, accuracy being the accepted prime requisite of the apparatus. It would seem, however, in this age of efficiency and economy that, other things being equal, preference should be given to the measuring device which consumes, for operation, the least amount of the pressure energy which the pumping station supplies and the system is designed to conserve. On the ordinary service the meter usually consumes approximately from 25 per cent on small sizes to 90 per cent on large sizes of the total loss on the service. An apparatus so constructed that the water in passing through will displace a well-fitted piston or disc, with the motion of the latter transmitted to a registering dial, might of necessity constitute a measuring device that would meet the requirements of the ordinary accuracy test. A water meter, however, that combines a high degree of sensitiveness, durability and accuracy with a minimum of pressure consumed in operation requires careful and expensive investigation, design and manufacture. The ignoring of friction loss or its reciprocal feature—capacity—has resulted in the low capacity meter gotten out in inferior sizes by the meter companies to meet the competition under requirements which have included accuracy only.

In the case of 2-in. disc meters recently investigated by the New York department it was found that 75 per cent of the 2-in. meters being delivered to consumers were of the low capacity type, and inquiry in six cases at random showed that the purchasers had no knowledge of high and low capacity, simply specifying 2-in. meter and taking what his plumber delivered. In one of these cases the complaint of low pressure called for an investigation by the department, which revealed the fact that two 2-in. low capacity meters set in parallel were responsible for a drop of 6 lbs. in pressure at the time of maximum draft. This loss could have been reduced to only 2 lbs. under the same rate had full-capacity meters been installed, which would have obviated complaint and saved investigation; or, conversely, full capacity meters under the same loss of head in the meter would have delivered nearly twice the existing maximum draft.

In regard to the question of capacity, tests were made to determine curves of friction loss at varying rates of flow on high and low capacity 2-in. meters and 1½-in. meters of those makes which included two capacities of the one size. Comparing the data furnished by the meter companies as to capacity of disc meters it may be noted that under a 10-lb. loss of head the variations of discharge on the same sizes of different makes is as high as 97 per cent, and averages 64 per cent. On fire line meters and compound meters the curve of friction loss is also a guide as to the rates which should be used in testing. The curve usually shows a "change point" at a low rate—somewhat subject to pressure conditions. At this point a fluctuation in pressure loss and accuracy is to be expected, and this rate should be avoided in the test. The rates used should be those scheduled for each of the meters included in the design.

ACKNOWLEDGMENT.

From paper by F. B. Nelson, assistant engineer, Department of Water Supply, Gas and Electricity, New York City, before annual convention of New England Water Works Association.

Large shipments of Oregon pine are being sent to Japan for use in ship building. There has been a great increase in this industry as a result of the opening of the Panama Canal, and the withdrawal of so many European vessels from commercial service.

Pollution of California Water Supply Wells by Discharges from Sewage Wells.

(Staff abstract.)

In some localities in the state of California there exists a menace to underground water supplies due to the pollution of the deep water-bearing strata by the direct discharge thereinto of sewage liquor. Reference to this matter by Prof. Charles Gilman Hyde was made about a year ago in these words:

> In some sections of this state a scheme of private sewage disposal has been developed which augurs badly for the future of the ground waters in the regions where such methods are employed. In the vicinity of Stockton, and in the environs of Sacramento, for instance, it is understood that the sewage from private residences is being treated in small septic tanks constructed at a convenient depth below the surface of the ground and from which the effluent is being discharged into deep wells, perhaps 10 or 12 ins. in diameter, sunk to porous strata. These wells, it is understood, are sometimes as much as 60 ft. deep. They are carried to this depth because the overlying materials are tight and not sufficiently porous to permit of disposal by ordinary cesspools. It would seem to require no extended comment to make apparent the grave danger which lurks in this practice. In the first place it is to be recognized that the septic tanks provided cannot and will not remove disease germs nor other typical sewage organisms. These, therefore, must pass with the effluent down into the subterranean waters. In these, if the materials are sufficiently porous, they may be transported through considerable distances, possibly eventually to enter wells taking water from the same porous strata. Even if the time element were sufficient to insure the actual destruction of the pathogenic bacteria, it is certainly not a pleasing situation to realize that this water contains great quantities of dissolved organic matter whose origin is sewage.

THREE SPECIFIC INSTANCES OF POLLUTION OF THIS CHARACTER.

Since making the foregoing statement the writer's attention has been specifically directed to three typically dangerous cases of underground water pollution of the sort in question. One of these cases was in the vicinity of Sacramento, another was in the neighborhood of Stockton. The third was in the vicinity of Fresno. To this last case further reference will be made.

In March, 1915, a certain county health officer addressed a letter to the State Board of Health directing its attention to a demonstrated contamination of a certain public water supply. The situation described in the letter may be outlined as follows: The community is supplied with water by a certain company. The supply is derived from a well about 130 ft. deep, located ½ mile distant from the town to the south. The town is not provided with sewers, and open privy vaults are in use. In this vicinity the direction of flow of underground water is from east to west. In order to dispose of the sewage from certain shops, in which from 25 to 50 men are employed, three wells or sumps 130 ft. deep were sunk in the ground in a location about 600 ft. east of the position of the water well in question. Into these sumps or wells sewage has been discharged and has thus been disposed of. It will be noticed that the sewage wells and water well are of the same depth, and in this case unquestionably penetrate the same formation of water-bearing strata. Prior to the sinking of the sewage sumps or wells the supply well was free from contamination, but shortly after the practice was begun of disposing of the sewage by delivery into the same water-bearing strata as are penetrated by the water well B. coli (the typical intestinal bacterium of man and animals) began to appear in the water of the well.

PRECAUTIONS TO BE TAKEN IN SINKING WATER WELLS NEAR SEWAGE PLANTS.

This subject is one which is involved and requires most careful consideration. Obviously the greater distance between any possible source of pollution and the source of water supply the better. In all cases of doubt with existing plants bacteriological analyses should be made to determine whether or not dangerous bacteria may be present in the water supply, and, if so, to demonstrate the source of the pollution and the best means of permanent removal. Where sewage disposal works are projected in the vicinity of ground water supplies, or vice versa, the conditions should be very carefully examined and every precaution should be taken to conserve the hygienic quality of the underground waters.

ACKNOWLEDGMENT.

From a paper before the League of California Municipalities by Charles Gilman Hyde, Professor of Sanitary Engineering, University of California, Berkeley, Cal.

Lightning Attraction for Water and Gas Pipes.

(Staff Abstract.)

In enumerating the causes of leakage in water and gas mains it is not customary to mention lightning, yet it has long been known that water and gas mains at times attract lightning. Thus recent breaking of a service water pipe at southeast corner of 189th St. and Arthur Ave., in Bronx, City of New York, by a lightning discharge in line with an adjacent iron trolley pole again shows the great attraction of the opposite electricities of the clouds and earth during a thunderstorm for underground water, gas and other metal pipes and structures. There have been quite a number of similar cases. In the writer's first work on Lightning Protection issued in 1877, he cites a case of 6-in. cast iron water pipe broken by lightning in line with a lightning rod on a building and such adjacent pipe which was well separated from the lower end of such rod.

In the annual report of the Water Department of Fitchburg, Mass., of 1878, it is stated that on five different occasions lightning in line with water pipes in buildings of that city shattered on each occasion about 1,000 ft. of connecting cement lined water pipes in the streets of that city. The author also cited a number of cases of lightning in line with lightning rods breaking through brick walls in order to flow to the street gas mains via the interior gas pipes. In the case of All Saints' Church, Nottingham, England, cited in the writer's third work on Lightning Protection issued in 1883, the lightning broke through 4½ ft. of solid masonry between a lightning rod on the outside of the stone wall and an inside gas pipe. In all such cases there is invariably an impairment of the ordinary oakum or cement joints of the street gas mains, thereby partially contributing to the gas leakage of such mains, which in this country now averages about 15 per cent of total gas output.

Upon proper investigation it will be found that the water and gas leakage in connection with service pipes and street mains is greatest in the cities and towns where thunderstorms are prevalent and solid rock or other high resistance earth exists beneath such pipes, and which greatly retards the safe union of the opposite electricities during a lightning discharge.

Owing to the intense induced electrification of the underground water and gas pipes during thunderstorms, the electric light, power and railway companies must utilize such pipes for the proper lightning protection of their overhead and underground electrical circuits. Hence, the electric utilities should be compelled to provide a proper lightning protection system, by which such pipes can be so utilized, but without impairing the joints of such pipes. This matter should receive the proper consideration of the American Water Works Association and the American Gas Institute.

ACKNOWLEDGMENT.

From an article in the Water and Gas Review by H. W. Spang.

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Honors to Exposition Engineers.—The Panama-Pacific International Exposition Board of Directors has awarded honors to the nine engineers who were chiefly responsible for the planning of the exposition, presenting each with a bronze plaque, of Florentine design, suitably inscribed. The engineers honored were: H. D. Connick, director of works; A. H. Markwart, assistant director of works; G. L. Bayley, chief mechanical and electrical engineer; E. E. Carpenter, chief civil engineer; Shirley Baker, construction engineer; William Waters, superintendent of construction; W. M. Johnson, engineer of fire protection; L. E. Lourey, assistant chief mechanical and electrical engineer, and H. D. Dewell, chief structural engineer.

Engineering Publicity in Pittsburgh Newspaper.—During the past summer the Pittsburgh Gazette-Times published an article each Sunday for five consecutive weeks on subjects of interest to engineers. The five subjects were: Comprehensive City Planning, Development of Business Districts, Development of Residence Districts, An Ideal Park System and Development of the Water-Front. The articles were published at the suggestion and under the direction of the Art Commission of Pittsburgh. They were written in popular style.

50,500,000 ft. of Lumber for Italy.—One of the largest single orders for lumber ever placed in the United States was given out recently by the Italian Government. The order calls for 50,500,000 ft. of yellow pine, and includes 29,000,000 ft. of boards, 15,500,000 ft. of timber ranging in sizes from 2x4 to 12x12, and 6,500,000 ft. of cross ties.

The Lighter Side of Engineering and Contracting

A Second George Washington.

ON a piece of railroad construction in Oregon the engineering party secured the services as chainman of a very Virtuous Youth. He neither smoked, drank, chewed, gambled, swore, stayed out late o' nights; in fact, he had none of the vices that are possessed perhaps in a greater or less degree by the ordinary run of embryo engineers. The boys in the camp had been in the habit of playing a little friendly poker of an evening. Some one had been indiscreet enough to tell about it in town, and one or two of the town boys had been dropping in to join in the game. While a little card playing among the party boys might be all right, the possible evil consequences of making it a public affair were apparent. So one evening after the start of a game as our Virtuous Youth was putting on his hat and coat to go to town, the chief of the party said to him: "Earl, when you get downtown tell the fellows that there isn't any game going on tonight." "Why, Mr. Jones, Earl replied, "I could not tell a *lie*."—M. K. T., North Bend, Ore.

He Wished Something That Time.

TWO negroes, formerly body servants of George Washington, at least they claim to have been, are employed at a hotel at Hot Springs, much frequented by contractors taking the rest cure. The other day a contractor heard these octogenarian darkies quarreling. "Nigger," said the older one, "does you know what I wisht? I wisht? I wisht? I wisht dat hotel yander had a thousan' rooms in it and you wuz laid out daid in ev'ry room."—J. B. L., St. Louis, Mo.

His Only Use for It.

THE gang was short handed and the foreman kept his eye peeled for recruits. Presently he saw a husky looking tramp coming down the road. He stopped him. "Want a job?" he asked. The wayfarer paused. "What kind of a job?" he inquired, cautiously. "Well, what can you do with a shovel?" The tramp beamed, "I could fry a slice of bacon on it," he said hungrily.

Informed.

A WORKINGMAN was tamping the backfilling in a trench. A "curb stone" inspector inquired: "Are you going to get all the dirt back in the trench?" "Nope," was the reply, "we didn't dig the trench deep enough." "Oh! I see," said the c. s. i., and went his way.

LITTLE grains o' sugar, little drops of rye,
Keep the thirsty skinners stepping mighty spry.

The Mule.

The mule he is a funny sight,
He's made of ears and dynamite,
His heels is full of bricks and springs,
Tornadies, battering rams and things.
He's fat as any poisoned pup;
It's jest his meanness swells him up;
He's always scheming 'round to do
The things you most don't want him to.
The mule he lives on anything.
He's got a lovely voice to sing,
And when he lets it loose at noon,
It sounds like a buzz saw out of tune.
He stands around with sleepy eye
And looks as if he'd like to die,
But when there is any dying done,
It ain't the mule, I'll bet a bun.
Some folks don't treat mules with respect,
They say they ain't got intellect;
That may be so, but if you've got
To go to heaven on the spot,
And want a way that doesn't fail,
Just pull the tassel on his tail.
The mule, he tends to his own biz—
He don't look loaded, but he is.

Infants and Adults.

UNCLE JACKSON, a deacon of a little negro church down in Partloe, Virginia, has all the negro love for long words. Recently there was an entertainment given at the church and Uncle Jackson had charge of the seating arrangements. "How am yo' gwine to sot de congregation, Brudder Jackson?" asked the speaker of the day. Pointing out the spaces he had reserved, Uncle Jackson replied: "Right dere on dat side I'se gwine to have de *infant*ry and right heah by the pulpit will sit de *adult*'ry."—W. A. H., New York.

ONE little contractor laughing to beat the band:
Figured on rock work and only struck sand.

Admonished.

A STOUT party stood about 4 ins. from one of the rails on a passenger track of the Chicago & Western Indiana R. R. at the Kensington station. He was busy watching a freight train going towards the city on the fourth track over and failed to see a big passenger train coming towards him at the rate of 88 ft. per second. The towerman took in the situation and rung his bell with fervor. Still the stout party continued to gaze at the freight, evidently trying to identify the cars by the initials they bore. Finally the towerman opened a window and, seizing a megaphone, yelled: "Hey! Wake up down there! You ain't in no park." In two hops to the rear the rotund individual was 30 ft. off the right-of-way.

Between the Bull and the Bear.

IN the early '70's Western railroad contractors had little difficulty in obtaining fresh meat for their commissaries. All they had to do was to send out men to knock over a few buffalo. Daniel O'Connell and David Tyter, fresh from the Emerald Isle, were members of one of these construction gangs. One day Daniel and David decided they would go hunting, so borrowing a couple of guns they set out. Presently they discovered a bull buffalo. The animal also discovered the hunters, and being in a somewhat angry mood, charged. The Irishmen threw down their guns and ran. O'Connell managed to reach a tree and scrambled up it. Tyter dodged into a cave as the buffalo dashed by. No sooner had it passed than out popped David. The bull rushed back and David disappeared into the hole, only to scramble out again as soon as the animal had passed. Back came the bull and in went David, to emerge again a second later. Whereupon Daniel from his safe perch in the tree yelled: "You damn fool, you, while you're in there, why don't you stay there." To which David replied: "Phat the divil do you know about this cave? There's a big he bear in here."—H. A. C., Denver, Colo.

The First Buzzard.

JOCK MORGAN, an ancient riverman, well-known to levee contractors on the Lower Mississippi, owns a horse which, if not the best in the county, is certainly the oldest. The other day Jock drove into town. The village cutup, thinking to have some fun with the old man, shouted: "Hello, Uncle, how long has that horse been dead?" Without an instant hesitation Jock shot back at him. "One week; but you're the first buzzard that noticed it."—E. J. M., Memphis, Tenn.

A SECTION foreman was making out a requisition for track supplies. When he had completed his letter he found that he needed a switch frog, so his letter ran as follows:

"Mr. Roadmaster.

"Dear Sir: Please ship me some pick-handles, spike mauls, spikes and wrenches.

"Yours truly,

"Pat Hogan and a Frog."

Skinner Mulvey says: I know why George Washington could throw a silver dollar across the Potomac River. Money went further in those days. If you haven't anything worse to do today write a story for this page.

CURRENT NEWS

The Doings of the Week.

The past week has brought out continued favorable developments in industry and finance. Many prominent industries are now working under normal conditions. High volumes of payments through banks reflected greater use of money. Bank clearings were far in excess of those for corresponding weeks of 1914 and 1913. In the Chicago district they were over 20 per cent higher. One of the outstanding features of the week was the large purchase by the railroads. Rail orders for the week amounted to considerably over 200,000 tons. Car and locomotive buying also was greater than has been the case for months. There was a broadening demand for investment bonds. It is expected that many railroads now will take steps for new financing on a large scale. In the construction field the lateness of the season is having its effect on operations. New work coming up for bids is not as plentiful as might be wished. A considerable number of large undertakings, however, are yet to be advertised this fall, and these with smaller jobs will furnish many bidding opportunities during the next few weeks. In the iron and steel market prominent features of the week were advances in price of many products and the apparent beginning of a new pig iron buying movement. There was a heavy foreign demand for steel products and this was supplemented by the buying by railroads and other domestic concerns. Rail orders placed in the last few days include 10,000 tons for the Santa Fe System; 55,000 tons for the Illinois Central; 20,000 tons for the Great Northern; 17,000 tons for the Pere Marquette; 7,500 tons for the Wabash, and 5,000 tons for the Monon. In addition, it is expected the Pennsylvania R. R. will come into the market with inquiries for its 1916 supply amounting to possibly 250,000 tons. Of the foreign countries, Russia alone has now placed orders with the Lackawanna Steel Co. for close to 200,000 tons of steel rails. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Oct. 20 were as follows:

Finished Iron and Steel.	Oct. 20.	Oct. 13.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill...	1.25	1.25
Iron bars, Philadelphia	1.559	1.559
Iron bars, Pittsburgh.........	1.40	1.40
Iron bars, Chicago	1.35	1.35
Steel bars, Pittsburgh........	1.45	1.40
Steel bars, New York	1.619	1.569
Tank plates, Pittsburgh	1.45	1.40
Tank plates, New York.......	1.619	1.569
Beams, etc., Pittsburgh......	1.45	1.40
Beams, etc., New York......	1.619	1.569
Skelp, grooved steel, P'gh....	1.40	1.40
Skelp, sheared steel, P'gh....	1.45	1.45
Steel hoops, Pittsburgh.......	1.50	1.50
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	2.00	2.00
Galv. sheets, No. 28, P'gh...	8.50	3.50
Wire nails, Pittsburgh.......	1.85	1.75
Cut nails, Pittsburgh........	1.70	1.70
Fence wire, base, P'gh.....	1.70	1.60
Barb wire, galv., P'gh........	2.70	2.60

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.45 cts.

Railways.—There is little question that most railways are now having more prosperous times than has been their share for many months. Reports from the east indicate a revival of freight traffic unequaled since 1907. Tonnage figures of the Erie, for instance, show that the business done in September was the greatest ever recorded on the books of the company. On the Baltimore & Ohio tonnage of shipments to New York and for export is said to have increased 40 per cent within the last three months. Corresponding gains are shown by nearly all the eastern roads. In the west crop movements are keeping the railroads busy and many of them will end the year with a good sized surplus of earnings. Material and equipment buying by the railroads last week was greater than it has been before for some months. All of which brings nearer the time when the carriers will take up once more their long deferred construction operations.

Roads and Streets.—New street paving and highway construction contracts, as is to be expected, are not particularly abundant at present. New York is calling for bids for constructing about 40 miles of state highway; Special Road and Bridge District No. 8 of Loanoke, Fla., is asking for proposals on 68 miles of highway; Arcadia, Cal., opens bids Nov. 8 for 16 miles of oiled macadam streets; County Commissioners at Greensburg, Pa., are asking for proposals on about 61,000 sq. yds. of brick paved roads; New Brunswick, N. J., is advertising a 22,000 sq. yds. paving job; Princeton, Ind., opens bids Nov. 8 for 2 miles of 6 ft. concrete walk; County Commissioners at Beaumont, Tex., are asking for proposals on road work to cost about $50,000. Bids were opened by California for several sections of state highway; Idaho awarded contract for 65 miles of state highway; Cincinnati, O., let a $80,000 resurfacing job; County Freeholders at Jersey City, N. J., let two road contracts amounting to $73,000, and County Freeholders at New Brunswick, N. J., let a $45,000 contract; Independence, Kan., awarded a $33,000 paving contract; Massachusetts awarded a $48,000 state road job.

Bridges.—No particularly large bridges appear to have reached the call for bids stage during the past week. The Missouri Valley Bridge Co., Leavenworth, Kan., was awarded contract at $199,910 for the Kaw River reinforced concrete bridge at Lawrence, Kan.; Walter F. Rae, Pittsburgh, Pa., at $54,911 was low bidder for steel bridge at Lyons Falls, N. Y. Bids are being asked by Robert W. Hunt & Co., Pittsburgh, Pa., for a number of bridges for a Chinese railway.

Drainage and Irrigation.—Bids were opened last week on one of the largest undertakings in the drainage field that has come up for letting this year. This work covered contract Sections 13 and 14 of the Calumet-Sag Channel for the Sanitary District of Chicago. James O. Heyworth, Chicago, at $720,170, was low bidder on Section 13; A. Guthrie & Co., St. Paul, Minn., at $828,822, was low bidder on Section 14. The U. S. Reclamation Service is calling for bids on two or three small contracts, and a number of small drainage undertakings, ranging from the yardage for 100,000 to 250,000 cu. yds., are ready for proposals.

Water Works.—Contracts were awarded for several water works for small municipalities. Very little new work, however, came up for advertising. Attica, Russell and Spearville, all Kansas towns, awarded contracts for water works systems. Miller, Ind., and Van Buren, Ind., also let water works contracts, as did Orchard City, Colo. Surveys and studies have been started for the new $11,000,000 water supply development of Providence, R. I.

Sewerage.—Bids are being asked by the President of Manhattan Borough, New York City, for the construction of a large tunnel relief sewer, the security required being $100,000; two good sized contracts for sewerage and sewage disposal plants for New York state institutions are ready for bids. One of these is to be installed at Yorktown, N. Y., the other at Yorktown Heights. Greenwich, N. Y., is asking bids on a small sewer job, and Woonsocket, R. I., opens proposals Nov. 2 on a surface water drain; San Benito, Tex., opens bids Nov. 24 for a sewage disposal plant. Hert-

Stationmen and 8-Hour Day.

The Superior Court of Washington will be called upon shortly to decide whether or not stationmen on public work can labor more than 8 hours a day. A construction company engaged in building a state highway let out some of the clearing and grading in small sections to laborers. The company rented tools and equipment to these men and boarded them for a certain sum. The contract signed by the laborers made it binding on them to have their work completed within a certain length of time. Charges now have been brought against the construction company on the grounds that these stationmen worked more than 8 hours per day, and thus were violating the state law. The case is of some little interest to contractors, for station work is a very economical method for handling light grading and clearing, and is much employed in the West. The pay of a stationman depends on the amount of work he does, and consequently he does not mind long hours. If the court rules that he comes under the 8-hour statute his usefulness is seriously handicapped.

The Lowest Responsible Bidder.

A commonsense ruling regarding the lowest bidder and the lowest responsible bidder has been handed down by the Attorney General of Ohio. The advice was given to the State Highway Department and the gist of it was as follows:

> Where the State Highway Commissioner is required to let a contract to the lowest responsible bidder it is his power and duty to look not only to the size of the bids, but also to the pecuniary ability of the bidders and to their skill, experience, integrity and judgment. If in the exercise of a sound discretion he determines that the lowest bidder is not responsible, it is his right and duty to reject the lowest bid and award the contract to the lowest responsible bidder, and in the absence of fraud or bad faith his decision upon a matter of this kind is final and not subject to review by the courts. A similar but somewhat broader construction is to be given to a statute requiring the letting of a contract to the lowest and best bidder.

City officials who can see only the dollars and cents part of a bid might well make a note of this advice. If they followed it they would save themselves and bonding companies lots of trouble.

Political Capital.

Candidates for elective offices often use strange reasoning in order to secure political capital. For instance, a man running for mayor in a large middle west city charges that the party in power cost the city over $200,000 on a construction job because of lack of business methods in awarding the contract. It seems that when bids were taken on the work the lowest bidder was some $154.000 below his nearest competitor. The low man, however. had made a mistake in his estimate and withdrew his bid. The contract was then awarded to the next lowest bidder. Thus according to the candidate the city paid $154,000 more than was necessary. It was desirable that the work should be completed as soon as possible, so to expedite it a bonus was offered. The contractor completed the job so far ahead of his contract time that he received $65,000 in this way. Therefore, assumes the would-be mayor, the undertaking has cost the city $219,000 more than it should.

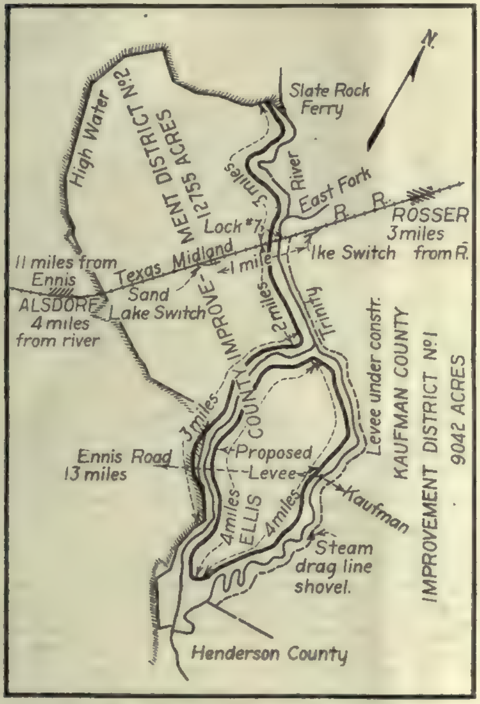
LEVEE CONSTRUCTION ON TRINITY RIVER, TEXAS.

A $92,000 Contract for Work in Ellis County.

Other Districts Planning Similar Work.

Contracts probably will be let about Nov. 25 for the construction of about 18 miles of levee in Ellis County, Texas. This is one of several levee undertakings proposed for the reclamation of overflow lands along the Trinity River in Dallas, Ellis, Henderson and Kaufman Counties.

The work to be awarded about the last of next month will be done for Ellis County Levee Improvement District No. 2. The levee will be approximately 10 ft. high net (20 per cent shrinkage added) and will have 6-ft. crown and 2 to 1 slopes. It will average about 950 cu. yds. per station. The soil is black silt and is reasonably easy to handle. The Texas Midland R. R. extends across the district and has an unloading switch in the district at a point about 1 mile from the river. The town of Allsdorf is about 4 miles from it, while the town of Rosser is about 3 miles distant. Ennis, a larger city, is 11 miles distant from the proposed levee.



Location of Levee Work.

At the present time Kaufman County Improvement District No. 1 is completing a levee on the east side of the Trinity River, opposite the Ellis County Improvement District No. 2. The latter district will build its levee on the east side of the river paralleling a portion of the first mentioned work. The Ellis County improvement also will cover about 4 miles of the east side of the Trinity River cut-off and likewise will extend for 3 miles on the west side of the cut-off.

Three other districts in the immediate vicinity of the present work shortly will undertake reclamation work. Henderson County Improvement District will be a continuation of the Kaufman County District No. 1 and probably will begin its work immediately after the completion of the improvement in Kaufman County. Ellis County Improvement District No. 3 and Dallas County Improvement District are now being organized for the purpose of reclaiming 18,000 acres of land along the Trinity River.

Drag line shovels have been used in the two districts now under construction and have given excellent service. One of these is a gas machine and the other is operated by steam. The latter weighs about 80 tons and puts up 1,500 to 2,000 cu. yds. per day.

Part of the right of way for the levee for Ellis County Improvement District No. 2 is through cultivated land. The estimated cost of earthwork alone is $86,000; of clearing, $6,000, and grubbing, $6,000. O. W. Finley, Ennis, Tex., is district engineer.

$30,000,000 for Railway Terminals at Cleveland, O.

The citizens of Cleveland, O., will vote on Nov. 2 on granting franchises for two railway terminal projects that will call for an expenditure of about $30,000,000. The companies asking these rights are the Cleveland, Akron & Canton Terminal Ry. and the Cleveland & Youngstown R. R. Each company proposes to expend about $15,000,000.

The Cleveland, Akron & Canton Terminal Ry. desires the right to extend a railroad subway under East Fifty-fifth street from Morgan Run to the lake front, where it intends to establish piers and warehouses and to open a 3,800-ft. stretch of water front to railroads that now have no means of reaching the lake. The Cleveland & Youngstown R. R. proposes the establishment of a high-level freight yard in the lower Broadway section from East Ninth street to East Thirty-fourth street, in connection with a rapid transit line. The yard would be 4,000 ft. long and 800 ft. wide.

The East Fifty-fifth street subway is planned to be the central feature of a development following the lines of the Bush terminal at New York City. The top of the tube will be 22 ft. below street level, thus permitting the construction of a passenger subway in East Fifty-fifth street if desired. Warehouses to be located along the route of the subway would have direct connection with the terminal by means of elevators. It is claimed that this new terminal would give direct freight service to Akron, Canton and the undeveloped upper Cuyahoga Valley.

The Cleveland & Youngstown R. R. project requires the vacating of several streets and the crossing of others. It is claimed the development will be one of the largest railroad freight terminal and warehouse systems in the United States.

Municipal Street Railways at Detroit.

Municipal ownership and operation of street railway systems on the most extended scale yet undertaken in this country will be carried out by Detroit, Mich., if a referendum on Nov. 2 receives the necessary number of votes. If the plan carries the city will take over and manage the city lines of the Detroit United Rys., together with a small mileage outside the city limits. All of the trackage is within the one-fare zone.

For a number of years there has been much dissatisfaction with transit conditions in Detroit. As a consequence the traction company has been unable to secure new franchise grants. The principal ones have expired, and the company has been operating under a day to day agreement. An appraisal of the property was made for the city and the value fixed at about $17,000,000. Unexpired franchise values and additions to property will increase this amount somewhat. The city in order to secure immediate control and a clear title without litigation offered the company $23,285,000 for the property desired. This offer was refused. The agreement for purchase on which the citizens vote provides that the purchase price of the property be determined by the Circuit Court of Wayne County. If the plan is approved by the voters the company is to turn over to the city street railway commission within 60 days after Nov. 2 all of its property within the one-fare zone, and the commission will at once begin to operate it.

The commission will consist of three men, who will serve without pay. These men are James Couzens, formerly vice president of the Ford Motor Car Co.; John F. Dodge of the Dodge Motor Co. and James Wilkie of the Parke-Davis Chemical Co. It is believed the plan will receive a majority of the votes cast, but there is some doubt as to its obtaining the necessary 60 per cent affirmative vote.

DREDGING CONTRACT IN FLORIDA WATERS.

Requires Removal of About 183,000 Cu. Yds. of Rock.

Bids to Be Opened Nov. 8 by U. S. Engineer.

A dredging contract calling for the excavation of approximately 183,000 cu. yds. of rock is being advertised for bids by the U. S. Engineer, Jacksonville, Fla. The work is located in Miami Harbor and St. Lucie Inlet. The dredging at the first mentioned locality will be confined to the channel at the northerly entrance to Biscayne Bay, opposite the city of Miami.

The latest survey indicates that the channel across the bay from Miami to this entrance has a least depth of 9 ft. at mean low water for a least width of 100 ft. Two jetties have been constructed extending seaward from the ocean beach. These jetties are 1,000 ft. apart and the entrance channel is midway between them. The north jetty is 1,635 ft. long and the south jetty is 1,700 ft. long. The water ends are practically abreast. Under previous contracts a channel has been excavated from the bay through the original land between the bay and the ocean seaward between the jetties 110 ft. wide and from 18 to 19 ft. deep at mean low water. The mean range of tide is 2.18 ft.

This channel subsequently partially filled with sand and the latest soundings indicate that the available depth near the outer end of the excavated channel is only 5 ft. at mean low water. By turning to the northward about half way out between the jetties an available channel having a least depth of 9 ft. at low water may be followed out to sea. The working season extends throughout the year, but interruptions from storms may be expected. The most favorable season for work is from April to September.

The work to be done will be to widen the previously excavated channel along the northerly side for its full length of 3,000 ft. to such additional approximately uniform width as the funds available at the prices bid will permit, by excavating the rock and overlying sand to a depth of 20 ft. at mean low water. About $90,000 is available for this work, and it is believed this sum will be sufficient for widening the channel 107.5 ft. for its length of 3,000 ft. It is estimated that this will require the removal of 60,000 cu. yds. of sand and 110,000 cu. yds. of rock. The material heretofore excavated at this locality has consisted of a soft coral limestone overlaid in places with the usual beach sand, consisting of small rounded particles of silica, broken shell, and coral detritus.

The work at St. Lucie Inlet is located on the east coast of Florida, 100 miles north of Miami. Stuart, Fla., is the most convenient railroad station to the work. There is at the present time no well-defined fixed channel through the inlet, but depths of 6 ft. can generally be found, although there are limiting depths of 5 ft. No difficult currents are to be expected. The inlet is exposed to northeasterly, easterly and southeasterly storms, and considerable interruption of work on account of bad weather is to be expected. The working season extends throughout the year. The most favorable period for work is usually from April to September. The work to be done is to dredge a channel 18 ft. deep at mean low water of such approximately uniform width as available funds at the price bid will permit, and approximately 5,500 ft. in length from the 18-ft. contour in the Atlantic Ocean through the St. Lucie Inlet, to a point just within the entrance. The sum of $90,000 is available and it is believed this will be sufficient to dredge a channel 18 ft. deep at mean low water and about 60 ft. wide for a length of 5,500 ft. It is estimated this will require the removal of about 73,000 cu. yds. of rock and 112,000 cu. yds. of sand place measurement.

The material to be removed is believed to be a rather soft coral rock, overlaid with sand and black detritus. It is believed the surface of the rock is about 18 ft. below mean low water at the 18 ft. contour; that from this line it gradually rises to the westward to about 10 ft. below mean low water just inshore of the 12-ft. contour. From this latter contour for a distance of about 3,000 ft. it lies generally about 10 ft. below mean low water, and from this point westward it gradually falls until it reaches a depth of about 22 ft. below mean low water just inside the North Point. It is believed the rock near the seaward end of the work will be found bare, or nearly bare, and that it will be found overlaid with a layer of sand and beach detritus, varying in thickness from a few inches to 10 ft. or more as the general line of the coast is approached, increasing to 20 ft. toward the river end of the work.

The excavated material at Miami Harbor if handled in dump scows, if deemed suitable, may be deposited for extensions of north and south jetties. Dredged material not suitable for this purpose will be carried out to sea and dumped about ⅛ mile southeast of the end of the south jetty. If the work is done by hydraulic process the material excavated must be deposited north of the north jetty between the shore and a point not less than 700 ft. shoreward of the seaward end of the jetty or south of the south jetty, between the shore and a point not less than 500 ft. shoreward of the seaward end of the jetty. In the work at St. Lucie Inlet the excavated material, if dump scows are used, will be conveyed an average distance of not more than 4,000 ft. If the work is done by the hydraulic process it will be conveyed an average distance of not over 1,500 ft. by pipe line.

Bids will be received for the work at Miami Harbor only, for the work at St. Lucie Inlet only, or for doing the work at both places. Bids will be opened at noon, Nov. 8, at U. S. Engineer's Office, Jacksonville, Fla.

New Railway for Central Oregon.

An important prospective railway development for central Oregon has been announced recently. Incorporation papers were taken out early this month for a new railway, proposing the construction of a 400-mile system to connect five existing lines. The new company will be known as the Oregon, California & Eastern. Its declared purpose is as follows: To construct a line of railroad extending from Bend, Ore., in a southerly and southeasterly direction to Lakeview, Ore.; a branch line from Silver Lake to Kirk in Klamath County; a branch line from a point at or near Millican in a southeasterly direction to Arden in Harney County, and another branch line from a point to be determined by the board of directors to the Warner Valley.

The construction of these lines it is claimed would open for development a territory as large as the state of Ohio. Surveys for the new railway have been underway for some time, and from the information already at hand it is believed the system could be completed and equipped in about 3 years at a cost of $6,000,000 to $7,000,000.

The recently elected officers of the Oregon, California & Eastern R. R. include Robert E. Strahorn, Portland, Ore., president; James G. Wilson, secretary, and W. E. Bond, treasurer. Mr. Strahorn was president of the North Coast R. R. during its construction, and when that road was taken over by the Harriman System he became president of the Portland, Eugene & Oregon R. R.

American Association of Engineers.—The first national convention of the American Association of Engineers will be held Dec. 10 and 11 at the Hotel La Salle, Chicago, Ill. All engineering societies have been invited to send official representatives to the convention to join in the discussions and to assist in attempts to solve a few of the welfare problems confronting the engineer. The association announces that 55 new members were obtained during the latter half of September, and that owing to the increase in its activities larger quarters have been taken at 29 South La Salle st., Chicago. Arthur Kneisel is secretary of the association.

PLAY GROUND CONSTRUCTION AT BOSTON, MASS.

Estimated $690,000 Will Be Expended for Their Completion.

Itemized List of Proposed Expenditures.

Boston, Mass., now has an excellent system of play grounds. These recreative centers, however, are by no means completed and a great deal of work remains to be done that will offer many opportunities to contractors and suppliers of material and equipment. The following tabulation shows the estimated cost of completing the various playgrounds of the city:

BRIGHTON.

North Brighton Playground, Western Ave., 14 Acres.

8 tennis courts, grading and surfacing, at $400	$ 3,200
1,000 lin. ft. tennis fence at $1.25	1,250
420 lin. ft. iron picket fence at $2	840
460 lin. ft. 10-ft. baseball fence at $2.50	1,150
Bleachers to seat 600	2,400
Shelter	800
Apparatus	800
Planting	500
Total	$10,940

Portsmouth St. Playground, Portsmouth St., 4.29 Acres.

Grading	$ 2,500
1,800 lin. ft. 10-ft. baseball fence at $2.50	4,500
1,050 lin. ft. iron picket fence at $2	2,100
500 lin. ft. tennis fence at $1.25	625
Sanitary and locker building	15,000
Shelter	800
Apparatus	1,000
Bleachers to seat 500	2,000
Total	$28,525

Rogers Park Playground, Foster St., 6.9 Acres.

Sanitary and locker building	$15,000
500 lin. ft. tennis fence at $1.25	625
1,050 lin. ft. boundary wall at $4	4,200
1,000 lin. ft. 10-ft. baseball fence at $2.50	2,500
1,500 cu. yds. grading at 60 cts.	900
Bleachers to seat 500 at $4	2,000
1,000 sq. yds. brick walk at $1.50	1,500
Apparatus	800
Planting	500
Total	$28,025

CHARLESTOWN.

Charlestown Playground, Sullivan Sq., 14 Acres.

1,200 lin. ft. sea wall at $50	$60,000
1,000 lin. ft. tennis fence, at $1.25	1,250
5,000 cu. yds. excavation and grading at 40 cts.	2,000
1,600 cu. yds. loam at $1.50	2,400
4,400 sq. yd. granolithic walk at $1.25	5,500
Completion of locker building	12,000
Bleachers to seat 600	2,400
Apparatus	1,200
2,500 lin. ft. 10-ft. baseball fence at $2.50	6,250
Planting	300
Total	$93,300

Rutherford Avenue Playground, Rutherford Ave., 1.07 Acres.

Grading	$ 200
Loaming and planting	300
Drainage and water supply	350
Apparatus	1,200
Total	$ 2,050

Mystic Playground, Chelsea St., 2.39 Acres.

122 lin. ft. sea wall at $50	$ 6,100
2,000 cu. yds. filling at 60 cts.	1,200
700 lin. ft. baseball fence, 10-ft. high, at $2.50	1,750
120 lin. ft. fence on sea wall at $2	240
Seats	260
Loaming and planting	300
Apparatus	600
350 lin. ft. wall on Scott's court at $6	2,100
Total	$12,550

CITY PROPER.

Tyler St. Playground, Tyler St., 0.26 Acre.

1,200 sq. yds. granolithic pavement at $1.50	$ 1,800
Loam and planting	50
Repairing shelter roof	250
Drainage	250
Apparatus	1,200
Drinking fountain	150
Total	$ 3,700

DORCHESTER.

Christopher Gibson Playground, Geneva Ave., 5.8 Acres.

12,000 cu. yds. grading at 60 cts.	$ 7,200
1,600 lin. ft. 10-ft. baseball fence at $2.50.	4,000
1,250 lin. ft. iron picket fence at $2	2,500
500 lin. ft. tennis fence at $1.25	625
Bleachers to seat 500	2,000
Shelter	800
Drainage	500
Planting	300
Total	$17,925

Franklin Field, Blue Hill Ave., 77 Acres.

90,000 cu. yds. excavation and grading at 60 cts.	$54,000
3,600 sq. yds. granolithic walk at $1.50	5,400
2,600 sq. yds. tar macadam walk at 60 cts.	1,560
Planting	2,500
2,400 lin. ft. tennis fence at $1.25	3,000
8,000 sq. ft. tennis court surfacing at 30 cts.	2,400
Drainage	3,500
460 lin. ft. wall on Blue Hill Ave. at $4	1,840
Apparatus	1,500
Total	$75,700

John Winthrop Playground, Dacia St., 1.57 Acres.

Sanitary and locker building	$10,000
200 lin. ft. baseball fence, 10 ft. high, at $2.50	500
500 lin. ft. railing on wall at $1.50	750
510 lin. ft. pipe rail fencing at $1	510
Apparatus	800
Drinking fountain	250
Planting	250
Total	$13,060

Neponset Playground, Neponset Ave., 16.65 Acres.

15,000 cu. yds. filling and grading at 60 cts.	$ 9,000
2,000 cu. yds. loam at $1.25	2,500
Drainage	1,000
Sanitary and locker building	15,000
Shelter	800
500 lin. ft. tennis fence at $1.25	625
1,050 lin. ft. iron picket fence at $2	2,100
1,600 lin. ft. boundary fence, wood, at 75 cts.	1,200
Apparatus	800
Bleachers to seat 600	2,400
Total	$35,425

Norfolk St. Playground, Norfolk St., 6.35 Acres.

Completion of grading	$ 2,000
300 lin. ft. retaining wall at $4	1,200
500 lin. ft. 10-ft. baseball fence at $2.50	1,250
900 lin. ft. iron picket fence at $1.50	1,350
600 lin. ft. tennis fence at $1.25	750
Bridge over railroad	6,000
200 sq. yds. granolithic walk at building at $1.50	300
1,400 sq. yds. tar macadam walks at 60 cts.	840
Planting	500
Bleachers to seat 500	2,000
Apparatus	1,200
Drinking fountain	75
Drainage	50
Total	$17,515

Ronan Park Playground, Adams St., 11.07 Acres.

Provided for	$100,000

Savin Hill Beach Playground, Denny St., Savin Hill, 8.26 Acres.

50,000 cu. yds. filling and grading at 60 cts.	$30,000
Loam and planting	1,000
Drainage	500
2,000 lin. ft. 10-ft. baseball fence at $2.50	5,000
620 lin. ft. boundary fence, wood, at 75 cts.	490
500 lin. ft. tennis fence at $1.25	625
Sanitary and locker building	15,000
Bleachers to seat 500	2,000
Apparatus	1,200
Total	$55,815

Wood Playground, Neponset, 3.1 Acres.
Not practicable to construct at this time.

EAST BOSTON.

Cottage St. Playground, Cottage St., 3.85 Acres.

1,800 lin. ft. 10-ft. baseball fence at $2.50	$ 4,500
1,000 lin. ft. guard fence at $1	1,000
Planting	200
Bleachers to seat 500	2,000
Total	$ 7,700

Orient Heights Playground, Boardman St., 8.31 Acres.

75,000 cu. ft. filling at 60 cts.	$45,000
2,200 lin. ft. 10-ft. baseball fence at $2.50	5,500
Sanitary and locker building	15,000
Shelter	800
Loaming and planting	1,200
Drainage	600
Apparatus	1,200
Drinking fountain	250
Total	$69,550

Paris St. Playground, Paris St., 1.27 Acres.

1,000 cu. yds. filling at $1	$ 1,000
170 lin. ft. retaining wall at $5	850
Loaming and planting	300
Drainage	200
360 lin. ft. 10-ft. baseball fence at $2.50	900
215 lin. ft. iron picket fence at $2	430
Sanitary building	10,000
Shelter	800
250 sq. ft. concrete stairways at $1	250
Apparatus	1,200
Drinking fountain	250
Total	$16,180

HYDE PARK.

Smith's Pond Playground, Cleveland St., 20 Acres.

1,600 lin. ft. 24-in. main drain at $3	$ 4,800
15 acres grading and drainage at $1,500	22,500
Sanitary and locker building	15,000
Shelter	800
Apparatus	1,200
Drinking fountain	250
Total	$44,550

Factory Hill Playground, Sunnyside St., Rough Estimate 4.9 Acres.	
Grading	$ 5,000
Drainage	2,500
Planting	500
Sanitary and locker building	15,000
Shelter	800
Apparatus	1,200
Fencing	1,500
Total	$30,000
ROXBURY.	
Marcella St. Playground, Marcella St., 5.1 Acres.	
1,000 lin. ft. 10-ft. baseball fence at $2.50	$ 2,500
1,000 cu. yds. rock excavation at $2	2,000
Bleachers to seat 500	2,000
Total	$ 6,500
Ward 19 Playground.	
Provided for	$200,000
William Eustis Playground, Norfolk Ave., 4.88 Acres.	
Bleachers to seat 500	$ 2,000
420 lin. ft. baseball fence at $2.50	1,050
Apparatus	800
Total	$ 3,850
SOUTH BOSTON.	
Commonwealth Playground, D St., 8.07 Acres.	
1,900 lin. ft. 10-ft. baseball fence at $2.50	$ 4,750
500 lin. ft. tennis fence at $1.25	625
1,000 lin. ft. iron picket fence at $2	2,000
2,300 lin. ft. guard rail at 50 cts	1,150
Bleachers to seat 600	2,400
Apparatus	1,200
Loam and planting	500
Total	$12,625
WEST ROXBURY.	
Billing's Field, La Grange St., 11 Acres.	
15,000 cu. yds. filling and grading at 60 cts.	$ 9,000
990 lin. ft. iron picket fence at $2	1,980
1,000 lin. ft. 10-ft. baseball fence at $2.50	2,500
760 lin. ft. boundary fence wood at 75 cts.	570
500 lin. ft. tennis fence at $1.25	625
Bleachers to seat 500	2,000
Planting	500
Apparatus	1,200
Total	$18,375
Carolina Ave. Playground.	
Grading	$ 2,500
325 lin. ft. retaining wall at $6	1,950
1,440 lin. ft. baseball fence 10 ft. high at $2.50	3,600
350 lin. ft. iron picket fence at $2	700
700 lin. ft. tennis fence at $1.30	910
Shelter	1,000
Apparatus	800
Planting	500
Total	$11,960
Forest Hills Playground, Washington St., Forest Hills, 9.6 Acres.	
1,400 lin. ft. 10-ft. baseball fence at $2.50	$ 3,500
330 lin. ft. iron picket fence at $2	660
500 lin. ft. tennis fence at $1.25	625
Bleachers to seat 600	2,400
Planting	250
Apparatus	600
Total	$ 8,035
Roslindale Playground, Robert St., Roslindale, 3.84 Acres.	
270 lin. ft. retaining wall at $6	$ 1,740
740 lin. ft. iron picket wall at $2	1,480
Apparatus	600
Total	$ 3,820
Total	$627,675
Incidentals—expenses about 10 per cent.	62,767
Grand total	$690,442

John H. Dillon is Chairman Park and Recreation Department. C. E. Putnam is Engineer.

Contracts for Rapid Transit Work, Philadelphia.

The second letting in connection with the new rapid transit development of Philadelphia, Pa., was held on Oct. 19. At this time bids were opened for the manufacture and erection of the steel superstructure of the four sections of the Frankford Elevated Line, extending from Girard avenue north to Unity street, Frankford. These contracts covered 20,520 ft. of two-track elevated railway. In all 20 bids were received, the McClintic-Marshall Co., Morris Bldg., Philadelphia, Pa., being low bidder on all four sections. The contract for three of these sections was awarded to that company at $1,455,000, and it probably also will receive the fourth section at about $249,000. The Connors Bros. Co., New York City, at $1,684,000, and E. E. Smith Co., New York City, at $1,720,211, were next low bidders on the first three sections. The contract provides that work must start on or before April 1, 1916, and must be completed by Oct. 31. The concrete track floor and station buildings are not included in the contract.

PERSONALS

Mr. Oscar F. Lackey, who for the past nine years has been president and chief engineer of the Harbor Board of Baltimore, has opened an office at 4 West Eager street, Baltimore, Md. Mr. Lackey has had nineteen years' experience in various kinds of engineering practice, seven of which were with the U. S. Government service in Cuba, on streets and sewers and water supply for the city of Santiago. Under his direction during that time, plans, estimates and specifications were prepared covering expenditures of over six million dollars, and included asphalt and block pavements, sewage disposal, water supply, dams, culverts and bridges. He became president and chief engineer of the Baltimore Harbor Board nine years ago, and in that office he planned the harbor improvements for the port, part of which has been completed, at an expenditure of eight millions.

Mr. A. C. Watson has been appointed division engineer of the Cleveland and Pittsburg division of the Pennsylvania system, succeeding Mr. E. F. M. Crea, recently deceased. Mr. Watson was assistant on the Pennsylvania engineering corps from 1900 to 1903, when he left to enter the service of the Illinois Central. He was assistant engineer on the New Orleans division of that road for a time and later on the St. Louis division of the Vandalia. From July, 1905, to December, 1910, he was assistant engineer on the Indianapolis terminal division of the P., C., C. & St. L. Since that time he has held successively the position of assistant engineer on the Richmond division, the Western division and the Cleveland & Pittsburg division of the Pennsylvania, division engineer of the Zanesville division and since February, 1914, division engineer on the Logansport division.

Mr. Jay A. Rossiter has been appointed as engineer of track elevation for the city of Chicago and will be in charge of the preparation of ordinances relative to track elevation work, plans and construction work. He will also serve as technical representative of the city in discussions of track elevation and railroad subway matters, and consulting engineer to the track elevation committee of the city council. Mr. Rossiter has for the past year been office engineer for the Water Pipe Extension Division of the city of Chicago. He was educated at the Armour Institute, and entered the service of the city in 1902 as rod man and junior engineer on pumping station, sewer and paving work. In 1907 he left Chicago to go to the Philippines, as assistant engineer and superintendent of construction for the government. He remained there until 1911 when he returned to the United States to enter the contracting business in bridge and drainage work. In 1912-13 he was general superintendent of constructon for the contractor on 175 miles of the Algoma Central Railroad in Canada. In 1914 he entered the Water Pipe Extension Division of Chicago.

OBITUARIES

James F. Everett, one of the men who contributed largely to the development of the cement industry, and said to be the oldest employe of the Atlas Cement company, died at his home in Allentown, Pa., October 17, aged 62. Mr. Everett engaged in the contracting business in 1883, erecting homes and business blocks in Whitehall, Pa., now Cementon. Later he built the Rock Lock cement mill at Siegfried, where experiments in the manufacture of cement were carried out, and from which the present Lawrence plant developed. Mr. Everett then assisted in the erection of the Bonneville cement plant and then in the rebuilding of the old Keystone plant near Coplay. This plant became the nucleus of the Atlas Cement Co. and Mr. Everett later became superintendent of construction for that company. He built Plant No. 2 at Northampton, in 1901, his biggest work. When the Valley Mill was rebuilt he was made superintendent, and remained in that position until his death.

NEW CATALOGUES

Garage Pump.—Paper, 3½x6¼ ins.; 4 pp., The Gardner Governor Co., Quincy, Ill.

Circular AC-11, describing Gardner's Garage Pump, or "Gee Gee Special." Illustrated.

Steam Separators.—Paper, 3½x6¼ ins.; 8 pp., The Gardner Governor Co., Quincy, Ill.

Describes the Gardner Steam Separator, and shows exterior and sectional views and diagrams. Gives table of sizes, weights and prices.

Valves.—Paper, 3¼x6 ins.; 12 pp., Chicago Pneumatic Tool Co., 1079 Fisher Building, Chicago.

Describes Simplate flat disc compressor valves in detail and shows construction and application by views and diagrams.

Generators.—Paper, 8x6 in., leaflets; Jantz & Leist Electric Co., Cincinnati, Ohio.

A series of leaflets showing the various types of generators, belt driven, direct current, gas or steam engine connected, etc. Briefly states the purposes for which each type is adapted and gives data as to sizes, voltage, etc.

Gasoline Engines.—Paper, 6x9 ins.; 24 pp., Schaefer Manufacturing Co., Berlin, Wis.

Schaefer Marine gasoline engines for 20 to 50 ft. launches are described in the annual catalogue of the company. Views of a number of different outfits are shown and details of construction, dimensions, attachments, operation, etc., are given in convenient tabular form.

Fuel-Oil Burners.—Paper, 6x9 ins.; 16 pp., Hauck Manufacturing Co., 140 Livingston Street, Brooklyn, N. Y.

Bulletin No. 60, illustrating and describing Hauck Burners and appliances for heating metals for welding, repairing, etc. Shows methods and appliances for boiler shop, preheating for oxy-acetylene welding, brazing, foundry work, etc.

Shipping Room Supplies.—Paper, 4x9 ins.; 32 pp., Acme Steel Goods Co., 2834 Archer avenue, Chicago.

Illustrated catalogue and price list of the many steel and wire appliances for packing and shipping handled by the company. List includes all kinds of box strapping, clasps, joint fasteners, staples, tie fasteners, steel door mats, box hinges and locks, etc.

Fireproof Floors and Partitions.—Paper, 8½x11 ins.; 16 pp., Trussed Concrete Steel Co., Youngstown, Ohio.

Kahn pressed steel building construction is the subject of this pamphlet, which is extensively illustrated with views of the numerous applications in floors, walls, bearing partitions and ceilings. Data on tests, safe loads, etc., specifications and standard sections are included.

Coal Gas Plant.—Paper, 7x10 ins.; 12 pp., and insert. Stone & Webster Engineering Corporation, New York City.

The coal gas plant of the Fall River, Mass., Gas Works Co., installed by the above company is described and effectively illustrated with photographic reproductions. Includes a fine panoramic view of the plant which has a present capacity of 1,050,000 cu. ft. per day, and is so designed as to be easily extended to meet future requirements.

Carbic Light.—Paper, 6x9 ins.; 16 pp., Carbic Manufacturing Co., Duluth, Minn.

The Carbic Flare-Light for contractors, miners, street work, camps, etc., is described and its uses explained. Shows various types and sizes of this portable gas torch, the fuel of which consists of carbic cakes, or briquetted gas producing materials and water. A swivel jointed aluminum reflector adds to the efficiency of the light, which is claimed to be safe, economical and reliable.

RAILWAYS

BIDS ASKED.

Massachusetts:

Boston, Mass.—Until noon, Nov. 11, by Boston Transit Commission, B. Leighton Beal, Secretary, for building Section G, Dorchester Tunnel, in Dorchester Ave., between West Fourth St. and Old Colony Ave., South Boston. The section is about 1,200 ft. long, and the structure will be mainly of reinforced concrete.

PROSPECTIVE WORK.

California:

Los Angeles, Cal.—Pacific Electric Ry. Co. will construct elevated track from station at 6th and Main Sts. to San Pedro St. Estimated cost, about $300,000.

Quincy, Cal.—Preliminary surveys are under way for a branch line from the Western Pacific R. R. to the Engel's copper mine in Light's Canyon. The branch would develop a large area of rich farming, stock and timber country.

Patterson, Cal.—Surveys are being made for the recently incorporated Patterson & Western R. R. Company proposes a 22-mile line to give rail outlet to deposits of magnesite. H. G. Ginaca, San Francisco, is president of the company.

Delaware:

Wilmington, Del.—Philadelphia & Reading Ry. has surveys under way for extension from South Wilmington, Del., to new plant of Baldt Steel Co., and new plant of General Electric Co. near Newcastle.

Indiana:

Fort Wayne, Ind.—Pennsylvania R. R. and Wabash R. R. have submitted plans for track elevation.

Iowa:

Muscatine, Ia.—Muscatine & Iowa City Ry. Co. is to be incorporated with capital stock of approximately $150,000. It proposes to operate an interurban service between Muscatine and Iowa City. Company is said to plan taking over Muscatine west branch of the Rock Island R. R. and line extending from Iowa Junction to Iowa City. A. B. Bowen is interested.

Kansas:

Hutchinson, Kan.—Larned and Pawnee County Townships have voted $110,000, in bonds, to aid in construction of Anthony and Northern R. R. into Larned. It is stated that construction on extension from Trousdale will be started Nov. 1. O. P. Byers is President.

Maryland:

Baltimore, Md.—Pennsylvania R. R. has made preliminary surveys for tunneling Patatsco River. This project would be undertaken in connection with terminal developments at Baltimore. Estimated cost of tunnel is about $12,000,000.

Hagerstown, Md.—Baltimore & Ohio R. R. is securing right of way for a proposed branch from Hagerstown to Security, 2 miles east of former place.

Michigan:

Detroit, Mich.—Citizens will vote Nov. 2 on taking over and managing local street railway system.

Montana:

Great Falls, Mont.—Surveys have been completed for proposed line of Great Falls & Southwestern Ry. from Ulm in Cascade County. E. L. Dana, Parkman, Wyo., is president.

Nevada:

Eureka, Nev.—Richmond Mining Co. is reported to be planning construction of railroad from Eureka to Elko.

North Carolina:

Hookerton, N. C.—Fisher Creek Timber Railroad Co. has been chartered with a capital stock of $50,000. G. A. Rogers, Tarboro, N. C., one of the incorporators of the Stamper Timber Corporation, is interested in the new railroad.

Ohio:

Columbus, O.—East Linden Electric Ry. Co. has been granted franchises for two short street railway extensions.

Cincinnati, O.—West End Transit Co. proposes construction of link to connect Cincinnati, Lawrenceburg & Aurora Traction Line at Anderson's Ferry so as to give interurban fast service into city. Plans contemplate elevation of tracks over Millcreek and over the railroads in the bottoms.

Canton, O.—Baltimore & Ohio R. R. is reported planning an expenditure of $200,000 for trackage extensions and a new station in Canton.

Oklahoma:

Blackwell, Okla.—Company is being organized here for promotion of railroad to connect with the Frisco System at Peckham, and with the Santa Fe System at Braman.

Oregon:

Portland, Ore.—The Oregon, California & Eastern Ry., mentioned in our last issue, has been incorporated with a capital stock of $100,000. The Oregon office is to be at Portland and the main office at Carson City, Nev. Robert E. Strahorn is president.

Eugene, Ore.—Southern Pacific R. R. has entered into contract with Booth-Kelly Lumber Co. for immediate construction of spur to timber land near Wendling ranch.

Pennsylvania:

Media, Pa.—Philadelphia & West Chester Traction Co., Upper Derby, Pa., is reported planning to extend its Collingdale division from Parker Ave., Collingdale, to Chester Pike, Sharon Hill.

Texas:

Galveston, Tex.—Plans are being worked out for the reconstruction of the causeway at this city. It is understood that plans will call for extension of arch bridge construction practically all the way across the bay. Formal action in the matter probably will not be reached by the railroads and other interested parties until next month. Frank Merritt, Chief Engineer, Gulf, Colorado & Santa Fe R. R.

Van Horn, Tex.—Plans are well advanced for the construction of a connecting line from Van Horn north to the New Mexico state line, 71 miles. Van Horn Valley Land & Railway Co., R. H. Owen, president, is interested.

San Antonio, Tex.—Missouri, Kansas & Texas R. R. proposes to replace 115 miles of light rail with 85-pound steel. Work will be between New Braunfels and San Antonio, Smithville and Fayetteville, and Alvarado and Fort Worth.

West Virginia:

Huntington, W. Va.—Officials of Huntington-Chesapeake Bridge Co., recently chartered, will ask county for franchise for street railway from Fourth Ave. and Sixth St. over Ohio River to a point in the town of Chesapeake, O. Company proposes to construct highway bridge with double-track street car line. The work will cost about $500,000. Incorporators include R. P. Aleshire, Paul Hardy and J. C. Miller.

BIDS OPENED; CONTRACTS LET

Kansas:

Salina, Kan.—Good progress is being made with construction of Salina & Northern R. R., and it is expected that the line will be completed to Lincoln by Jan. 1. Keystone Construction Co., E. A. Tennis, president, has the contract.

Newton, Kan.—Newton, Kansas & Nebraska Ry. Co. has awarded contract to Newton Construction Co., for railway from Newton through Harvey, Saline, Clay and Washington counties. S. O. Waddell, Chief Engineer.

New York:

New York, N. Y.—Astoria Realty & Construction Co., M. E. Rountree, President, has been awarded contract at about $2,000,000 for construction of 23 stations along Jerome Ave., and White Plains road extensions of subway system. Considerable amount of reinforced concrete will be used for this work.

North Carolina:

Belmont, N. C.—Grading has been started for branch line of Piedmont & Northern Interurban Ry. P. R. Huffstetler, Gastonia, N. C., has contract.

Pennsylvania:

Philadelphia, Pa.—McClintic-Marshall Co., Philadelphia, at $1,455,000 was awarded contract for the erection of main steel structure of Frankford Elevated Line from south of Girard Ave. to Unity St. for city of Philadelphia. McClintic-Marshall Co. also was low bidder for the work between south of Girard Ave. and south of Callowhill St.

ROADS STREETS

BIDS ASKED.

California:

Morgan Hill, Cal.—Until 8 p. m., Oct. 29, by F. R. Bone, Town Clerk, for improving Monterey Road. H. B. Fisher, Town Engineer, Rea Bldg., San Jose, Cal.

Arcadia, Cal.—Until 8 p. m., Nov. 8 (readvertisement), by City Clerk, for oil macadam for about 16 miles of streets.

Florida:

Titusville, Fla.—Until 9 a. m., Nov. 9, by J. F. Mitchell, Clerk, County Commissioners, for constructing 68 miles of highway for Special Road and Bridge District No. 3. Estimated cost $150,000. Bids will be asked on shell surfacing with an alternative of ojus or similar local stone surfacing.

Tavares, Fla.—Until Nov. 1, by H. H. Duncan, County Clerk, for 2½ miles of roadway and for fill and bridge across marsh. J. B. McCreary Co., Engineers, Atlanta, Ga.

Fort Pierce, Fla.—Until Nov. 2, by J. E. Foltz, County Clerk, for hard surfacing on Fellsmer-Sebastian Road.

Illinois:

Des Plaines, Ill.—Until 7:30 p. m., Nov. 1, by Board of Local Improvements, H. H. Talcott, Secretary, for paving on Lee St. and Perry St., with asphalted concrete, and on Ashland Ave. with reinforced concrete. W. H. Allen, Engineer, 1403 Harris Trust Bldg., Chicago.

Quincy, Ill.—Until 11 a. m., Nov. 2, by State Highway Commission for construction of 4,140 ft. of brick and concrete road in Sangamon County. Estimated cost, exclusive of cement furnished by state, is $14,460.

Indiana:

Princeton, Ind.—Until Nov. 8 by city for constructing about 2 miles of 6-ft. concrete walk, estimated to cost $0.12 per sq. ft. Sidewalks will be on 6-in. cinder base and will consist of 4-in. concrete base and 1-in. top coat. H. J. Toelle, City Engineer.

Kansas:

Columbus, Kan.—Until noon, Nov. 1, by County Commissioners, for 7 miles of gravel road.

Massachusetts:

Boston, Mass.—Until noon, Oct. 29, by Edward F. Murphy, Commissioner of Public Works, for asphalt or bitulithic pavement on Jones Ave., Dorchester. Bond of 3,000 required.

Sheffield, Mass.—Until noon, Nov. 9, by Massachusetts Highway Commission, 15 Ashburton Place, Boston, for about 19,000 ft. of state highway in Sheffild and Great Barrington.

Minnesota:

Park Rapids, Minn.—Until 2 p. m., Nov. 2, by County Auditor, for work on State Highway No. 1, requiring about 26,000 cu. yds. of excavation.

Mississippi:

Hattiesburg, Miss.—Until noon, Nov. 1, by County Supervisors, Herbert Gillis, Clerk, for furnishing adjustable wheel grader with 10-ft. blade.

Missouri:

Independence, Mo.—Until 10 a. m., Nov. 4, by Allen C. Southern, County Surveyor, for 11,733 sq. yds. of bituminized earth pavement and 10,560 ft. of crubing.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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Some Recent Engineering Developments.

As examples of the widening field for the engineer's activity we wish to mention two important and comparatively recent developments which are essentially engineering in character, namely, grain storage houses, and coal and ash storage and handling plants. In the embryo, such structures have been in use for a long time, but it is only within recent years that they have been developed to a high degree of efficiency. Neither has yet approached perfection, but few who have not been directly interested in their design and construction can appreciate the advances which have been made in the past few years.

The use of concrete and steel has revolutionized the construction of grain storage houses, until at present we have numerous terminal storage houses with capacities of a million bushels of grain or more. In hand with the development which has taken place in the structures themselves, there has been a corresponding development in the loading, cleaning and unloading facilities of such plants.

The use of steel and reinforced concrete has also resulted in the evolution of highly efficient coal and ash storage and handling plants. Such constructions have been highly developed both as separate units and as auxiliary plants in connection with central heating and lighting systems.

The development of these plants has been so rapid in recent years that engineering literature contains comparatively little up-to-date information on them. The design and construction of these plants offer a promising field for engineers who are willing to make a systematic study of them. Their design can hardly be said to be on a purely rational basis at present as the assumptions made by designers are numerous and in some cases of doubtful accuracy.

The Attitude of Engineers Toward New Engineering Societies.

Probably a majority of engineers hold the opinion that there are already enough, if not too many, engineering societies. A good illustration of this belief was furnished a couple of years ago when an earnest young engineer advocated certain reforms in connection with the operation of water purification and sewage treatment plants and suggested the formation of a society to work for the reforms advocated. A mature engineer expressed himself with reference to this plan substantially as follows: "I agree with all Mr. Blank has said, except that a new engineering society be formed—which Heaven forbid!" The society was not formed and, to date, the reforms have not been effected.

The editor, a few days ago, was one of a group discussing the newly formed engineers' society called The American Association of Engineers. A well known consulting engineer was present and, quite properly, because of his age and attainments, he was the center of the group. A much younger man asked him: "What do you think of the American Association of Engineers?" "Well," was the answer, "as far as I can see they are working along the right lines. All I have against them is the starting of another engineering society. I think these reforms should be worked out within the old societies." The latter remark suggested this editorial.

Quite possibly the engineer to whom we refer was well justified in the stand he took for he already is a very active member of numerous organizations. For many years he has given freely of his time and strength in furtherance of the aims of these various societies. However, we do not feel that the average engineer is at all justified in withholding his interest in a new society just because it is new.

The difficulty of introducing reforms within old organizations is familiar to all interested in politics or in business. Thus the Progressive Party was formed in 1912 because the progressive element in the Republican Party was unable to introduce certain reforms from within the old party. Many there are who assert that the reforms should have been worked out on the inside—the answer is that an effort to this end was made but without success. The merits of this controversy are still in dispute but it is sufficiently clear to many of us that some of the reforms advocated will be effected, perhaps after a reunion of the reformers with the reformed, which could not have been reached so soon, perhaps by several decades, by any other method than the one taken. Again, in the world of business, many a new business is a monument to some man's unsuccessful efforts to introduce desired reforms in an old one.

A new engineering society can not consistently ask the support of engineers until it has a clean cut field of usefulness. Such a field of usefulness may find its origin in the indifference of old societies towards certain matters which a considerable number of men want to see added to the interests and objects of the existing societies. If the latter persist in their indifference an unconscionable long time there is no satisfying alternative for those who wish to move forward but to get out and start a new organization.

The engineer has a right to inquire whether a new society gives promise of service not offered by existing societies before he lends it his support. Having satisfied himself on this point he should not withhold his support because the movement is new. Above all, he should not be too lazy, mentally, to investigate the merits of the new society.

A Court Decision Against Deducting Accrued Depreciation in a Rate Case.

For the first time the supreme court of a state has ruled against deducting accrued depreciation. We refer to the decision of the Idaho Supreme Court on an appeal from a decision of the Public Utilities Commission in the Pocatello water case. We quote:

> "So far as the question of depreciation is concerned, we think deduction should be made only for actual, tangible depreciation, and not for theoretical depreciation, sometimes called 'accrued depreciation.' In other words, if it be demonstrated that the plant is in good operating condition and giving as good service as a new plant, then, the question of depreciation may be entirely disregarded." (Murray v. Public Utilities Commission, Pacific Reporter, Aug. 9, 1915, p. 50.)

This decision practically sustained the dissenting opinion of Public Utilities Commissioner Ramstedt.

A very interesting 24-page pamphlet has been printed containing abstracts from a brief submitted on this case by John F. MacLane, as Amicus Curiae to the Supreme Court of the State of Idaho, in which numerous engineers and utility commissioners are quoted.

There is, we think, a growing tendency among commissioners in rate cases either to make no deduction for accrued depreciation of any sort or to regard depreciation as more than offset by the cost of establishing the going business. It is reasoned by many that although accrued depreciation is a liability, and that therefore it should be deducted in case of *purchase* of plant, no deduction should be made in a rate case, for the owners of the plant are bound to maintain the plant in good service condition and can not escape that liability. But whatever the reasoning, certain it is that rates should not vary with the depreciated condition of the plant. And we think it equally sound that dividends should not fluctuate with fluctuating plant condition.

It has been proposed that as fast as plant depreciates, the depreciation annuities be distributed among the owners. By using a sinking fund formula for calculating accrued depreciation, it would thus be possible to maintain constant rates of charge for service, for while the dividends would be decreasing the depreciation annuities would be rising so that the sum of the two would be a constant annual amount. This "equal annual payment method" ignores, however, existing methods of financing. But, what is worse, it rests upon the false assumption that depreciation accrues uniformly with the lapse of time. Most depreciation is functional, due to obsolescence and inadequacy, and has no definite relation to the lapse of time.

Will Great Cities Become Extinct?

Comment on the probable effect of the automobile on rural life has been frequent in editorial columns. We can not recollect having seen many prognostications as to what the motor car may do to cities. Yet it is apparent that it will effect changes, some of which may be fundamental.

Already many streets in large cities are so badly congested that it is evident that very soon there must come not only marked changes in the regulation of vehicular traffic but a more general improvement of pavements and possibly a widening of the principal roadways. However, it is not these relatively minor alterations that we have in mind when we speak of fundamental changes.

More suburban towns will probably spring up around existing large cities and most of the population now in the large cities may move to the surrounding suburbs. There is more than one force working toward such a change, but the automobile is likely to prove to be the strongest of these change forces.

Bearing in mind the chief reason why cities have grown great—namely because they attract a working population on account of the variety of cheap amusements that they offer—it seems likely that a similar attractiveness will be found in the suburban towns when almost every family owns some sort of motor vehicle. To have suggested such a reason a few years ago would have sounded altogether visionary. But with good touring cars selling at less than $450, with the prices rapidly descending, and with the earning power of the average American family steadily rising, there is nothing particularly Utopian in a picture of almost universal use of automobiles. One American family in ten now owns its car. When even three or four in ten have reached this opulent goal—and it is distinctly on the horizon—who can doubt that cities as well as rural districts will pass through an evolution that we have scarcely dreamed of?

Motor cycles enable workmen to go long distances to factories and fields in whiz time—too whizzy at times for safety. There is no doubt that excellent motorcycles will be sold for less than $100, and that good serviceable touring cars will sell for less than $350. Upkeep costs will decrease much more rapidly than first costs, for this is the universal experience in the world of machinery. There will then remain only three things needed to make life in suburban towns more attractive than life now is in the greater cities:

First, good wide roads well lighted.

Second, removal of snow from the roads as soon as it falls.

Third, amusement centers.

The rest will follow. Under such conditions almost every advantage that a great city offers will be available to residents in and near the smaller towns.

The removal of snow from roadways is, of course, much less expensive in suburban and rural districts than in crowded city streets. But as yet this problem of road upkeep has received scarcely any attention. With the growing use of automobiles, however, snow removal from roadways is certain to become a part of the regular duties of those who maintain the road systems. Automobile snowplows and rotary brushes will make short work of any ordinary snow fall on town and rural roads.

Amusement centers—theaters, libraries, ball grounds, tennis courts, golf links, etc., will be so far superior to anything available to the average man in the large city that the rural towns of the future will have no difficulty in attracting and holding population. The 48-hour week is already a reality for a large percentage of workmen. The 36-hour week will come. Indeed, the office forces in the large cities now average less than 36 hours' work weekly. It is true that they lose about 12 hours every week going to and from work. But this is a loss from pleasure time that will be largely eliminated by residence in rural towns. Given only 36 hours of weekly work, there will remain several hours daily for recreation. But that the recreation may be healthful a considerable part of it must be in the open air—a condition not attainable in the large cities.

Well may it be questioned whether a generation hence, the disintegration of the great cities of America will not have begun. As Spencer points out, evolution is progressive integration resulting in a rigidity that resists change. All that lives and all that life produces thus pass into a senility and thence to a final decadance. The present great city has grown to be a huge organism too vast and rigid to admit readily of the changes needed to meet the new conditions of life. Like the giant tyrannosaurus, because of its very bulk of body, may it not pass into complete extinction?

The Bureau of Standards Investigations of Fineness of Cement.

Because of their too great size a considerable proportion of the particles composing Portland cement are only partially hydrated when mortar and concrete are mixed and placed for engineering construction. Many different studies have demonstrated this fact. It has not been demonstrated where the upper limit of size of completely active cement particles exists. That it is somewhere below the size of the coarser particles which pass a 200-mesh sieve seems, however, reasonably certain and that it is somewhere above the finest flour of cement which passes this finest of test sieves is also quite as certain. Beyond this approximation our knowledge does not extend.

About three years ago the U. S. Bureau of Standards began a study of fineness of cements. Its first work was an investigation of the accuracy and limitations of the 200-mesh sieve as a means of measuring fineness of cement. From this study the necessity of a further investigation to develop a device for conducting closer analyses of fineness was apparent. This second study has reached its end in the development of the air-analyser described in another section of this issue. There remains further perfection of this device to enable definite subdivision of the 0.001 in. grade particles which constitute some 30 per cent of the total cement. With this final grading made possible the physicists of the Bureau are in position to determine: (1) the upper limit in size of cement particle at which complete hydration ceases to be certain; (2) the relative efficiency of grinding of different types of grinding machines; (3) the effect of hardness and other variations of clinker upon fineness of grinding, or the degree of pulverization of different clinkers.

Speculation before the facts are available is not of great value but it is to a high degree entertaining. When that maximum size of cement particle at which hydration is undoubtedly complete is determined what is the practical value of the knowledge? It has none unless more concrete or better concrete can be produced from a unit measure of the fine cement than can be produced from the same measure of 200-mesh sieve cement. If a less amount of the finer cement is required for a yard of concrete something is certainly gained unless the greater cost of the finer grinding more than equals the cost of the volume of coarser cement which is saved.

It is rather a curious quirk of concrete production that thought of securing greater refinement is nearly always directed toward cement. One who watches concrete making and observes the sand, the stone, the water, the proportioning and the mixing must conclude that about the only refinement of materials or methods that exists is confined to the cement. Were all the other materials and processes employed as close an approach to the ideals of perfect concrete production as is the cement, one feels that a material would be brought into being beside which ordinary concrete is rough and crude. To seek how to refine and improve further our cement standards is good, but is it really the most profitable direction in which to direct effort for concrete improvement? Of course it is not and equally of course it is no criticism of the worth of the work of the Bureau of Standards that concrete making is not uniformly precise and perfect in all its materials and processes.

A Summary of Experience with Grouting in Sinking Wet Shafts.

Methods of grouting in sinking a wet rock shaft in the Lake Superior mining district are described in another section of this issue. In the United States there are now recorded perhaps a dozen tunnel and mine shafts in the sinking of which grouting has played always a principal part and sometimes a stellar part in making the work successful. Grouting as a means of shaft sinking is by these records raised to a place of prominence among construction methods. As one experience after another has been recorded a number of generalizations have been made possible and as these have nowhere been summarized it may be of interest to perform the task here with a notably good example of shaft grouting directly before us.

Grouting is the newest of the several means employed for sinking shafts through water bearing materials. Pumping the excess water, excluding the water by freezing the ground and retaining the water by pneumatic pressure are all older processes. So also are the picturesque Kind-Chaudron boring method and the drop shaft processes of which German mine workings exhibit so many notable examples. The grouting process or as it is called in Europe, the cementation process, seems to have been first extensively employed in the Pas-de-Calais coal fields in France. Its use appears to have been developed about 1904; in any event the first record in detail of its use is the published account of the sinking by cementation in 1904-5 of the colliery shaft in the concession of Lens. Following this work the process became common and standardized in the district named. Compared with these French records the United States present only a few examples of the use of grout in shaft sinking but these are important and establish the process as a positive success.

Two broad methods of grouting in shaft sinking can be distinguished. The first is to grout and solidify the ground preceding any excavation; the second is to proceed with excavation by usual methods and only grout the strata immediately ahead as conditions arise which make grouting necessary. The first method implies foreknowledge of water in troublesome volumes and pressures in the strata to be penetrated. In some cases this foreknowledge is ready at hand, but in the great majority of shafts it can be had only by rather expensive prospecting and then with no great certainty of its accuracy. With conditions accurately known economic planning is of course more certain, and a choice can be made between the two general methods by which very likely money and time may be saved. The prosecution of underground excavation is, however, necessarily a task to be performed in uncertainty as tunneling and shaft sinking experience has many times demonstrated and too meticulous regard for what may happen is as unwise as it is to disregard reasonable means for securing useful advance knowledge.

These reasonable means are: (1) Geological study of the ground penetrated, (2) prospecting the shaft bv diamond drill, and (3) preceding excavation with pilot drill holes. With the use of fissure detectors, diamond drill prospecting will tell a surprising amount about subsurface water conditions in unknown rock formations. Of course, where the ground is known none of these precautions are required and the engineer's judgment must always be the guide that determines what should be done and what may safely be left undone. In the following paragraphs are listed the principal guiding lessons taught by recorded examples of American shaft grouting:

(1) In shaft sinking in rock suspected of carrying water, precede the excavation with a pilot drill hole. The pilot hole will usually disclose volume and pressure of water sufficiently well to enable the necessity of grouting to be determined. If grouting proves to be necessary the pilot hole enables excavation to be stopped while sufficient cover of solid rock yet remains to seal the shaft and resist back pressure of grout injection.

(2) Cleanse as thoroughly as practicable all fissures and cavities within the area which it is desired to solidify with grout. Sand and other fine material in fissures and cavities retard or prevent grout penetration and where penetration is possible the mixture of cement and fine material frequently does not set hard and fill the cavity tightly.

(3) Experience in grouting great continuous depths of water-bearing rock indicates that it is more effective to grout in successive stages using short holes than in one stage using long holes the full depth of the wet zone.

(4) Drilling in certain textures of rock or with certain types of drills often closes or stoppers small fissures by crowding into them chips and dust produced by the drilling. Thorough cleansing and sometimes reaming the hole are necessary in such instances if good grout penetration is to be secured.

(5) The nipple set into the drill hole to afford connection with the grout pump requires tight wedging to prevent grout leakage. Where leakage occurs despite precautions in wedging, mixture of some fibrous substance with the grout will often close the leaks.

(6) Provision of ample grouting pressure is essential. Experience shows that pressures only slightly in excess of the hydrostatic pressure of the water are effective only when the fissures are of size and are clean; if tortuous or if they contain sediment, pressures several times as great as the hydrostatic pressure are required. Also fewer holes will often suffice and a more dense grout will result if high pressures are employed.

(7) Experience indicates that long grout conveying pipes from mixer to hole are objectionable; they retard flow and make necessary

the use of thinner mixtures than would otherwise be selected.

(8) Exploration of rock strata in all formations where uncertainty exists regarding volume and pressure of subterranean water is a desirable precaution. Methods employed in exploring dam foundations are applicable in shaft work.

(9) A single grouting is not always sufficient even though at the time the hole ceases to take grout at very high pressure. Holes when let stand for a day or so will often take grout anew in considerable quantities. It is well to put the grouting pressure onto each hole at least twice, the second time after a reasonable interval of rest.

(10) Scrupulous care of grouting apparatus is essential. Piping, mixers, pumps, cocks and nipples require thorough cleansing preceding every period of considerable rest. Grout hardened in pipes, valves, etc., is exceedingly difficult to remove.

(11) Grouting sand to permit dry shaft sinking is represented by only one recorded example in American practice and the experience was practically a failure. The possibility remains, however, that success could be expected were very high pressures employed.

BUILDINGS

Design and Construction Features of the Ocean Steamship Co.'s Terminal at Savannah, Ga.

(Staff Article.)

Construction is well advanced on the comprehensive terminal now being built in Savannah, Ga., by the Ocean Steamship Co. The terminal represents an expenditure of approximately $1,000,000, and it is expected that it will be ready for use by Apr. 1, 1916. The project includes a slip, 225 ft. wide by 1,020 ft. long, having a depth of water at mean low tide of 26 ft.; a reinforced concrete bulkhead extending along the banks of the Savannah River and around three sides of the slip, a total distance of 2,590 ft.; steel freight sheds, surrounding three sides of the slip; an office building; and a system of tracks under the sheds having a total length of about two miles.

The improvement covers an area of about 20 acres, of which the freight sheds and office building occupy about 11⅓ acres. The north bound freight shed covers an area of 249,733 sq. ft., the south bound shed an area of 166,898 sq. ft., and the shed at the head of the slip an area of 30,910 sq. ft. The arrangement and capacity of the 17 tracks within the freight sheds are such that 225 freight cars may be placed alongside the platforms, all loading or unloading at the same time; 100 cars in the north bound shed and 125 cars in the south bound shed. For handling freight from cars to vessels, and vice versa, there are provided five 10-ton hoists, operating on I-beam trolley tracks, two of these hoists being located in the north bound shed and three in the south bound shed.

The city delivery shed, which will be used for handling wagon freight, is a brick and steel building adjoining and connecting with the south bound shed. It has a length of 782 ft., a width of 63 ft., and covers an area of 49,266 sq. ft. The office building is also of brick and steel construction, two stories high, with a length of 175 ft. and a width of 52 ft. The waiting room for passengers is on the second floor of this building, from which galleries, suspended from the roof trusses, lead to the landing stages of steamer berths, and to a mezzanine gallery at the sea end of the sheds.

Figure 1 is a general plan of the terminal showing the arrangement of the various units.

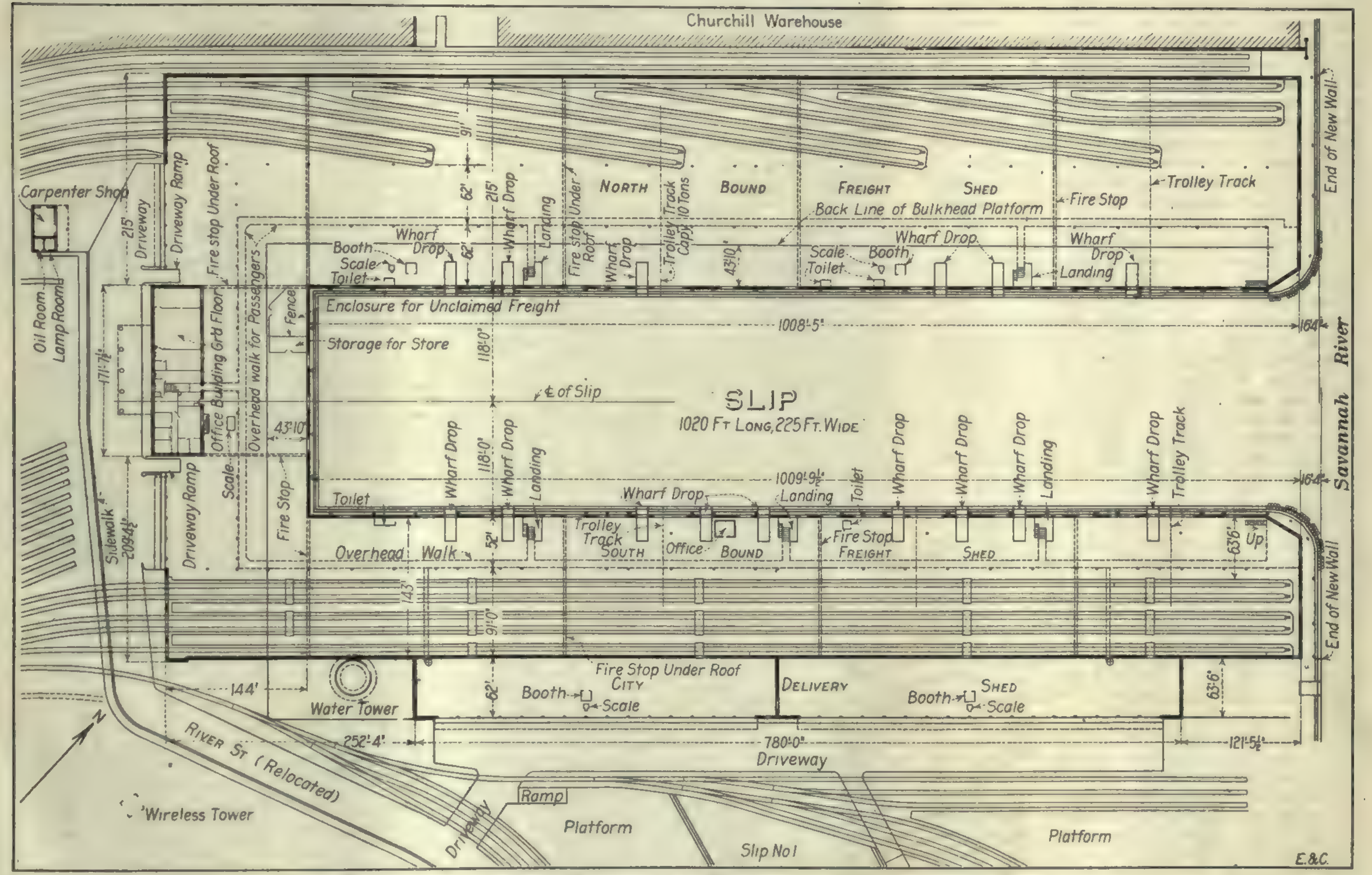


Fig. 1. Plan of Ocean Steamship Co.'s Terminal at Savannah, Ga.

DESIGN FEATURES OF FREIGHT SHEDS.

Substructure.—The substructure of the terminal is of reinforced concrete founded on wood piles. The concrete deck of the freight sheds is 12 ft. 9 ins. above mean low water level, and the timber fender extends 11 ins. above the deck. The range of tide between mean low water and mean high water is 6 ft. 6 ins. Below the deck are the concrete pits and a system of concrete girders resting on the foundation piles. The deck is supported from this system of girders by means of short concrete columns and piers. Between the tracks there are reinforced concrete platforms, the latter being at the same elevation as the deck.

Figure 2(a) is a plan of the deck at the east end of the south bound freight shed. In general, the deck slab has a thickness of 9½ ins., although this thickness is increased to 10½ ins. at the end of the track pits. The size of the panels and the arrangement of the deck beams are shown in the drawing.

Figure 2(b) is a plan of the framing below the deck of that portion of the south bound shed shown in Fig. 2(a). This drawing shows the size and arrangement of the girders and indicates the position of each supporting pile.

Figure 2(c) is a cross section of the substructure near the east end of the south bound freight shed. This drawing shows the construction of the track pits and platforms.

Superstructure.—The framework of the freight sheds consists of steel columns, stee roof trusses and bracing, and channel purlins, supporting a roof consisting of five-ply tar-and-slag roofing on 2x6-in. tongue-and-groove yellow pine sheathing. The sheathing is nailed to 3x4-in. yellow pine nailing pieces, bolted to the purlins with ⅝-in. bolts, spaced 2 ft. on centers.

Fire stops are provided at the locations shown in Fig. 1. These fire stops consist of a 2-in. cement plaster curtain extending from the upper to the lower chord of the roof trusses. This curtain wall is reinforced with No. 26 gage "Self-Sentering," and all truss members in the plane of the curtain wall are wrapped with No. 26 gage expanded metal and plastered with a 1-in. coat of cement plaster.

In the north bound freight shed, which has a width of 215 between centers of outside walls, the two lines of interior columns divide the shed into a center bay of 62 ft. and side bays of 91 ft. and 62 ft. The trusses, which have a depth of 6 ft. back to back of angles, are of the sub-divided Warren type, with knee-braced ends. The trusses in the center bay are raised above those in the side bays to provide two lines of steel sash equipped with ¼-in., factory-ribbed wire glass. The north wall of this shed is 17 ins. thick, without openings. Lighting of the north part of the structure is therefore effected by means of skylights in the roof. The south, or slip, side is covered with No. 22 galvanized corrugated iron, through which are cut the doors which communicate with the platforms of the slip. Under the gutter, extending along this side, there is a line of continuous sash. The structure is braced longitudinally by means of a line of deep latticed girders, in the plane of each interior row of columns. From the continuous ventilator at the middle of the center bay (constructed of No. 22 galvanized iron), the roof has a slope of 1 in. in 12 ins.

The south bound freight shed has a width of 143 ft. This shed is divided into a north bay of 52 ft. and a south bay of 91 ft. by a line of steel columns. The roof trusses are of the sub-divided Warren type, with a depth, back to back of angles, of 6 ft. There is a continuous ventilator, built of No. 22 gage galvanized iron, along the line of the interior row of columns. The roof surface slopes in each direction from this row of columns, at the rate of 1 in. in 12 ins. The construction of the north side of this shed is similar to that in the south side of the north bound shed. The south wall is of brick, 17 ins. thick, with a 13-in. parapet wall. This wall is common to the city delivery shed which adjoins it.

The city delivery shed has a width of 62 ft., the type of construction being similar to that used in the freight sheds. The platform and a portion of the drive along the south side of this shed are protected by a 12-ft. canopy, which is carried on cantilever brackets attached to the columns.

As shown in Fig. 1, the head house, which is located at the west end of the slip, has a width of 144 ft. and consists of two 72-ft. bays. The roof trusses are of the sub-divided Warren type, 6 ft. deep. The roof slopes in each direction from the center row of columns; that in the east bay at the rate of 1 in. in 12 ins., and that in the west bay at the rate of ⅝ in. in 12 ins. At the center line of columns the roof trusses in the east bay are raised above those in the west bay, to provide space for a line of continuous sash. There is also a line of continuous sash under the gutter at both the east and west sides of the head house. The platform along the west side of this structure is protected by a 12-ft. canopy, cantilevered from the columns.

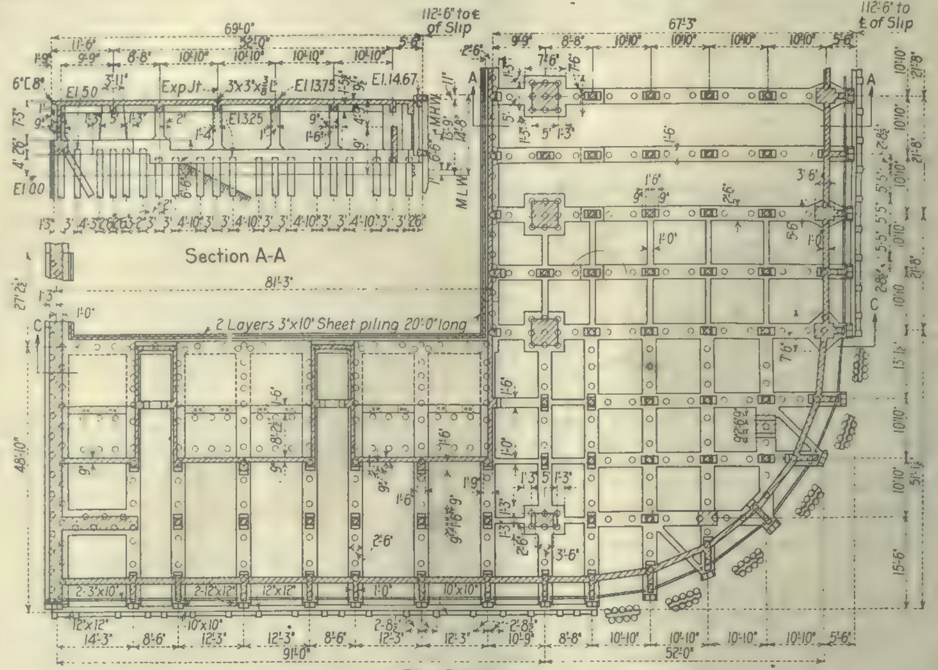
CONSTRUCTION FEATURES.

After the foundation piles were driven, construction tracks were laid, and two concreting units were set up for spouting the concrete to place, the height of the towers being sufficient to enable all parts of the work to be reached from them.

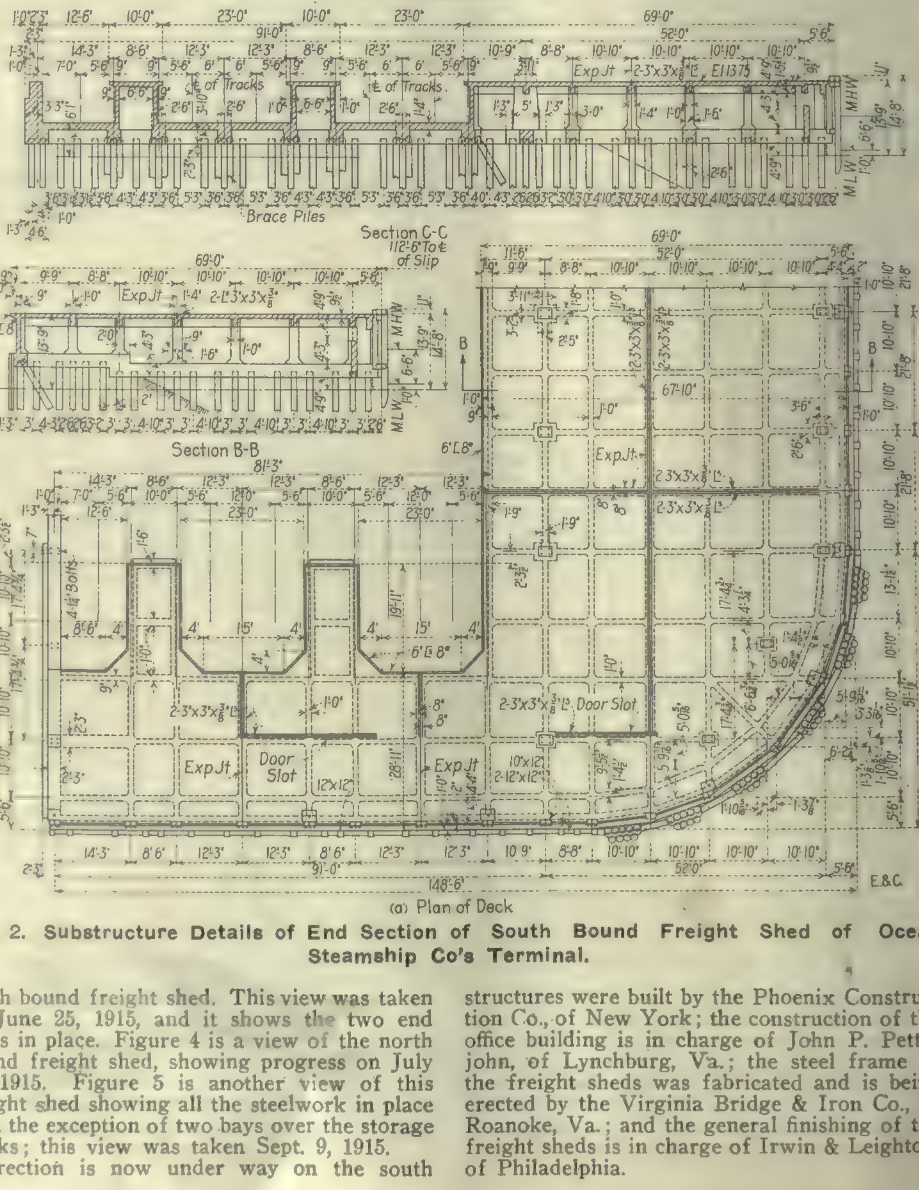
The steel superstructure is being erected as fast as the foundations are cleared. In erecting the steelwork two traveling cranes, operating over construction tracks, are being used. One of these cranes has a capacity of 30 tons and a length of boom of 80 ft. (see Figs. 3 and 4), while the other has a capacity of 20 tons and a length of boom of 50 ft. (see Fig. 5). With the use of these cranes it is possible to rivet the trusses in large sections in the shop, thus reducing the field riveting to a minimum.

Figure 3, p. 345, is a view of a portion of the north bound freight shed. This view was taken on June 25, 1915, and it shows the two end bents in place. Figure 4 is a view of the north bound freight shed, showing progress on July 23, 1915. Figure 5 is another view of this freight shed showing all the steelwork in place with the exception of two bays over the storage tracks; this view was taken Sept. 9, 1915.

Erection is now under way on the south bound freight shed. It is expected that the terminal will be completed by Apr. 1, 1916.



(b) Plan Below Deck



(a) Plan of Deck

Fig. 2. Substructure Details of End Section of South Bound Freight Shed of Ocean Steamship Co's Terminal.

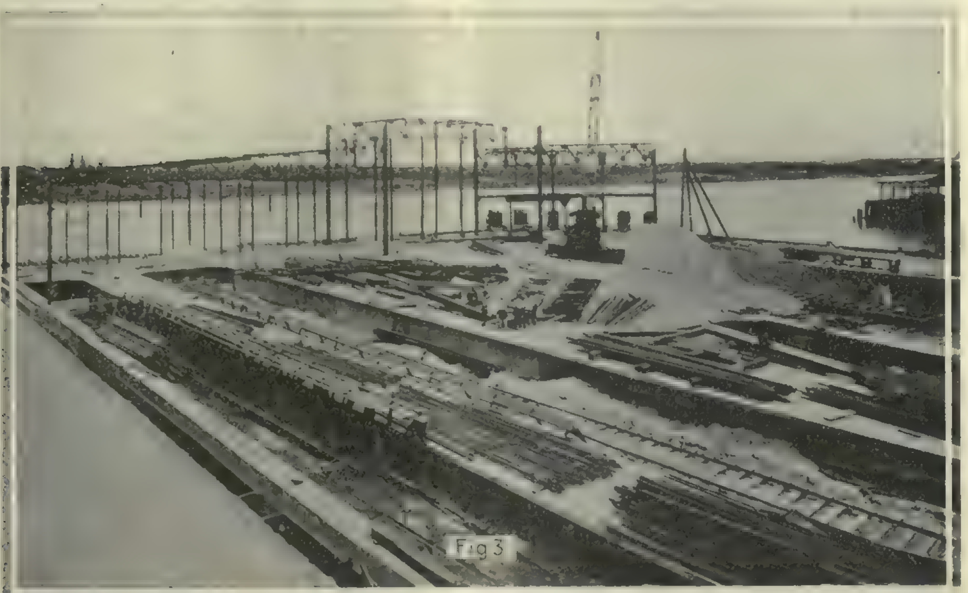
PERSONNEL.

J. G. Basinger, of New York, is designing and supervising engineer for the terminal. The preliminary dredging of the slip to a depth of 16 ft. was done by P. Sanford Ross, Inc., of Jersey City, N. J.; the bulkhead and substructures were built by the Phoenix Construction Co., of New York; the construction of the office building is in charge of John P. Pettyjohn, of Lynchburg, Va.; the steel frame of the freight sheds was fabricated and is being erected by the Virginia Bridge & Iron Co., of Roanoke, Va.; and the general finishing of the freight sheds is in charge of Irwin & Leighton, of Philadelphia.

Use and Care of Manila Rope.

(Staff Abstract.)

Possibly there is no article in the outfit of a railroad construction organization or of a contractor that suffers more neglect and abuse than manila rope. In nine cases out of ten, this condition is due more to a lack of knowledge than to wilful neglect. It is the general impression that the use of manila rope is decreasing and that it is being replaced by wire rope, but this is true only along certain lines and, on the contrary, the field for its use is increasing.



Figs. 3, 4 and 5. Progress Views Illustrating Erection of North Bound Freight Shed of Ocean Steamship Co.'s Terminal. Fig. 3 Taken June 25; Fig. 4, July 23; and Fig. 5, Sept. 9, 1915.

COMPOSITION AND MANUFACTURE.

Fibers from which ropes are made are termed by manufacturers as hard and soft. The hard fibers are of manila, sisal and New Zealand hemp, and the soft fibers are of jute, American hemp and flax. Of the hard fibers, very little New Zealand hemp is used. The best rope for all purposes is made from manila hemp, and very little rope over 1 in. in diameter is made from anything else. Sisal hemp is shorter and coarser than manila, it is not as strong, and will not withstand water or the weather as well. Considerable rope less than 1 in. in diameter is made of sisal hemp. The soft fibers are used mainly for the manufacture of small rope and cord. This article is to be limited to the best and larger ropes, and, therefore, deals entirely with manila rope.

Until rather recently all rope was made by hand, but its manufacture has been revolutionized by the introduction of modern machinery. In a modern plant the bales of fiber are opened and graded as to quality by expert workmen, and are then passed to machines where the fibers are reduced to suitable size for rope making. After this operation the fiber is spun into yarn by twisting it in a right-hand direction. From 30 to 75 yarns, according to the size of the rope, are put together and twisted in the opposite, or left-hand direction, into a strand. Three or four of these strands are then twisted together in a right-hand direction into a rope. In the manufacture of a very large rope or cable, three hawers or three strand ropes are twisted together in a left-hand direction. It will be noted that each operation is in an opposite direction, and because of this, the rope keeps its form. The rope maker has learned by long experience how to make these twists so that the tendency of one part to untwist will cause another part to twist until an equilibrium is attained. If the twist is great the rope will be hard and stiff, and will keep its form well, but it will not be as strong as a rope with less twist. This is explained by the fact that in the latter case the fibers lie more nearly in the line of tension.

CHARACTERISTICS OF ROPE.

A good hemp rope is hard, but pliant, yellowish or greenish gray in color, with a certain silvery or pearly luster. A dark or blackish color indicates that hemp suffered from fermentation in the process of curing, and brown spots show that the rope was spun while the fibers were damp, and is consequently weak and soft in those places. Sometimes a rope is made of inferior hemp on the inside, covered with yarn of good material. This may be detected by dissecting a portion of the rope. Other inferior ropes are made from short fibers, or with strands of unequal lengths or unevenly spun. The rope in the first place appearing woolly, on account of the ends of the fibers projecting; in the latter case the irregularity of manufacture is evident on inspection.

A test for ascertaining the purity of manila hemp rope consists in forming balls of loose fiber for the ropes to be tested and burning them completely to ashes; pure manila burns to a dull grayish-black ash; sisal leaves a whitish-gray ash; a combination of manila and sisal yields a mixed ash resembling the beard of a man turning from black to gray. Manila hemp is frequently adulterated with phormium (New Zealand flax) and Russian hemp, both of which are much inferior in strength.

It is not always true that the highest priced material is the best, and there are no doubt many cases where from lack of knowledge or time for investigation, a better grade of material is purchased and used than is necessary. The price of this material is governed largely by its quality, but the selection of the quality should be governed by its suitability to the work in hand.

MANNER OF DETERIORATION.

Rope in service deteriorates in two ways: The wear on the outer surface, which can readily be seen; and the stretching, bending, crushing and breaking of the inner fibers, which cannot be discovered without a careful examination.

Should these conditions develop more rapidly than the service in which the rope is used seems to warrant, they may be due to the following causes: The first might be caused by chafing, resulting from ropes rubbing against each other or dragging across hard materials, or by running over sheaves having too small grooves. The latter may be due to overload, or to running over sheaves or pulleys of too small diameter.

Ropes do not give out all at once, and therefore need much care and attention. The factors that determine the usefulness of a rope and its length of service or life are: the material of which it is made; the care and skill with which it is manufactured; the manner in which it is used or its application; and the care taken of it while in service and while being stored.

Manila hemp is a vegetable fiber and is susceptible to the action of water and air the same as an unprotected piece of wood. In fact, the hardest wear on a rope is exposure to all kinds of weather. This cannot be avoided in construction work; therefore, when a rope has become wet and muddy, it should be cleaned, dried and stored in a well ventilated place. Wet rope placed in a box or unventilated storeroom is likely to rot or ferment and will become worthless in a very short time. Ropes that must necessarily be constantly exposed to the weather are tarred frequently, but as the tar affects the tensile strength it cannot be used on ropes that are subject to hard use on derricks and cranes. Tarred ropes may be used for guy lines, the rigging of ships or similar work.

It is generally conceded that moisture will not injure a rope in storage, provided the storeroom is well ventilated, and in fact some dealers advocate a damp storeroom. On the other hand, a rope may be seriously injured by becoming too dry, because the fibers become brittle. A rope should not be allowed to freeze after becoming very wet, or if frozen, it should not be used, because the frozen fibers will break and thus make it useless. Neither should rope be piled against radiators or steampipes, for obvious reasons.

CAUSES OF FAILURE.

The failure of ropes is more likely to be due to overloading than to any other cause. Should a rope be submitted to an overload, it may be shown by the twist coming out of it, or by one of the strands slipping out of its proper place. In the handling of heavy loads with a derrick or crane, the load should never be applied suddenly or with a jerk, not only because the stress will be many times that of the weight to be lifted, but it will cause deformations in the rope which start deterioration. Should there be a kink in the rope, the damage may be serious enough to cause failure, and in any event the rope will have lost much of its strength and value. Ropes used on derricks, cranes and pile drivers wear out very rapidly. It is said that a rope 1½ in. in diameter will wear out in handling from 7,000 to 10,000 tons of coal, while a transmission rope of the same size, running 5,000 ft. per min. and carrying 1,000 hp. over sheaves 5 ft. and 17 ft. in diameter, will last for years.

The rapid wear of ropes used on derricks and pile drivers is due to their passing over comparatively small sheaves under load. When passing over a sheave, the rope is subject to bending, which causes the fibers to slide slightly on each other, and, as they are somewhat rough, the friction ultimately causes the fibers to break. Frequently upon opening up ropes of this kind, it is found that some of the inner fibers have been ground to a fine powder. Manufacturers aim to overcome this difficulty by treating the fibers with tallow or graphite, or both, but there seems to be considerable difference of opinion as to the value of such treatment. Tallow-laid rope is not affected as much by weather conditions as rope not so treated. Should it be necessary for a rope to run over two sheaves, bending first in one direction and then in another, the difficulty last described is much exaggerated, and is much like bending a pliable wire first one way and then the other. It will soon break.

SPLICES.

It is frequently necessary to splice the ends of two ropes together in order to make one long rope. Either a short splice or a long splice may be used. If properly made, the short splice will develop the full strength of the rope, but it cannot be used over a sheave because it is considerably thicker than the original rope. The long splice can be used over a sheave, but it cannot be expected to give as good service as an unspliced rope. The short splice is more quickly made.

Manila rope is usually supplied to the storekeeper in coils of 1,200 ft., and shipped out by him in lengths suitable for the work. The shorter pieces left over are used for making slings. After it is worn out, rope is returned to the storekeeper as scrap. The accumulation is disposed of from time to time by selling to scrap dealers at a price approximating $50 per ton.

SLINGS.

Slings made from manila rope for handling and hoisting heavy materials do not always receive the care and attention that they should, largely because of a lack of knowledge of what a sling will stand. Many advocate the use of new rope, and this is without doubt the safe plan. A new rope, however, is too stiff and it is better, where possible, to use parts of a rope that have been limbered up by a day's service. There are others that advocate the use of old rope for this purpose. If this is done, care should be taken to select pieces that have not been overstressed or that have not been working over sheaves. An examination can easily be made by opening up the strands, and if the inner fibers show deterioration, the rope should not be used for slings. Slings are made by splicing the two ends of a rope together, using usually what is known as the short splice.

On construction work and during wet weather slings are subject to severe usage. When muddy they should be thoroughly cleaned, preferably with a hose, before the mud has been allowed to dry. They should then be allowed to dry under shelter, but never in the hot sun.

When slings are sent to the tool car or toolroom for storage, they should be inspected carefully and such as are not fit for continued use should be discarded. Those in good condition should be hung on suitable pegs. Slings are frequently called for in a hurry, and under such conditions there is not always time to make an examination, or it may be overlooked. It is well to be on the safe side, because the failure of a sling may result in serious injury to the workmen and a fall of only a few feet may damage or utterly ruin a piece of machinery.

The method of attaching a sling to a load should always be delegated to a reliable and experienced man. Whether one or more slings are to be used will depend not only on the weight of the load to be lifted, but also on its shape. In placing a sling on a load care should be used to see that the load is evenly distributed on the two sides of the hoisting hook and also that the turns of the sling do not overlap, thereby throwing an excessive stress upon one part of it.

The stresses that are thrown upon slings and ropes vary a great deal with conditions, and they are often influenced to a marked degree by circumstances, which the casual observer might consider trivial and unimportant. In particular, the inclination or obliquity of the sling, in those parts which lie between the supporting hook and the points at which the sling first touches the load, must be carefully considered, as it is a highly important feature in connection with safety.

ACKNOWLEDGMENT.

The foregoing paper was presented by F. E. Weise, chief clerk, engineering department, Chicago, Milwaukee and St. Paul Ry., before the annual meeting of the American Railway Bridge and Building Association, in Detroit, Oct. 19-21, 1915.

Some Data on Prepared Paints for Metal Surfaces.

(Staff Abstract.)

In designing protective coatings for metal the modern practice has been to apply the results available from researches into the cause of corrosion. These results have shown that materials of a basic nature, or substances which contain soluble chromates, prevent the rusting of iron. For this reason pigments of a basic nature or pigments containing the chromate radical have come into wide use in the manufacture of protective paints. That they are the best pigments for this purpose has been proved not only in practice, but also in the Atlantic City tests, which were made on a series of 300 large steel panels, using nearly 100 different pigment paints. Applying the results of these tests to the practical manufacture of protective coatings, the writer will discuss the use of the various pigments under separate headings, taking up the composition of the most widely used colors for metal painting, namely, red, gray, black, and green. Most of the paints outlined herewith are suitable for the painting of structural steel, bridges, steel railroad cars and equipment, ornamental ironwork, poles, posts and for general work on metal surfaces.

RED LEAD PRIMING PAINTS.

It is well understood that one of the most valuable properties of red lead is its ability to set up to a hard, elastic film that shuts out moisture and gases which are apt to cause corrosion. This cementing action is due to the presence of unburnt litharge, a pigment which rapidly reacts upon linseed oil to form a lead linoleate compound. It will readily be seen, therefore, that red lead free from litharge has no cementing action and should not be considered more protective than iron oxide or any other similar neutral pigment. It is thoroughly essential that red lead should be highly basic and should contain a considerable percentage of litharge, if it is to protect iron from corrosion. It is a growing custom to use prepared red lead paints made from finely divided red lead ground to a fluid condition in linseed oil. Such paints remain in excellent condition for a long period of time. They have a high protective value and are well suited for general purposes. They are used extensively for priming steel vessels. The Navy Department has found that inert pigments, such as silica and asbestine, give good results when used in ready mixed red lead paints, their action being to prevent settling of the red lead upon storage.

A specification which may be used by the grinder when purchasing dry red lead for the manufacture of prepared paints is given herewith:

1. The dry pigment to be the best quality, free from all adulterants, and to contain not less than 85 per cent nor more than 90 per cent Pb_3O_4, the remainder being practically pure lead monoxide (PbO).

2. It shall contain not more than 0.1 per cent of metallic lead, nor more than 0.1 per cent of alkali figured as Na_2O.

3. It shall be of such fineness that not more than 0.5 per cent remains after washing with water through a No. 21 silk bolting-cloth sieve.

Note.—If desired, the gram weight of the red lead may be specified. Extremely light, fluffy red lead should run from 10 to 13 grams per cubic inch. Medium red lead will run from 13 to 16 grams per cubic inch. Heavy red lead will run from 17 to 19 grams per cubic inch.

COMPOSITION OF RED LEAD PRIMING PAINTS.

The cost of red lead paints is a subject of vital importance to the large user. Red lead may be produced in different physical states. Ordinarily the grade that has been overburned is extremely heavy, 1 cu. in. weighing from 18 to 20 grams. For the production of a paint from such red lead, according to the formula used by one large consumer, the following quantities would be required:

Red lead, lbs.	26
Linseed oil, gills	26
Petroleum spirits, gills	3
Drier, gills	3

This would produce approximately 1.4 gal. of paint. Each gallon would contain about 20 lbs. of red lead, the actual cost of the red lead itself being in the neighborhood of $1.60. A red lead of a much better protective value, containing from 10 to 12 per cent of free litharge and produced in an extremely fine physical state of comminution, so that 1 cu. in. would not weigh over 12 to 15 grams, would produce a paint of exactly the same body on the following formula:

Red lead, lbs.	20
Raw linseed oil, gills	26
Turpentine, gills	3
Drier, gills	3

This would produce approximately 1.33 gals. of paint, each gallon of which would contain about 15 lbs. of red lead, the actual cost of the dry pigment per gallon being in the neighborhood of $1.20. Red lead of still lighter gram weight could be used, so that a still smaller quantity of pigment would be required per gallon of oil. The durability of such paints should compare favorably with those containing very high percentages of red lead of high gram weight. Pigments of an extremely light nature, such as lampblack, grind in very large quantities of oil, yet their films are more elastic and durable than many paints which are composed of much pigment and little oil.

RED PAINTS.

Iron oxide has always been one of the most widely used pigments for the manufacture of protective coatings. Oxides that are free from acid or soluble substances give the best results. There are many grades, from the brilliant Indian reds, containing 98 per cent, down to the natural mined brown shale oxides, containing from 30 to 60 per cent of ferric oxide, the balance being silica, clay, etc. Venetian reds, consisting of about equal parts of ferric oxide and calcium sulphate, are also quite widely used. It is customary to add to iron oxides from 10 to 20 per cent of zinc chromate, zinc oxide, or red lead, in order to make them rust inhibitive. Such red paints are widely used for application to tin roofs, metal siding and general structural steel. Red paints made from basic lead chromate (American vermilion), the pigment which gave the best results in the Atlantic City tests, would doubtless be the most economical in the long run, but the high cost will probably prevent their use to any great extent. The use of a percentage of basic chromate of lead in iron-oxide paints is to be approved.

GRAY PAINTS.

Mixtures of white lead (basic carbonate or basic sulphate) and zinc oxide, tinted gray with carbon black, are widely used for this purpose and give excellent results in every climate.

A valuable rust inhibitive coating for general priming or finishing work may be prepared from sublimed blue lead. The use of two parts of blue lead and one part of linseed oil containing about 5 per cent of turpentine drier makes a paint of the right consistency. This may be purchased in prepared form. The rust inhibitive value of this pigment is due to the high percentage of lead oxide (litharge). When purchased ground to a paste in 10 parts of oil, there should be added approximately 5 gals. of linseed oil and 1 pt. of drier for use. A specification for blue lead for use in metallic paints is given herewith:

	Minimum.	Maximum.
Lead sulphate	44 per cent	52.0 per cent
Lead oxide	33 per cent	40.0 per cent
Lead sulphide	....	0.5 per cent
Lead sulphite	....	8.5 per cent
Zinc oxide	....	3.0 per cent

BLACK PAINTS.

Black paints are often preferred for the finishing coat on steelwork, carbonaceous paints being unsuited for application direct to the metal on account of their rust-stimulative action. Carbon pigments, such as gas carbon black, oil black, artificial and natural graphite (flake and amorphous) are usually the base pigments used in black paints. Silica and other earth pigments may be combined with the carbon. The slow-drying nature of such paints is lessened by the addition of litharge. The use of boiled linseed oil as a vehicle is advisable.

Magnetic black oxide of iron (precipitated) forms an excellent black protective paint when ground in linseed oil. The slightly basic character of this pigment accounts for its inhibitive value. The natural variety of black magnetic oxide of iron is also suitable for this purpose, but should be tested for freedom from soluble acid impurities before use. Willow charcoal is not made in commercial quantity: its use, therefore, will be restricted. Its inhibitive value depends on the basic nature of the impurities present.

GREEN PAINTS.

Mixtures of zinc chromate and Prussian blue in oil are highly inhibitive and have proved satisfactory in long service tests. Chrome yellow tinted with black oxide of iron to an olive shade is permanent and protective. Chrome green made from lead chromate and Prussian blue is generally used when precipitated upon a barytes base.

PAINTING GALVANIZED IRON.

Roofing, siding, railing, drain pipes, cornice work, etc., constructed of galvanized iron require painting if they are to be kept in a good state of preservation. Paints are apt to peel from galvanized iron on account of the smooth, spangled surface. This condition, however, is obviated by first treating the metal before painting with a solution of copper salts. Such a solution may be prepared by dissolving 4 ozs. of copper acetate, copper chloride or copper sulphate in one gallon of water. By brushing on this solution the galvanized iron is roughened, a thin deposit of copper being plated out over the surface. After an hour or so, the surface may be lightly brushed and then painted with a thoroughly inhibitive oil point. Firmly adhering films are thus produced.

PAINTING TINNED SURFACES.

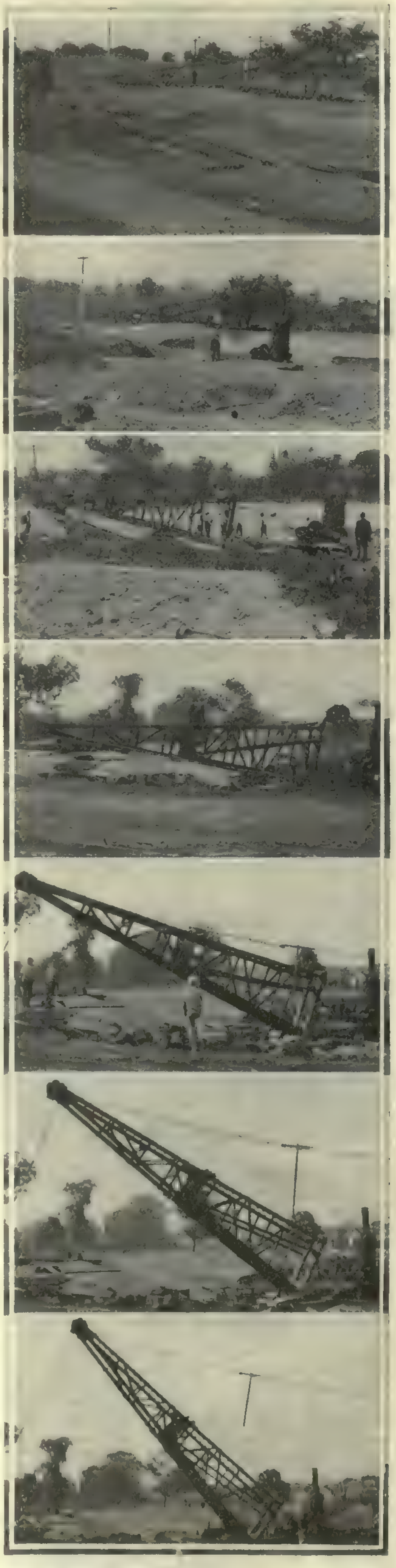
Tin plate, such as is used for roofing and siding, will rapidly corrode unless protected by paint. The pin holes present in the tin coating on the steel base metal act as pockets to catch moisture, which causes rust spots and pit-holes. Before applying paint to the sheets it is advisable to rub the surface of the tin with a cotton rag saturated with benzine or turpentine. This will remove the palm oil that is present on the surface and allow the paint to firmly adhere. Iron oxide paints containing an inhibitive pigment are widely used for preserving tin. The use of 15 to 20 per cent of zinc oxide, red lead or zinc chromate with a neutral bright iron oxide produces an excellent paint. The partial use of boiled linseed oil or kauri gum mixing varnish will add to the gloss and water resistance. Such paints are also suited for use on metal shingles and pressed steel siding—plain black, galvanized or tinned. For dipping purposes, turpentine or high boiling point mineral spirits should be used for thinning. Cheap driers containing a low boiling point benzine should be avoided.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by Henry A. Gardner, assistant director, The Institute of Industrial Research, Inc., Washington, D. C., presented before the recent convention of the Master Car and Locomotive Painters' Association, at Detroit, Mich.

Raising a Heavy 65-Ft. Piledriver.

(Staff Article.)



Views Illustrating Various Operations Connected with the Raising of a Heavy 65-ft. Piledriver of the MacArthur Concrete Pile & Foundation Co.

In the acompanying series of views there is illustrated the complete operation of erecting one of the heavy 65-ft. piledrivers of the MacArthur Concrete Pile & Foundation Co. The work was done in connection with the construction of a large power station for the Mississippi River Power Distributing Co., St. Louis, Mo., the station being founded on concrete piles.

After the site had been excavated the bed frame was assembled in the excavation and the boiler and hoisting engine then mounted on it and bolted in place. It is the practice of this company to move this type of driver on two 16-in. diameter rollers, set about 17 ft. apart and turning in chocks, and this practice was followed here. The running timbers on which the rollers operate are about 40 ft. in length, so that when the bed frame was installed it was placed well toward the back of the timbers and the timbers extended several feet ahead of the front roller. Special care was taken to have the bed frame level in order to minimize the strain on the side guys when the leads were raised.

After this work was completed the leads of the piledriver were pulled into position in front of the bed frame, with their base about 12 ins. below the level of the bed frame. A set of tackle blocks was then reaved up triple and laid along the back ladder, with the upper block located about two-thirds of the way up on the leads and the lower block attached to the running timbers directly under the front drum of the engine. This arrangement gave a leverage equal to the length of the bed frame plus that of several feet of timber projecting ahead of the bed frame. The cable used in this set of tackle was ¾-in., the cable being attached to the back drum of the engine.

"Dead men" were then placed at convenient distances on each side of the leads and directly in line with the front roller. Guys were carried from these "dead men" to the head of the leads, where they ran through tackle blocks and from these down to the front roller.

A strain was then taken on the triple blocks and the leads raised, the latter pivoting around the front of the bed frame. In this case the guys were so well placed, and the bed frame was so nearly level, that it was not found necessary to re-adjust the guys during the raising. A study of the different views will make clear the operations described.

We are indebted to M. W. Wheeler, superintendent in charge of installing the concrete pile foundations, for the data upon which this article is based.

ROADS AND STREETS

Method of Constructing Concrete Road in Freezing Weather.

Contributed by H. Colin Campbell, Chicago, Illinois.

Within recent years experience has proved the possibility of successfully carrying on many classes of concrete construction during cold weather. This has been made possible by the discovery and application of such precautions as heating the sand, gravel or broken stone and water so as to give the concrete mixtures a temperature of from 70° to 80° when placed, then quickly protecting the mass in the forms as soon as deposited so as to prevent the possibility of freezing for at least 48 hours.

Carrying on concrete highway or street construction during the fall months when low temperatures prevail is, however, quite a different proposition, and one which generally should be avoided. Nevertheless, during the fall months very mild days alternate with cold nights perhaps accompanied by frost or a freeze, and it sometimes seems necessary or desirable to continue working on a pavement job to finish a short stretch to fulfill a contract. Under such condition it is possible to place concrete providing certain precautions are rigidly observed.

During the summer months prevailing temperatures generally average about 65°, and for the proper hardening of the concrete pavement a protective layer of moist earth on the concrete, kept moist by frequent sprinkling, is recommended as a moisture-retaining covering to assist hardening under favorable conditions. Such protection prevents rapid evaporation from the concrete and is in large part a guarantee that work will have a successful outcome—mixtures and methods of placing having been what they should be.

During the fall damp or rainy and cool weather is common. Under such conditions the concrete looses less moisture by evaporation than when days are warm and clear. Then the protective earth covering may frequently be omitted, although sprinkling during the day may be advisable. However, the cool nights require that certain precautions be exercised to prevent the damage that is almost certain to occur from freezing if this should take place before the concrete has had sufficient time to harden. Sprinkling during the day when temperatures reach a summer mean, should be frequent enough to keep the surface moist. The color of the concrete surface will disclose to the experienced eye whether the concrete is drying out too rapidly.

If a frost or freezing weather may be expected, which can be anticipated quite accurately by obtaining Government weather forecasts, then no sprinkling should be given to the pavement during the day. When possibility of frost or freezing seems imminent, a protective housing or covering of canvas should be laid over the concrete. The contractor should provide himself with sufficient canvas to cover one day's work at least. Building paper tacked on slat frames a few inches above the pavement surface can be used, but in case of wind or storm such covering is likely to be torn loose and leave the pavement unprotected, to say nothing of resulting in a loss of the covering material thus preventing its further use. Therefore, a supply of canvas will be found by far more economical.

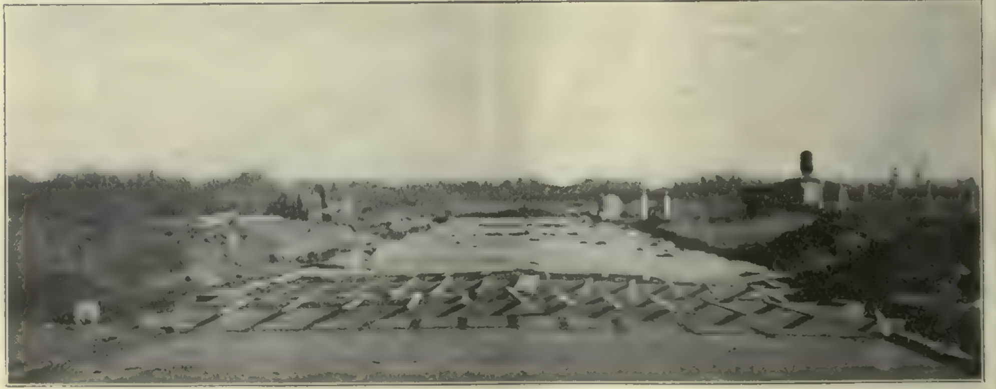
During the day the canvas covering should be removed as soon as the temperature has gone above the freezing point, and if it should rise to summer mean, then a sprinkling may be given the concrete, as already described. If on the second night it becomes necessary to cover the concrete again to protect it from freezing, a 3-in. layer of straw or similar covering may be applied. A little earth may be thrown on top of the straw to prevent it from being blown away.

Most specifications provide that if prevailing temperatures are likely to be 35° F. or below, mixing water and aggregates must be heated and necessary precautions taken by placing protective covering, to prevent freezing for at least 10 days. This provision in specifications aims to direct the method of carrying on work when the temperature falls to 45° or does not rise above 50°, and when freezing may be expected each night or may continue for several days. It is quite necessary to secure an interpretation of the specifications that will make possible the enforcement of all measures to protect the concrete from injury.

Concrete pavement construction should not be advocated during the fall when temperatures are variable, and under no cases when the prevailing temperature is around 35°, with the exception that if materials are heated it would be permissible to lay a short strip or section to complete a certain contract. Another objection to continue concrete paving under the conditions described, is the uncertain and variable increase in cost involved to thoroughly safeguard the work. Yet the possible increase in cost, especially where only a small section of a contract remains to be completed, would be less than the loss that would be suffered if, through neglect of proper precautions, the contractor could not collect the work done or had to tear out and replace imperfect work.

Freezing of freshly placed concrete will eventually cause a surface scaling that will render the work unsightly even though doing no greater damage; but there is always the possibility that strength also will be impaired. No attempt should be made to control the freezing point of the concrete by introducing salt or chloride of lime into the mixing water. This does not accomplish the desired end, which is to hasten hardening under favorable conditions rather than to lower the freezing point of the concrete. In no case should concrete be deposited upon a subgrade containing any frost.

Sometimes where there is a boiler plant on the job, it is possible to obtain a supply, steam may be turned in between the pavement surface and canvas covering thus maintaining warmth and moisture, consequently contributing to the progress of hardening. With a watchman on the job, such protection can be kept constant during the night.



Concrete Road Covered with Canvas on Framework to Prevent Freezing.

Finally, it should be remembered that concrete gains strength more slowly during protracted spells of low temperatures than under summer conditions. Concrete pavements must be closed to traffic for a longer period of time when the concrete has been deposited during cool days than is necessary during favorable weather conditions. Sometimes, however, there is considerable pressure brought to bear to have a road thrown open to traffic, especially in the case of a much traveled highway or main thoroughfare which when out of commission causes considerable inconvenience. It may be possible, after having kept traffic from the road for 30 days, to cover the concrete with 3 or 4 ins. of straw or similar cushioning material, then apply a layer of several inches of soil so the abrasion and shocks of traffic will not be communicated to the pavement. This treatment, however, cannot be counted upon to eliminate the possibility of injury likely to result from dense traffic, and from heavy loads. Under such conditions there is considerable liability that the pavement will crack, because not having developed its full strength. Opening concrete roads to traffic too soon has been identified as the cause of occasional failure, and during the unfavorable conditions of fall concrete cannot be expected to gather strength very rapidly; hence all desirable precautions should be selected and exercised to the utmost.

Cost Keeping System Oregon State Highway Commission.

Contributed by Ernest F. Ayres, Corvallis, Oregon.

The old style force account had just one recommendation. It gave the head office the impression of knowing something about the cost of the work. That this impression was erroneous was proved by the great discrepancy between the preliminary estimate and the final cost of the next contract.

The force account sheets all had printed headings, designed to fit that non-existent piece of work, the average job. Then the field engineer cheerfully lumped his costs under the heading that seemed nearest correct, and the home office accepted the figures as an exact classification. Spaces devoted to such items as Labor, Teams, etc., were far too few to cover the different wages paid, so the engineer tried to "strike an average." Having found his average, he stuck by it whatever happened. Higher or lower priced labor might come and go, but the average wage stayed on forever, or at least as long as that particular job lasted.

Keeping force account was a duty to be shoved off on the youngest and greenest member of the party. He usually started well, but soon found that no one attached any importance to his figures. After seeing his chief average the wages which he had so laboriously secured, he decided that he could do a little averaging himself. He forgot to take the account one day and discovered how easy it was to "fudge in" by averaging the day before and the next day. In a short time he was taking force account once a week and making up the rest of the days in his spare time, out back of the office. Or, worse yet, he depended on a friendly foreman or timekeeper for his figures, and the way they padded that poor force account was almost a deadly sin.

Sheet No. 1.. TIME BOOK, *October*, 1915 (Month)

Section 2. **Time and rate of pay correct.**

...*Grading*... (Feature) (Signed) *T. H. Noyes* (Engineer)

Carried to next sheet per 8 hr day

No.	NAME Occupation	Account No.	1	2	3 S	4	5	6	7	8	9	10 S	11	12	13	14	15	16	17 S	18	19	20	21	22	23	24 S	25	26	27	28	29	30	31 S	Total to	Total time	Rate bro't from pr'vi'us sheet	Amount earned	Total earned	Meal tickets	Orders on store	Rent and hospital	Total deductions	Amount due
	Smith, B. D.....	*1165*	*3*	*1*	..	*2*	*1*	*4*	*2*	*3*	*2*	..	*3*	*1*	*1*	*2*	*3*	*1*	..	*3*	*2*	*1*	*2*	*1*	*2*	..	*1*	*1*	*2*	*1*	*1*	*2*	..	......	*48*	*$6.00*	*$36.00*						
	Superintendent																																					*$36.00*	......	......	......	......	*$36.00*
	Jones, F. L.....	*1165*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	......	*208*	*4.00*	*104.00*						
	Foreman																																					*104.00*	......	......	......	......	*104.00*
	Allen, Geo......	*1166*	*2*	*3*	..	*3*	*3*	*1*	*2*	*2*	*2*	..	*2*	*2*	*4*	*1*	*2*	*3*	..	*2*	*4*	*1*	*1*	*2*	*2*	..	*2*	*2*	*2*	*2*	*2*	*2*	..	......	*56*	*2.50*	*17.50*						
	Laborer	*1168*	*6*	*5*	..	*5*	*5*	*7*	*6*	*6*	*6*	..	*6*	*6*	*4*	*7*	*6*	*5*	..	*6*	*4*	*7*	*7*	*6*	*6*	..	*6*	*6*	*6*	*6*	*6*	*6*	..	......	*152*		*47.50*	*65.00*	......	......	......	......	*65.00*
	White, Sam.....	*1168*	*8*	.	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	......	*200*	*2.25*	*56.25*						
	Laborer	*1183*	..	*8*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	*8*		*2.25*	*58.50*	......	......	......	......	*58.50*
	Tracy, Ed......	*1168*	*8*	.	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	*8*	*8*	*8*	..	*8*	*8*	*8*	..	..	..	..	......	*176*	*2.50*	*55.00*						
	Laborer	*1183*	..	*8*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......	*8*		*2.50*						
		1187	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*8*	*8*	*8*	..	......	*24*		*7.50*	*65.00*	......	......	......	......	*65.00*
	French Bros....	*1166*	*2*	*3*	..	*3*	*3*	*1*	*2*	*2*	*2*	..	*2*	*2*	*4*	*1*	*2*	*3*	..	*2*	*4*	*1*	*1*	*2*	*2*	..	*2*	*2*	*2*	*2*	*2*	*2*	..	......	*56*	*4.50*	*31.50*						
	Team & driver	*1168*	*6*	*5*	..	*5*	*5*	*7*	*6*	*6*	*6*	..	*6*	*6*	*4*	*7*	*6*	*5*	..	*6*	*4*	*7*	*7*	*6*	*6*	..	*6*	*6*	*6*	*6*	*6*	*6*	..	......	*152*		*85.50*						
		1187	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*8*	*8*	*8*	..	......	*24*		*13.50*	*130.50*	......	......	......	......	*130.50*
	Wilson & Co ...	*1198*	*1*	*1*	..	..	*1*	*1*	*1*	*1*	*1*	..	*1*	*1*	*1*	*1*	*1*	*1*	..	*1*	*1*	..	*1*	*1*	*1*	..	*1*	*1*	*1*	*1*	*1*	*1*	..	......	*24*	*10 00*	*30.00*	*30.00*	......	......	......	......	*30.00*
	Rent of roller																																								*Sheet total*		*$489.00*

Time Book Sheets, Oregon State Highway Commission.

The Oregon State Highway Commission has recently installed a cost keeping system that gets results. Even the third assistant rear chainman will give respectful consideration to this method, and the chief of party is obliged to sit up and take notice of the figures. Indeed, he is willing to pay attention, for here is a system that gives him information he wants for his own use and which he had always intended to get when he had time.

Under the new plan, each individual from superintendent to water boy is given a separate space, and the number of hours he puts in on each part of the work is segregated. And best of all, his wages are entered exactly as they are, instead of being averaged with every other man of the same general classification.

Under the old force account, the entire contract was handled as a unit. With the Oregon system the road is divided into sections, each division being treated as a separate contract for cost keeping purposes. If the classification of materials is about the same from one end of the job to the other, the entire contract may be handled as one section. Where there is any decided change, the work is divided, the sections varying from a few hundred feet to several miles in length. Station numbers must run consecutively for each section. For instance, if the excavation is heavy clay from Sta. 0 to Sta. 50, hard rock from Sta. 50 to Sta. 55, and heavy clay from Sta. 55 to the end of the contract, the road would be divided into three sections instead of only two as the classification would indicate.

The system is applicable from the time of the preliminary survey to the close of the contract, and with all expenses filed together there is little danger, and no excuse, for overrunning the appropriation. The following are the general headings which have been worked out, with numbers assigned: General; Preliminary Survey; Right of Way; Construction Subgrade; Macadamizing; Hard Surfacing; Bridges and Culverts, and Gravel Screening and Rock Crushing Plants.

Each item is given a number for use on the time sheets, a different number being assigned for the same item on different sections of the contract. The following Table I shows the system of assigning numbers for Grading and for Macadam. The numbers left blank are to be used for items not covered in the first assignment, but only after approval from the main office.

TABLE I.

PACIFIC HIGHWAY, Marion Co., Section No. 2.
Sta. 99+54 to Sta. 276+85.
Length, 3.36 miles.
Width of roadbed, 24 feet.
Right-of-way, 60 feet.
Oregon State Highway Dept.

CONSTRUCTION SUBGRADE.

1161	Salaries, engineering.
1162	Salaries, drafting.
1163	Salaries, clerical and timekeeping.
1164	Salaries, miscellaneous.
1165	Labor, superintendence.
1166	Labor, plowing.
1167	Labor, excavation.
1168	Labor, earth excavation.
1169	Labor, hard rock excavation.
1170	Labor, loose rock excavation.
1171	Labor, soft rock excavation.
1172	Labor, shell rock excavation.
1173	Labor, overhaul.
1174	Labor, repairs to equipment.
1175	Labor, blacksmith.
1176	Labor, ditching and drainage.
1177	Labor, soaking.
1178	Labor, rolling.
1179	Labor, disposing of slides.
1180	Labor, rip-rapping.
1181	Labor, freighting materials.
1182	Labor, handling materials.
1183	Labor, carpenter work.
1184	Labor, cribbing.
1185	Labor, falsework.
1186	Labor, finishing.
1187	L., M. and S., road grader work, including plowing, laborers and teams.
1188	L., M. and S., grade crossings.
1189 to 1198	Blank numbers.
1199	M. and S., explosives.
1200	M. and S., ditching and drainage.
1201	M. and S., soaking.
1202	M. and S., rolling.
1203	M. and S., disposing of slides.
1204	M. and S., lumber.
1205	M. and S., cement.
1206	M. and S., repairs to equipment.
1207	M. and S., blacksmithing.
1208	M. and S., fuel.
1209	M. and S., falsework.
1210	M. and S., finishing.
1211 to 1221	Blank numbers.
1222	Telephone and telegraph.
1223	Contractor's earnings.
1224	Rental of equipment.
1225	Travel and livery.
1226	Freight and express.
1227	Legal expense.
1228	Advertising.
1229	
1230	
1231	
1232	
1233	General charges pro-rata.
1234	Administrative charges pro-rata.
1235	Depreciation on equipment.

PACIFIC HIGHWAY, Marion Co., Section No. 2.
Sta. 99+54 to Sta. 276+85.
Length, 3.36 miles.
Width of roadbed, 24 ft.
Width of surfacing, 12 ft.
Oregon State Highway Dept.

MACADAM SURFACING.

1301	Salaries, engineering.
1302	Salaries, drafting.
1303	Salaries, clerical and timekeeping.
1304	Salaries, miscellaneous.
1305	Labor, loading wagon.
1306	Labor, hauling.
1307	Labor, unloading.
1308	Labor, spreading rock.
1309	Labor, spreading binder.
1310	Labor, sprinkling.
1311	Labor, repairs to equipment.
1312	Labor, rolling and wetting.
1313	
1314	
1315	
1316	
1317	
1318	
1319	M. and S., crushed rock and gravel.
1320	M. and S., blacksmithing.
1321	M. and S., fuel.
1322	M. and S., oil, etc.
1323	M. and S., repairs to equipment.
1324	M. and S., binder material.
1325	
1326	
1327	
1328	
1329	
1330	
1331	
1332	
1333	
1334	
1335	
1336	Rental of equipment.
1337	Travel.
1338	Advertising.
1339	Freight, express and handling.
1340	Telephone and telegraph.
1341	Postage.
1342	Contractor's earnings.
1343	General charges pro-rata.
1344	Administrative charges pro-rata.
1345	Depreciation of equipment.

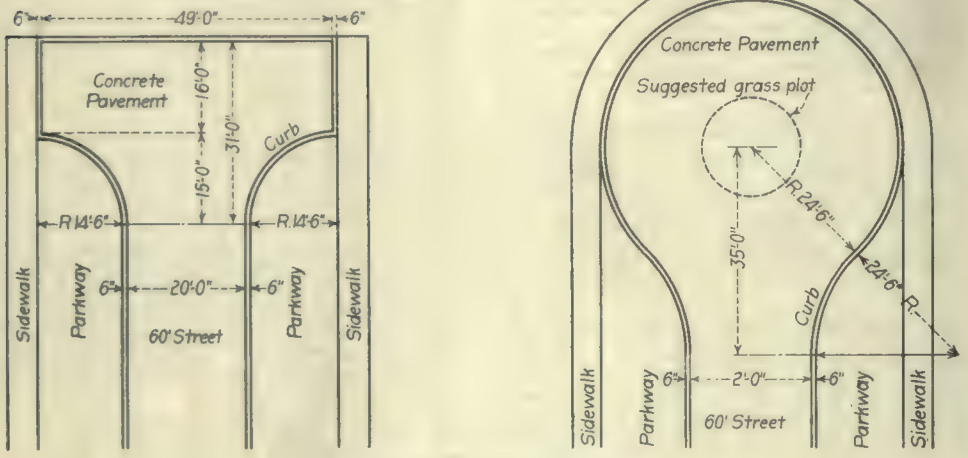
It will be noted that the items under Salaries and the last ten items on the number sheets are included on all subdivisions. The method in which the work is carried out in the field is shown in Fig. 1. The items of Meal Tickets, Orders on Store and Rent and Hospital only apply on survey or force account work. As far as the contractor's pay roll is concerned, the only interest of the engineer is in the total expense. Other sheets are used to show expense for material and supplies.

While this system looks complicated compared to the old force sheets, yet it is only a short time before the more important numbers are memorized and the time necessary to keep the account is much less than would be imagined. With these force sheets, the head office can follow the progress of the work and secure accurate data on which to base future estimates. And the contractor is as much interested in the figures shown as the engineer, as it shows him where he is making a profit, and where he is losing money.

Proposed Designs for Stub-End Streets.

Contributed by H. Colin Campbell, Chicago, Illinois.

In narrow streets particularly it is not always easy to turn an automobile or motor truck, and this is particularly true at a street with stub-end. The accompanying designs suggest layouts that not only improve the surroundings of a stub-end street but will facilitate the turning of most cars without backing, and where necessary to back will provide sufficient room to easily manipulate motor trucks or automobiles of the longest wheel base. Construction is inexpensive, and in the case of the design suggested for residence streets, can be modified by substituting a fountain or flower bed for the suggested grass plot, thus introducing a very pleasing landscape scheme into the general effect.



Designs for Stub-End Streets.

Notes on Methods and Costs of Grouting Granite Block Pavement.

(Staff Article.)

The value of grout joint filler for granite block pavement has been much discussed with great difference of opinion. Grout filling is extensively employed and this discussion considers only that fact in presenting methods and costs of grouting. As no general and much less no standard practice has been determined, information is best given by citing individual examples. These do not cover all places in which grouted granite block paving is employed but they fairly represent grouting practice.

Lawrence, Mass.—The method of grouting is as follows: After the blocks, 3½ to 4 ins. wide, 7 to 8 ins. deep and 11 to 13 ins. long are set, they are stiffened in place by ramming with a small amount of pea gravel, perhaps an inch in depth, in the joints. The grout is a 1 cement and 1 sand mixture and is mixed in iron boxes designed and patented by Mr. Paul Hannagan, Director of Engineering. When thoroughly mixed, the grout is discharged onto the pavement and then broomed grout is removed from the tops of the blocks. In a test made in 1912, it was found that 0.108 bbl. of cement was used per square yard of pavement. The cement cost $1.08 per barrel; pea gravel cost about $2.30 per cubic yard and sand cost $1.00 per cubic yard. With wages at $2.25 per day, the labor cost of grouting was 6.4 cts. per square yard of pavement; the total cost per square yard was 26¾ cts. Data reported by City Engineer Arthur D. Marble.

Lowell, Mass.—This city has about 8½ miles of grouted granite block pavement on concrete base. The average cost of grouting joints is 24¼ cts. per square yard. The amount of material per square yard of 4½ ins. deep blocks is 0.295 bags sand and the same volume of cement. The essentials for securing good grouted granite block pavement are stated as follows:

(1) Have sub-grade well rolled and all soft places eliminated; 6 ins of crushed stone spread over the sub-grade and rolled to a true crown; mixture for foundation, 4 parts sand and 1 part cement.

(2) Sand to a uniform thickness of 2 ins. should be spread over the foundation.
into the joints until they are completely filled; after the joints are filled all surplus

(3) The blocks, after careful culling, should be well rammed and at the same time pea stone should be broomed into the joints.

(4) For the grouting, be sure the cement is good and the sand clean and sharp. A small percentage of clay is good to use as a binder.

(5) Be careful to use the correct proportions of sand and cement. Use 1 part cement and 1 part sand for mixture.

(6) If a mixing machine is not used, keep the mixture constantly agitated in the box. Remove the grout from the box with scoop shovels. Never dump the contents of the box upon the street. Whenever this is done there will be a bare spot in the grouting.

(7) Wet blocks thoroughly before applying grout.

(8) As the grout is poured upon the blocks throw in pea stone and broom it into the grout, bringing the whole to an even smooth surface.

(9) Never do any grouting during cold or frosty weather. Good results can seldom be obtained after Nov. 15 in New England.

(10) If the grouting is done during very hot weather, precautions should be taken to keep grout moist. This can be done if the weather is extremely hot by covering it immediately with ½ in. of sand and frequently sprinkling with water.

(11) Do not allow any traffic upon pavement for at least seven days after grouting.

(12) For best results use a medium soft granite, similar to New Hampshire granite.

(13) If old blocks are used, see that they are thoroughly cleaned before grout is poured; this mixture being one part cement and two parts sand to give best results with old blocks.

Data reported by Stephen Kearney, City Engineer.

Worcester, Mass.—Grouted pavement in this city requires per square yard about 0.36 cu. ft. of cement and 0.36 cu. ft. of sand mixed with enough water to run freely. The mixture is spread with pails or spout and is broomed into place, the brooming being continued until the joints are filled and the surplus is largely removed from the tops of the blocks; trap rock screenings are finally employed to prevent tendency of the grout to run. Grouting costs about 24 cts. per square yard of pavement, including materials and labor. Data reported by F. A. McClure, City Engineer.

Albany, N. Y.—The following information is reported for grouting dressed granite block of the following size, length 6 to 10 ins., width 3½ to 4½ ins., depth 4¾ to 5¼ ins., end and side joints not exceeding ½ in. in width. The grout or filler is one part of fine, clean, sharp sand and one part cement, no pea stone being used in the joints. Preparatory to grouting, the entire gang is first put to filling bags with sand, and placing same alternately with bags of cement along the curb adjacent to the space to be grouted. This is usually done half to three-quarters of an hour before starting the machine. This gives a good start. Three men are left filling bags and distributing same, and one on cement. The gang on the machine, which is a Marsh-Capron grouting mixer, consists of:

2 men carrying cement and sand to machine.
1 man carrying water.
1 man emptying material into machine.
1 man ahead of spout brooming in grout.
1 man operating.
3 men on sand bags.
1 man on cement.
—
10 laborers—total for operation.

A gang of this size will grout at least 1,100 sq. yds. per day, at the following cost:

10 laborers 8 hrs. each—80 hrs. at 20 cts. per hr.	$ 16.00
1 foreman	4.00
107 bbls. cement at $1.10 per bbl.	117.70
16 cu. yds. sand at $1 per cu. yd	16.00
	$153.70

Including material and labor, this is a cost per square yard of 13.9 cts. or 14 cts. The cost of labor per square yard with machine for a total of over 2,000 sq. yds. has been on an average of $0.015 compared to $0.0525 by hand or a saving of over 3¾ cts. per square yard. For full 4-in. joints without peastone it requires 0.4 bag cement and same amount sand (1 to 1 mix.) per square yard of pavement. Data reported by Frank R. Lanagan, City Engineer.

Philadelphia, Pa.—The following information covers the main features of practice in grouting granite block by the Bureau of Highways and Street Cleaning of Philadelphia, Pa.

Blocks of uniform width and depth must be selected for each course. Each block must be laid upon a full bed of sand and "struck" in at the base so as to bring the stone in close contact with the next block in the preceding course. This is done with a view of making the joints as close as possible. The joints, particularly along the line of traffic, must be close, and the alignment of the courses should be true. Immediately after the blocks are laid, sufficient gravel shall be spread over the surface and swept into the joints to fill the space between the blocks to a depth of about 2 ins. from the bottom.

The ramming of the surface is likely to be slighted unless carefully watched. The important thing is to have each block equally and sufficiently rammed to bring it to a solid bearing on the sand, as well as to bring its top to the proper grade. The blocks should be rammed to settle and compact thoroughly the layer of gravel in the joints, and so as to leave no blocks above or below the general surface of the finished pavement. The rammers will be disposed to touch lightly blocks or areas which, if thoroughly rammed, would be driven below the true surface of the pavement, and subsequent travel may force these down, making depressions in the surface. This item of the work must be given special attention. There must be one rammer to every two pavers.

After the blocks have been brought to a uniform surface, a grout filler composed of 1 part of Portland cement and 1½ parts of clean, sharp sand shall be mixed with water in the following manner: A sand well graded and with the coarser particles predominating is desirable. The mortar is mixed in batches consisting of 1 bag of cement and 1½ bags of sand, which are first thoroughly mixed dry. The box in which this mixing is done should be 4 ft. 8 ins. in length, 30 ins. in width and 14 ins. in depth, resting on legs of different lengths so that the mixture will flow to the lower corner of the box, the bottom of which should be 3 ins. above the pavement surface. One of these boxes should be used for each 14 ft. of width of the pavement and at least two boxes must always be used. After the cement and sand have been thoroughly mixed until the mass assumes a uniform color, clean fresh water is added in a quantity to give a consistency just sufficiently wet to flow readily into the joints. From the time the water is added to the mixture until the last of the grout is removed and floated into the joints, the mixture must be kept in constant motion and before any grout is applied, the blocks must be thoroughly wetted on the surface by spraying or sprinkling. The grout is removed from the box with scoop shovels and applied to the blocks in front of sweepers who rapidly sweep it lengthwise into the unfilled joints until the joints are filled to within not more than ½-in. of the top of the block. After the grout has settled into the joints and before the initial set develops, which period usually amounts to about a half hour, the remainder of each joint shall be filled with a grout slightly thicker than the first grout, and if necessary the process is repeated a third time until the joints remain full to the top. After the second application has had time to settle but before the initial set takes place, the pavement should be finished to a smooth surface with a wooden scraper or squeegee having a rubber edge, which shall be worked over the blocks at an angle. The ideal condition is to have the surface of the grout exactly flush with the top of the pavement, but it is better to have a little excess of grout on the surface than any deficiency of grout in the joint. After the initial set has developed in the final application of grout, the pavement shall be covered with a ½-in. layer of sand which is to be sprinkled three times each day on which the air temperature is 75° or over. More frequent sprinkling should be required on the first day, so that during the first 24 hours, the grout is kept continually moist. Traffic should not be permitted on the pavement for seven days after the grouting or longer if weather or other conditions retard the hardening of the grout. Should the bond between the blocks become broken, the joints shall be cleaned out, even if it is necessary to take up and relay the blocks. The part so taken up and relaid shall be regrouted and protected until hardened. Barricades and watchmen should be provided for its proper protection during this period. Where the grades are sufficiently steep it is sometimes the practice to sweep the grout from the joints so that they have a depth of about ½ in.

On a recent granite block job where smooth dressed granite blocks were used of a size conforming to the size required by specifications, viz.: not less than 8 nor more than 12 ins. in length, and not less than 3½ nor more than 4½ ins. in depth, it was found that a bag of cement covered about 5 sq. yds. for the first coating and about 14 sq. yds. for the second coating. The cost of grouting per square yard, including the contractor's profit, using blocks conforming to the following dimensions —not less than 8 nor more than 12 ins. in length, and not less than 3½ nor more than 4½ ins. in width, and not less than 5 nor more than 5½ ins. in depth—is from 17 to 20 cts. per square yard.

Experience Repairing Sheet Asphalt With Home-Made Plant, Norfolk, Va.

(Staff Abstract.)

The City of Norfolk, Va., has 80 miles of paved streets, 43.7 miles of which are of sheet asphalt, or bitulithic construction, totaling 668,320 square yards. The streets of the city are on an average elevated 8 to 10 ft. above mean sea level. Drainage and sub-soil conditions are unfavorable, occasioning unusual maintenance outlays.

An analysis and subdivision of the streets into classes, according to various specifications, reveals the following relative durability and percentage of repairs. The age of the streets in the various classes being about the same and traffic conditions not dissimilar:

Class 1—Asphalt on concrete base; streets without car tracks; yardage, 189,200. Total repairs to date, 2.6 per cent.

Class 2—Asphalt on concrete base; streets with car tracks; yardage, 147,000. Total repairs to date, 29 per cent.

Class 3—Asphalt laid on old cobble stone base; streets without car tracks; yardage, 14,236. Total repairs to date, 39 per cent.

Class 4—Sheet asphalt laid without binder, on concrete base; streets without car tracks; yardage, 21,044. Total repairs to date, 25 per cent.

The question of repairs and of satisfactory equipment for making repairs became one of considerable moment and importance to the city of Norfolk, within a very short time following the expiration of the guarantee period of the first large construction contract. Briefly stated, the methods pursued, which have resulted in the present system, departing from the ordinary only in that we have used extensively for small repair work, "old surface mixture," vast quantities of which I have seen discarded and used for filling, have been as follows:

In 1908 the Barber Asphalt Paving Co. having completed a contract in Norfolk involving both new work and extensive repairs, just before dismantling the plant, furnished the city 266 tons of sheet asphalt surface mixture. This was stored in layers separated by boards and cut in cubes before cooling. With painstaking care and unlimited patience, the Department of Public Works of Norfolk made its first asphalt repairs by reheating the previously prepared mixture in a "fire wagon" built for the purpose. However, for very limited work only would I advocate or advise such a procedure.

With the above exception from 1906 to 1912 repairs in Norfolk were made by contract, the price varying from $2.00 to $1.40 per square yard exclusive of base. Our repairs at the present time average about 1,000 sq. yds. per month, to be exact, 23,500 sq. yds. the past 25 months, and are made by city pavers working usually one week each month, the material being manufactured by the city's own plant. This rate maintained annually amounts to 3¼ per cent of the yardage of all pavements in the city five years old and over.

Independence of the paving contractor for repairs, established by constructing a very small plant, has enabled us to keep Norfolk's streets in far more satisfactory condition and to reduce the cost of such work from the previous low price of $1.40 per square yard—average of $1.75 per square yard to 60 cts. per square yard. We have made many thousands of yards of repairs at 50 cts. per square yard using old material. The average cost above stated of 60 cts. for the past two fiscal years, embracing the use of both old and new materials includes all regular repair charges and 33 per cent each year of the original total plant cost—itemized as follows:

Materials	$0.05
Labor at plant	0.15
Labor on street, including haul	0.30
Plant and tools	0.06
Fuel and current	0.02
Miscellaneous	0.02
Total	$0.60

The asphalt repair plant was constructed of much discarded material and a small amount of new material. From an abandoned crematory steel smoke stack, 4 ft. in diameter, two 10-ft. sections were cut. Of one section a drum or cylinder was made, a shaft run through the center and supported on journal boxes, enabling the drum to be readily revolved. The usual "spider" and loading chute was constructed at one end and a discharge opening next to the outside of the circle, cut in the other end. The drum was mounted above a brick fire box or furnace, in length about 18 ins. shorter than the drum. Above the brick work a portion of the stack, section No. 2, was used to enclose the furnace over and around the drum. A 5-HP. motor furnished power through reduction gears and chain drive, to revolve the drum at the rate of twelve revolutions per minute. The loading chute terminates in an elevated platform from which an incline leads to the ground. The inside of the drum has fixed to its sides spiral vanes so arranged that they propel the material, as the drum revolves, towards the unloading end—it has several proportionately larger movable vanes or doors, so arranged that the material is propelled in a direction opposite to that set up by the fixed vanes, or when willed in the same direction. When set to work against the fixed vanes, the movable doors, one of which terminates at the unloading opening, prevent the material from coming out of the drum, and keep it well and evenly distributed throughout its length; when otherwise set the material is rapidly propelled towards the unloading end and through the discharge opening into a waiting cart. The movable doors are connected by rods and maintained in parallel position. They are operated by a small handle, attached to the door, protruding through the discharge opening and are held in the desired position by simple spring catches. The change of doors from one position to the other is made when the doors are at the top of the revolution, being then free of material.

This improvised apparatus erected for experimental work has served for nearly three years, making over and serviceable for use, a large amount of old material; it has also produced a considerable quantity of new "binder" and surface mixture. For the latter purpose, however, we have lately added a standard 9 cu. ft. "asphalt pug mixer," a sand bin and chain elevator with which we produce with more certainty new sheet asphalt surface mixture or binder, the drum of course being used to heat the sand or stone. You will note the dual nature of the plant, its adaptability for making over old material or producing new standard mixtures as desired.

Before attempting to use the old material we determine by analysis the sand grading, particularly with reference to the 100 and 200 mesh material, also the amount of asphaltic cement that it contains—a desirable though not absolutely necessary procedure, for if the amount of "AC" is unknown, a simple substitute—the "pat paper stain" with a little experience will fairly well determine an excess or deficiency of asphalt. Adding from one to 2 per cent of new asphalt (120 penetration Dow Machine) to take the place of that lost during its previous existence on the street, and that which suffers injury in the reheating process, and occasionally a small amount of Portland Cement, we have produced mixtures which carefully watched for over two years still evidence life and durability. Many chemical analysis before and after, indicate "live bitumen" in amount corresponding to that contained in the old mixture plus that added. The average of a large batch of old material used during 1913-14 showed a bitumen content of 9⅛ per cent.

Upon the addition of 2 per cent by weight of new asphaltic cement and reheating the same material analyzed 11 per cent bitumen, the complete analysis being as follows:

	Per cent.
Bit.	11.06
Passing No. 200 sieve	11.01
Passing No. 100 sieve Passing No. 80 sieve	23.62
Passing No. 50 sieve Passing No. 40 sieve	32.84

Passing No. 30 sieve	19.34
Passing No. 20 sieve	
Passing No. 10 sieve	
R. on 10	2.13
	100.00

There is undeniably a certain volatilization of the lighter oils of the asphalt as evidenced by a hardened mixture. The presence of steam generated from the moisture nearly always contained in the old material piled in an open lot, has, in my opinion, a tendency to prevent burning or "coking" and leads to better results than otherwise would be obtained. The old material broken in lumps from 4 to 5 ins. square, "binder" adhering, is wheeled up the incline, loaded into the drum and allowed to remain from 12 to 15 minutes. Investigation has revealed the fact that the old mixture disintegrated in the drum, not by a gradual pealing off of thin outer layers of each lump, but by sudden dissolution or breaking down of the whole mass, in from 5 to 7 minutes. A wood fire maintained as uniformly as possible heats the mixture in the length of time mentioned to 300 degrees. It has proven possible to regulate the temperature to within a few degrees of the desired heat, by timing—each batch being carefully timed in and out of the drum and temperature recorded.

With the original apparatus we made 11,000 sq. yds. of repairs during 1913-14 entirely of 150 to 200 sq. yds. per working day, and have recorded but few failures. A similar device will, in my opinion, serve for the initial "Asphalt Repair Plant for Small Municipalities." It will make serviceable for use old surface mixture. It will produce new surface mixture and binder in limited quantities. Time and experience will dictate when the addition of the "pug mixer" will prove advantageous. For ordinary repair work for small municipalities it has with us proven its practical value and efficiency.

A normal day's run for the plant is exhibited in the following summary taken from the reports of the plant foreman and paving foreman, respectively, September 30th, 1915. The work being the removing, reheating and relaying of a portion of Granby Street, one of our principal thoroughfares.

Plant Foreman's Report:
9 loads (18 boxes, 7 cu. ft.) new binder.
24 loads top.
Street Foreman's Report:
Laid 225 sq. yds. 1½-in. top.
Laid 115 sq. yds. 1-in. binder.
Material and time for day's work as follows:

Binder material, per sq. yd	$0.105
Top material (AC), per sq. yd	.010
Fuel, per sq. yd	.033
Plant and tools, per sq. yd	.050
Labor and haul, per sq. yd	.204
	$0.402

Several intersections and short stretches of streets have been taken up, reheated and relaid for test purposes both with and without "binder." To date neither cracks nor other unfavorable signs have developed. The renovated pavement softens under the summer sun and shows the markings of traffic. It has behaved in such a manner as to inspire confidence in its endurance.

Of the 480,230 sq. yds. of sheet asphalt in Norfolk 25 per cent with an average life of 14 years must soon be resurfaced, having deteriorated to a point where further repairs are impracticable. The present surface must be removed, reheated with the addition of sufficient A. C. and dust, to convert it into an acceptable sheet asphalt surface, then relaid, or the entire street surface hauled away to be used in part only for repairs. The problem is one fraught with many uncertainties and difficulties. I am not ready to admit that a practical solution is not to be found in the reuse of the old surface, and to this end intend shortly the building of a larger, more substantial and better mechanically designed plant, along the lines of our first efforts, with a capacity of from 60 to 80 sq. yds. 2-in. surface per hour.

The question is, can a material sufficiently uniform stable and durable be produced, justifying the expenditure of 40 cts. per square yard, which I estimate will be the total cost when handled in large quantities?

ACKNOWLEDGMENT.

Abstract of a paper by W. H. Taylor, Jr., City Engineer, Norfolk, Va., before the American Society for Municipal Improvements.

GENERAL

An Air Analyser for Determining the Fineness of Cement.

(Staff Abstract.)

A cement that passes a 200-mesh sieve is ordinarily regarded as a very fine cement. Figure 1 shows the appearance of the coarse particles of such a cement when magnified 150 diameters. Of course the cement which passes a 200-mesh sieve contains a great many fine particles and some particles almost infinitesimally small as compared with the coarser particles shown by Fig. 1. Between these finest and coarsest particles are particles of all gradations of size and to make further division according to size of these particles is the purpose of an air-analyser recently perfected by the Bureau of Standards. This analyser in its latest form, will divide a cement which passes a 200-mesh sieve into four sizes which including the two sieve sizes commonly used gives six sizes as follows:

Grade.	Size of Separation.
100-mesh	0.00793 in.
200-mesh	0.00428 in.
0.003 in.	0.00216 in.
0.002 in.	0.00154 in.
0.001 in.	0.00076 in.

As visual illustration of the degree of separation possible with the analyser there is shown by Fig. 2 the particles of cement of the finest grade tabulated above magnified 150 diameters for comparison with Fig. 1. The coarse particles in Fig. 2 are directly comparable with the particles in Fig. 1 which as previously stated are the coarse particles passing a 200-mesh screen.

To any but the cement physicist a discussion in detail of the new air analyser and its characteristics is of minor interest. The device is shown by diagram by Fig. 3. Air is supplied by fan *B* to the reservoir. The working pressure is 1 lb. per square inch and this pressure is kept constant by the gage, regulator, blow-off and fan speed. From the reservoir the air flows into the bulb and by means of the nozzle impinges on the weighed charge of cement in the bulb. From the bulb the air escapes up through the "analyzer" carrying with it some part of the cement which is caught in the dust collector. The size of the cement grains separated from the charge in the bulb depends upon the amount of air admitted into the bulb and this is controlled by the size of the nozzle. Three sizes of nozzles are used, namely, 0.001 in., 0.002 in. and 0.003 in. A full description of the analyzing operation is as follows:

The motor and blower are first started at slow speed, and the air tube leading from the reservoir to the analyzer is connected to the nozzle to be used. This causes a rise in pressure in the reservoir, indicated on the gage, which is to be raised to the working pressure of 1 lb. per square inch. The pressure is further raised by gradually closing the blow-off, and if not high enough when the latter is completely closed, the blower speed is increased. It is desirable always to have an excess of air supplied by the blower, and to have the blow-off so adjusted as to allow a slightly greater quantity of air to pass into the reservoir than is required for the analyzer. Further regulation of pressure is automatically provided by the regulator, which consists of a vertical pipe about 5 ft. long and 4 ins. in diameter, closed at the bottom and nearly filled with kerosene. Into this a long glass tube connected to the reservoir and open at the lower end projects to a depth which can be adjusted and is approximately the same as the difference in level of the kerosene in the two arms of the gage at working pressure. This adjustment is always made by trial, and when the proper depth is attained, the regulator functions perfectly for an indefinite time without further attention.

It is obvious that if the pressure in the reservoir is below the required working pressure, air can escape from the reservoir only through the analyzer nozzle, but by further closing the blow-off the pressure rises and the kerosene is driven down the regulator tube until finally the seal is broken and air bubbles off. The pressure in the reservoir will thereafter remain sensibly constant, unless the speed of the blower varies considerably. In normal operation, therefore, the oil in the pressure gage mounts quickly to its prescribed height and remains there while the regulator disposes of the slight excess of air supplied to the reservoir. Unavoidable irregularities in the speed of the blower are thus automatically

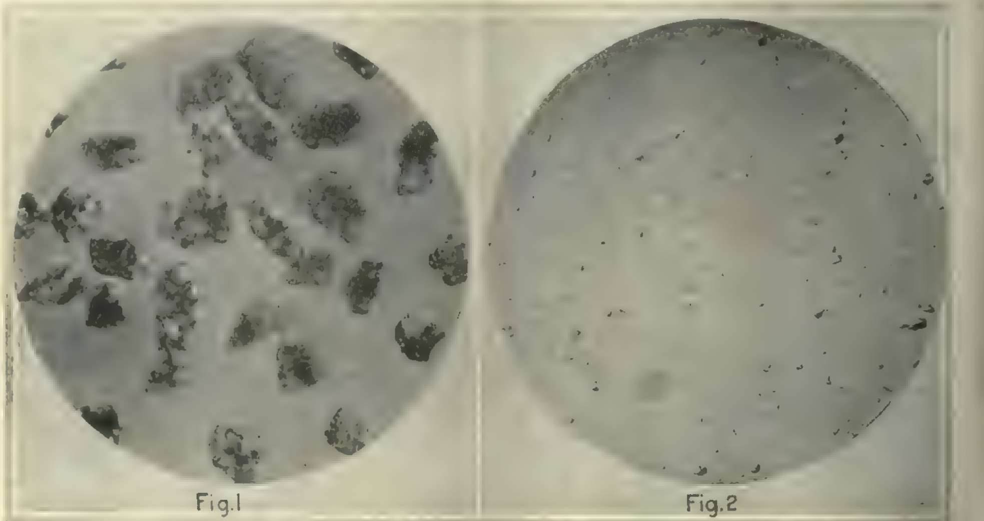


Fig.1

Fig.2

Cement Particles Magnified 150 Diameters.

Fig. 1—Cement Particles Passing a 200-Mesh Sieve at the End of Ordinary Sieving Operations. Fig. 2—Air Separated Cement Particles, Grade 1.

compensated and the gage indicates the constant pressure of the air supplied to the nozzle. Variations in the reservoir pressure as large as 1 per cent are rare, and of this magnitude are entirely negligible in their effect on the separations.

Having adjusted the blow-off, as previously described, the nozzle is removed from the air tube and inserted in the bulb, which is detached from the stack. The weight of nozzle and bulb should be known to the nearest 0.01 g. If the 0.001-in. separation is to be made, a 33⅓ g sample of cement is placed in the bulb; if the coarser separations are desired, 50 g are ordinarily used. The bulb containing the cement is then attached to the stack, the air tube is connected to the nozzle, the tapper is started, and the analysis proceeds without further attention on the part of the operator. The residue in the bulb gradually darkens as the fine material is removed and in the course of half an hour or less appears to become distinctly granular, especially in the coarser separations. It has been found by experiment that greater uniformity in the fractions is obtained if the separations are regarded as completed when a certain rate of loss is reached, as in the case of the No. 200 sieve fineness determination. The air separations require a considerably longer time, however, as the diminution of the quantity of material removed is much less rapid toward the end of the process than in the sieve separations.

The Bureau has arbitrarily adopted a loss of 0.02 g per minute as the most suitable rate to indicate the completion of a separation, but should the analyzer be found adapted to routine work, a considerable saving of time might be effected without much sacrifice of accuracy by adopting a higher rate. The rate of loss is determined in the following manner: The approximate time of an analysis is usually known from experience, and 15 or 20 minutes before the estimated time of completion the air tube is detached from the nozzle, and a half minute or more, depending upon the size of separation, is allowed for the particles suspended in the stack to settle back into the bulb. The latter is then removed and weighed. It is then replaced on the stack and the analysis is continued for exactly 10 minutes, after which the bulb and residue are again weighed. If the observed loss is greater than 0.2 g, the analysis is continued for another 10 minutes, and so on until a loss of 0.2 g or less has been observed in the 10-minute interval. The analysis is then completed, and the total loss computed to the minute when approximately 0.02 g was being removed. The total loss is expressed in percentage of the total cement, and check tests usually show an agreement within 0.5 per cent.

The time required for an analysis varies in practice as shown by the following sample analyses:

CEMENT NO. 406, 0.001-INCH NOZZLE.

[Monday, Dec. 7, 1914, began at 4.17 p. m.]

Weight of bulb	251.10 g
Weight of cement	33.33
Total	284.43
(Analysis interrupted at 4.43 p. m. and continued Dec. 8, beginning at 8.58 a. m.)	
Weight of bulb and residue after 80 minutes blow	274.67
Loss in 80 minutes	9.76
Weight of bulb and residue after 90 minutes blow	274.44
Loss from 80th to 90th minute	0.23
Loss in 90 minutes	9.99
Weight of bulb and residue after 100 minutes blow	274.27
Loss from 90th to 100th minute	0.17
Rate of loss in 90th min.	0.02
Total loss in 90 minutes	9.99 g
	= 29.97%

CEMENT NO. 406, 0.002-INCH NOZZLE.

[Dec. 8, 1914, began 11:22 a. m.]

Weight of bulb	251.10
Weight of cement	50.00
Total	301.10
Weight of bulb and residue after 90 minutes blow	276.44
Loss in 90 minutes	24.66
Weight of bulb and residue after 100 minutes blow	276.18
Loss from 90th to 100th minute	0.26
Loss in 100 minutes	24.92
Weight of bulb and residue after 110 minutes blow	275.95
Loss from 100th to 110th minute	0.23
Loss in 110 minutes	25.15
Weight of bulb and residue after 120 minutes blow	275.77
Loss from 110th to 120th minute	0.18
Rate of loss in 111th minute	0.02
Total loss in 111 minutes	25.17
	=50.34%

CEMENT NO. 406, 0.003-INCH NOZZLE.

[Dec. 9, 1914, began 10:30 a. m.]

Weight of bulb	251.55 g
Weight of cement	50.00
Total	301.55
Weight of bulb and residue after 70 minutes blow	272.83
Loss in 70 minutes	28.72
Weight of bulb and residue after 80 minutes blow	272.60
Loss from 70th to 80th minute	0.23
Loss in 80 minutes	28.95
Weight of bulb and residue after 90 minutes blow	272.40
Loss from 80th to 90th minute	0.20
Loss in 90 minutes	29.15
Weight of bulb and residue after 100 minutes blow	272.23
Loss from 90th to 100th minute	0.17
Rate of loss in 85th minute	0.02
Total loss in 85 minutes	29.05
	= 58.10%

The actual records are of course in more condensed form, each step in the above analyses being fully indicated for the sake of clearness. The operator also carefully notes the time of beginning each 10-minute check test. The stopping point is determined by simple linear interpolation of rates and is approximate only, but quite close enough for all practical purposes. This is carried out as follows for the 0.003-in. separation: 0.023 g is taken as the rate of loss at the seventy-fifth minute, 0.020 g as the rate at the eighty-fifth minute, and 0.017 g at the ninety-fifth minute. The eighty-fifth minute is therefore taken as the stopping point. The loss in 80 minutes was 28.95 g, and the rate of loss at the eightieth minute was assumed to be the mean rate between the seventy-fifth and eighty-fifth minutes, or 0.0215 g. Similarly the mean rate from the eightieth to the eighty-fifth minute is 0.0208 g and the loss from the eightieth to the eighty-fifth minute is 5 × 0.0208, or 0.10 g. Hence the total loss in 85 minutes is 29.05 g. While this procedure illustrates every step of the process, a simple inspection is generally all that is necessary to determine both the stopping point and the total loss.

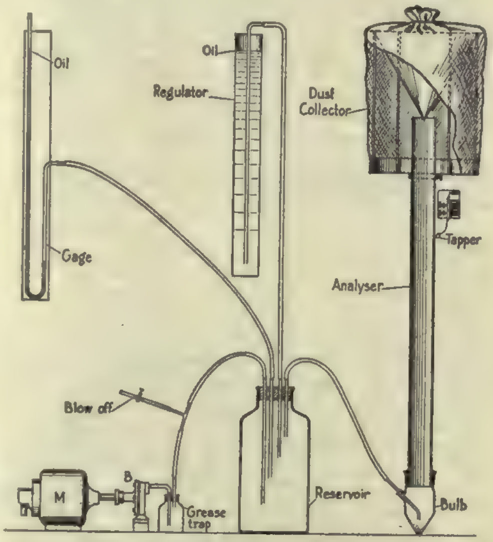


Fig 3. Bureau of Standards Air Analyzer for Determining Fineness of Cement.

The foregoing separations, combined with the fineness as determined on the No. 100 and No. 200 sieves, give a division of the cement into six fractions. These fractions can be compared with similar fractions of other cements obtained in the same way, and thus interesting information can be obtained regarding the performance of different finishing mills, the increase in the finer grades by regrinding, and the relation between the amount of the 0.001-in. grade, which may be provisionally called "flour," and the amount passing the No. 200 sieve, which is the present method of judging the fineness of different cements.

ACKNOWLEDGMENT.

This description is prepared from Bulletin No. 48, Bureau of Standards, by J. G. Pearson and W. H. Sligh.

Method and Cost of Grouting a Water Bearing Fissure and Seamy Rock in Sinking a Mine Shaft.

(Staff Abstract.)

The Francis Shaft was sunk through quicksand to ledge a distance of 102 ft. by The New York Foundation Co., who completed the work in June, 1910. As we were at that time not ready to continue the shaft The Foundation Company put a concrete seal in the bottom and turned it over to the company.

The shaft through the sand is circular, 17 ft. in diameter, inside dimension. It was constructed so that it might be continued in the standard size adopted by The Cleveland-Cliffs Iron Co.—10 ft. 10 ins. by 14 ft. 10 ins. inside measurements. This standard shaft is rectangular with two skip-compartments, a cage-compartment, and a ladder- and pipe-way. Work was resumed in the spring of 1911, but continued only for a short time, just long enough to put in the steel dividings in the concrete shaft, and to drill a number of holes through the seal in the bottom of the shaft to ascertain the flow of water to be handled. The holes all struck water at a depth of from 2 to 3 ft. The water came out under a pressure of a little over 40 lbs. and any two of these holes made sufficient water to give a No. 9 Cameron pump just about all it could handle. As fast as the holes were drilled, wooden plugs were driven into them to shut off the water. At first any pieces of wood at hand were used as plugs, but these did not entirely keep back the water. Accordingly regular soft-pine plugs, from 3 to 3½ ft. long and tapering from 4 to 6 ins., were turned out in the shops. With these the holes could be made water-tight.

The holes drilled demonstrated the fact that a large flow of water would be encountered as soon as the seal was broken and also that the slate ledge was probably broken to a greater or less degree. It was readily seen that the water would have to be excluded before continuing the shaft, or the shaft could be sunk only with the greatest difficulty and expense, if at all. The Foundation Co. might have carried the shaft down farther by their own process except for the fact that at the time ledge was struck the men were working under 47 lbs. air pressure on 15-minute shifts. This was not only exceedingly expensive, but hazardous.

The ledge at the bottom of the shaft being quite irregular, the thickness of the seal varied, but it was supposed to average 24 ins. The encountering of water so quickly in the holes seemed to indicate that the seal put in by The Foundation Co. had not formed a good contact with the ledge. Just at this point work was discontinued and was not resumed until the first of February, 1915.

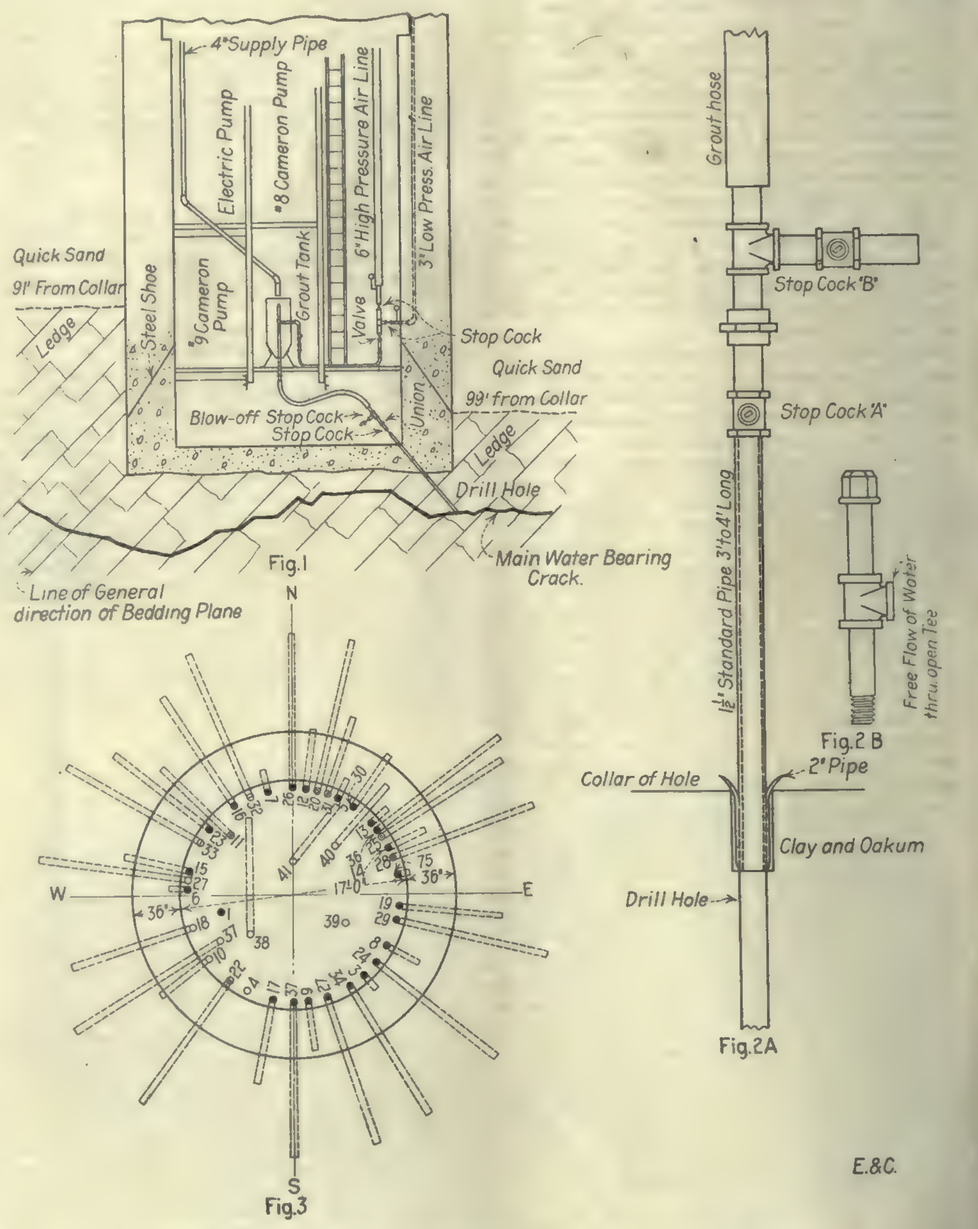
When work was begun anew last February various means were discussed for permanently cutting off the water which would come in at the ledge, and it was finally decided to attempt this by drilling incline holes around the inside circumference of the shaft, at such an angle that they would reach beyond the outside circumference of the wall of the shaft, and forcing neat cement into these holes under air pressure until all the water-bearing cracks and crevices were filled, thus making a water-tight ledge through which the shaft could be sunk with safety. As stated above, we were afraid that there was an open space between the seal and the ledge covering a good portion of the area of the shaft. If this was the case, the pressure exerted on the cement to force it into the holes would in turn be transmitted against the bottom of the concrete seal and develop an enormous pressure. Thus there would be great danger of breaking through it, and breaking through would be a very serious matter. As a precaution against this, 3-in. planks were set up on edge 8 ins. apart, like joists in a floor, and on top of these and at right angles to them 12-in. square timbers were put in across the shaft about 4 ft. apart and spragged with stulls to the steel sets above. Whenever there was any space between the joists and the cement seal, wedges were driven in so that should there be any tendency for the concrete to give, the pressure would be instantly transmitted to the bracing. This covered up the bottom of the shaft pretty well, but still left space enough for drilling holes until it was found that the space below the seal had been filled and the reinforcing could be removed with safety.

Six feet above the bottom of the shaft a platform was built, on which was installed the air-pressure grout machine, the valves for operating the low- and high-pressure air line, and a No. 9 Cameron pump. On the next set above, two other pumps were installed, a No. 8 Cameron and an Alberger electric pump. This gave a total pumping capacity of from 1,400 to 1,600 gals. a minute. A 3-in. pipe line for conveying the grout, which was to be mixed on surface was installed from surface so that it emptied directly into the grout pan. A mixing tub made by sawing an oil barrel in half was placed over this pipe. A few feet from the mixing tub a cement house was erected and water piped to it. Two air lines were set up in the shaft, one from the compressor which furnishes the mine for ordinary conditions at 80 lbs. and a 6-in. high-pressure line from the booster installed in the engine house. This high-pressure line also acted as a receiver. The booster was a 9½x9½x10-in. Westinghouse Air-Brake compressor, such as is used on locomotives. It is run by steam and is capable of raising the low pressure up to 250 lbs. The machine used on this job was a second-hand one which had been repaired and 150 lbs. pressure was about the most we could get out of it. Stopcocks were arranged so that when desired the low-pressure air could be quickly shut off and high-pressure air forced into the grout tank instead.

The tank used was the Caniff Grout Machine. It consists essentially of an iron tank of approximately 24x48-in. with connections for allowing air to be blown in at both the top and bottom. When the tank has been charged, air is blown in at the bottom to agitate the grout, which insures it a thorough mixing and keeps it from setting. This air is then shut off and air let in at the top to force out the grout. A stopcock with a long handle controls the flow of grout through the discharge pipe. The trapdoor at the top through which the charge is inserted is held shut when closed by the air pressure. After the charge has been expelled from the tank and all the connections, the air from the air line is shut off from the tank, the chamber exhausted by means of a relief valve on the top of the machine, and the charging door opened for a fresh mixture. These tanks come equipped with valves, but stopcocks were substituted for them, as they can be worked much more easily and quickly. The grout pan should be set up as near the working place as possible, as all parts of the outfit are thus much more easily controlled, and especially as it shortens the connection between the grout tank and the hole being grouted and prevents clogging. The cross-section in Fig. 1 shows the arrangement of equipment described.

The connection between the tank and the grout pipe was a 2-in. rubber hose of extra quality warranted to stand 300 lbs. pressure. One end was fitted up with a 1½-in. half-union for connecting it to the discharge pipe of the grout machine, and the other end was supplied with a blow-off valve and a 1½-in. half-union for coupling it to the grout pipe. (See Fig. 2-A). The blow-off valve (Stopcock *B*) served in finding out whether or not all of the charge had gone into the hole, in emptying the tank of air after the charge had been ejected, and in blowing out the hose after the hole would take no more grout. The function of emptying the tank of air after the contents had been discharged is quite as important, if speed is desired, as the relief valve on the tank for this purpose freezes up if worked too rapidly. The hose with connections was about 14 ft. long, sufficient to reach any point in the bottom of the shaft and yet not long enough to make loops or troublesome unnecessary curves.

The grout pipes were made from 1½-in. standard pipe 3 to 4 ft. long. To the end to be driven into the hole, a bell made from a piece of 2-in. pipe 8 ins. long was welded. The 1½-in. pipe is pushed into the large end of the bell until its end is even with the unexpanded end of the bell and welded at this point. (See Fig. 2-A). The other end of the pipe was equipped with 1½-in. stopcock, a 1½-in. nipple, a 1½-in. tee, which was left open on the side to permit the free flow of water while the pipe was being driven, and a nipple on to which was screwed a cap. (See Fig. 2-B). In drilling the holes, a starting bit of 2¾ ins. was used to a depth of 8 or 10 ins. The next bit was 2½, but the succeeding bits followed the usual change. The difference in size between the starter and the second drill provided a shoulder against which the grout pipes could be tightly driven. Before the pipe was driven into the hole, the bell was wrapped with oakum and this in turn was coated with clay. The pipes were driven with a sledge, a wooden block being held on the cap to receive the blow. After the pipe was driven as far as it would go, the stopcock (*A*, Fig. 2-A) was closed, and if there was no leakage around the pipe at the collar of the hole, the nipple in the stopcock, with its attached tee and cap, was replaced by another nipple to which was attached a half-union for the coupling with the grout hose.



Procedure and Plant Employed in Grouting a Mine Shaft.

If there was a little leakage, it was stopped by driving small steel wedges, shaped to conform to the pipe, between the pipe and the upper end of the bell welded to it. This upper end of the bell was drawn to a feather edge, which conformed to any little irregularity in the shape of the hole, and which extended out over the oakum and lay and prevented it from being forced up on the pipe. The effect of the steel wedges was to force back this feather edge and make a tighter contact against the collar of the hole. If this did not stop the water, small soft-pine wedges were driven in at the leaks. There were times, however, when even with wedging the pipes could not be made tight the first time and had to be taken out and put in until they were tight. However, a few wedges around the pipes was usually all that was required. The drawings 2-A and 2-B illustrate the details here described.

The general routine followed is illustrated by Fig. 3. A unit of operations was the drilling and grouting of six holes spaced at equal intervals around the circumferences of the shaft. The holes were numbered in the order drilled. To drill these six holes and put in the grout pipes was a day's work for a crew of two men and a mining captain. On the following day these holes were grouted, and for the next two work was suspended to give the grout time to set up and harden. At first only one day was allowed for this, but it proved insufficient in cases where a large amount of grout had been put into one hole. A total of 41 holes were drilled and 27 were grouted. As the work progressed the holes were drilled deeper, until 14-ft. holes put in at an angle of 45° encountered no water. Finally a few holes, Nos. 38, 39, 40 and 41, were put down in the interior of the shaft to reach any seam that might run up into the shaft parallel or nearly parallel to the incline holes which these holes might have missed. As no water was encountered, all was now ready for the excavating of the bottom of the shaft and for shaft-sinking.

Grouting was started on the morning of March 26. A gage attached to one of the grout pipes showed a pressure of 43 lbs. To begin with, it was surmised that there were relatively large areas to be filled, so that the only pressure to be overcome would be the hydrostatic head. Sixty pounds was therefore used in the first operations. The first mixture was very thin, being composed of two 12-qt. pails of cement and four 12-qt. pails of water, and as a result, the grouting went very slowly. Therefore the mixture was changed to one bag of cement and three 12-qt. pails of water to a batch. It is most important, however, that the mixture be thin enough so that it is perfectly fluid. No sand was used in these mixtures, but it may be used if desired. All of the cement was screened over a heavy wire screen running four meshes to the inch, to take out any lumps. The first hole grouted was one of the holes drilled in the operations of 1911. Some of the plugs put in at that time were not tight enough to keep the thin mixture of grout from being forced back up into the shaft. Wherever possible, these old plugs were replaced by plugs previously described. This helped a great deal, but there were some plugs which could not be removed and which could not be made tight enough to hold back the grout. Accordingly several batches of bran were forced into the hole, and then a richer mixture made with one bag of cement to a batch. The holes soon took up and there was no more trouble from this source.

From the first holes in particular, the water brought up fine sand and small pieces of broken ledge. With the very first of these, the water was shut off as soon as the grout pipe had been made tight, but later the stopcock was left open and the water allowed to flow for a period of ten minutes, until the water became clean and free of sand. The effect of this was seen later when the bottom of the shaft was cut out: in holes which had not been allowed to clear themselves the grout was mixed with the sand in the seams and could be readily taken out of the cracks with a pick, but wherever the holes had been allowed to clear themselves the cracks were filled with hard, clean cement.

On any day's grouting, the hole showing the largest flow was generally the first one connected to and grout was forced into it as long as it could be made to take any. When once started, the grouting of a hole was finished without any stop, for if the cement was allowed to start to set, no more could be forced in and the hole would be lost. Hole No. 13 required 33.2 bags of cement, grouting was started at 8:30 and run continuously until 3 p. m. Towards the end of the operation the holes took grout more slowly and if at any time the grout hose did not empty after the pressure had been left on for five minutes, the hole was considered finished. Sometimes in such cases the hose would have to be hammered and high-pressure air applied to it to clean it out. After a couple of days' work with 60 lbs. of air, it was decided that the seal and bracing were strong enough to stand a pressure of 80 lbs., and from then on this pressure was used almost entirely. Some holes that would not take grout at 80 lbs. were made to take a few batches under a pressure of 150 lbs. This pressure was also used towards the completion of the holes when they began to take grout slowly at 80 lbs. When the holes were taking grout freely we operated at the rate of a batch every 50 seconds, and this was just about as fast as the cement could be screened and mixed and sent down to us from surface. The grouting crew on surface consisted of five men, one man bringing the cement from the cement house, one man screening, one measuring out the charges, and two mixing them and stirring them with paddles to insure a thorough mixture. In the shaft the captain operated the grout machine, one man the blow-off valve near the grout pipe, and one the stopcock on the grout pipe.

At the end of a day's grouting, the stopcocks on the pipes used for the last previous grouting were opened. If no water came out, the stopcocks were taken off and thoroughly cleaned, so that they could be used over again. If water flowed from the pipes the grout machine was connected to the grout pipe and a batch of clear water forced into the hole.

If the hole took the water as many batches of grout were forced in as the hole would take. This amounted to anywhere from one-half a batch to two or three batches, and resulted in cutting the water off entirely. High pressure was used for these finishing batches.

Where the openings to be filled are as large as they were in this case, 80 lbs. of pressure will make a good job, but where the seams are smaller, higher pressure is not only desirable but absolutely necessary in order to overcome, in addition to the hydrostatic head, the friction in the seams being filled, and the tendency of the previous batches to set up. The farther in the grout can be forced, the larger will be the intervening wall built up and the more effectively will the water be cut off. If high pressure could have been used from the beginning, this particular job could have been done with fewer holes and grouting operations. The grouting was finished on April 26, a month after starting.

When it had been thoroughly demonstrated that the water had been all cut off, the rectangular shaft was started. Eight-foot holes were drilled around the perimeter of the rectangle two feet back from the neat line of the shaft and as close together as possible. The first four feet were then broken out by moiling with wedges and feathers. The concrete seal was the hardest part of this work, as the ledge broke easily along the slips and joints. Below these 4 ft. shallow holes and very light charges of powder were used. For the next cut the holes were drilled on the outside of the shaft as before and the ground broken out by drilling and blasting with light charges of powder, not over half a stick to a hole, and never over two or three holes at a time. This operation was repeated until the shaft was 18 ft. below the shoe of the concrete sunk by The Foundation Co.

To secure further the portion of the shaft which had been grouted, the sides of the shaft traversed by the filled seams were lined with a reinforced concrete wall averaging 2 ft. in thickness. This wall required 14 ft. of concrete lining. Hitches were cut 12 ft. below the shoe and 9-in. I-beams put in for bearers along the small dimension of the shaft. To these bearers, hanging bolts were attached so that the sets could be hung below. Forms were then constructed along the neat line of the shaft from the top of the concrete seal to 2 ft. below the bearers. First, however, 1¾-in. cramp rods spaced 2 ft. apart were put in the walls of the shaft. Wire rope, old pieces of expanded metal, iron bars and pieces of old angle iron and channels were fastened in for reinforcing. The space was then filled with concrete having a composition of one part cement, one part sand and gravel and two parts broken rock. This was given a couple of days in which to set and then work was resumed. For the first two or three cuts the perimeter was drilled around as in the previous cuts and the holes blasted carefully so as not to damage the concrete.

When the bottom of the shaft was taken up, the conditions were not exactly as had been anticipated, as the seal had a good contact with the ledge over the entire area of the bottom of the shaft. What we did find, however, was a large seam varying from 2 to 6 ins. in width cutting across the entire shaft. On the south and east side it was within a few inches of the bottom of the seal while on the north and west side it was farther down in the shaft. In the southwest corner it apparently made a turn and went outside of the shaft, as no water was encountered in any of the holes—No. 4, 10, 18, 22 and 37—put down in this area. From six places in the sides of the shaft small streams of water issued, the combined flow of which was not over 25 gals. per minute. Holes were drilled into the rock at these points and plugged with grout pipes so that later they could be grouted and the water stopped. In addition several weep pipes were put in, which all ran dry as soon as the concrete set.

After the 14 ft. of concrete had been allowed to set for six weeks, the sides of the shaft were well braced and the holes making water and the weep pipes grouted. The bracing of the shaft was to prevent the sides from bulging and breaking should there be any openings between the concrete wall and the rock sides of the shaft—making areas against which the air pressure used in grouting might be transmitted. Although some of the water was shut off and the total flow cut down to about 15 gals. per minute, it could not be cut off entirely with the available air pressure. The openings through which the water came were evidently so fine that only a higher pressure would force the grout into them. During the time between the installation of the concrete lining and the last grouting, the shaft was sunk 16 ft. After the weep holes were grouted the forms were removed, dividings installed and the shaft equipped for sinking in the ordinary way. Up to this time all the work had been done on day shift only.

To reach this stage four months were required, from March 26 to July 27. The greater portion of the last three months was spent in sinking, which, because of the care which had to be exercised, was slow and tedious.

The cost of this work up to the first of August, when two shifts could be employed and sinking carried on in the usual way, was as follows:

Grouting	$1,431.74
Sinking	1,882.45
Timbering	885.15
Concreting	407.42
Total	$4,606.76

When the advantages gained are taken into consideration, the method used seems very inexpensive. The actual flow of water there would have been to handle if it had not been shut off is entirely problematical, but 4,000 to 5,000 gals. of water per minute is undoubtedly a low estimate. Suppose the shaft could have been sunk to the present depth of ordinary methods and that the water could have all been caught and pumped from ledge—the expense of installing the necessary pumping equipment and of pumping this amount of water over the period of years comprising the life of the mine would be enormous. It is very obvious that one could afford if necessary to spend several times above amount to get the results obtained.

The method of grouting water-bearing seams can be used at any depth provided sufficient air pressure is available. For real effective results, the air pressure should be from 100 to 200 lbs. over the hydrostatic head.

No further trouble from water is anticipated in the sinking of the Francis Shaft, as the drill hole put down on the shaft location to a depth of 865 ft. was found in the bottom of the shaft and no water was coming from it.

ACKNOWLEDGMENT.

Slightly condensed from a paper before the Lake Superior Mining Institute by J. R. Reigart, Assistant Superintendent, Cleveland Cliffs Iron Co., Princeton, Mich.

WATER WORKS

The Valuation of Water Works Properties.

VII. Appraisal of Working Capital.

By Halbert P. Gillette.

By some appraisers the term Working Capital is restricted to the "cash and deposits" needed to operate a plant, and does not include "stores and supplies," the latter being classed with "plant" in the inventory of physical property. The present tendency is to class "stores and supplies" as a part of Working Capital.

Working Capital Defined.—For rate making purposes, Working Capital may be defined as being that amount of capital which an operating company should ordinarily have in order: (1) to provide a stock of stores and supplies; (2) to make ordinary payments and provide for reserves in advance of collections; (3) to provide a cash surplus for financial peak loads; and, (4) to secure adequate banking accommodations.

Nearly every company makes new additions to plant every year, and some working capital is needed for this purpose as well as for operating the old plant. Whether the working capital required for making these additions should be segregated, depends upon whether or not interest during construction is charged to the plant account for the use of the working capital. Ordinarily no interest is charged to construction on any of the working capital. So long as this remains the practice it would be obviously unfair to a company not to include in an appraisal all the working capital, both for operating the plant and for making additions to the plant, as the working capital to be considered in a rate case.

There is usually a considerable amount of "construction work in progress" which appears among the assets of a company under an account of that name. This may be called a plant suspense account. Where the cost of this "construction work in progress" is not included in the appraisal of the plant, it should appear as an item in the Working Capital.

In estimating the total Working Capital it is necessary to study the "curve" of cost of annual additions to plant, as well as the "curve" of cost of plant repairs and renewals. No particular year's data should be taken as a basis for calculating Working Capital for future years, unless the particular year is seen to be neither abnormally active, nor abnormally dull in respect of plant renewals and additions.

Even in the earliest rate cases, stores and supplies were recognized as being an essential part of any appraisal intended for use in rate making problems. But it was not until 1909 that a public service commission gave formal recognition of the existence of other items that might properly be included as working capital. I refer to the decision of the Wisconsin Railroad Commission in the Hill vs. Antigo Water Co. (3 W. R. C. R. 691). It became evident thereafter that a "working cash capital" should be allowed in addition to stores and supplies. However, it has not always been clear what method should be used in estimating the amount of this "working cash capital."

When a builder or contractor is estimating the amount of cash needed to finance a construction job, his first thought is the accumulated total amount of cash expenditures that he must make before he collects his first "monthly estimate." To this he adds an amount to cover probable delays in collections and probable "peaks" in his curve of expenditures. He usually finds it necessary to maintain some cash balance in his bank at all times. Evidently, then, his stores and supplies on hand form only a part of his working capital, and often a small part. The same holds true of many public service companies.

A simple illustration will serve best to make clear the relation of the payment "curve" to the collection "curve." Suppose the work to consist entirely of labor (no materials) and that the payroll is $1,000 a week, paid every Saturday. Suppose collections for this work begin on the fifth Saturday and are $2,000 that Saturday and every Saturday thereafter until the collections aggregate as much as the payments. Then collections will overtake payments on the eighth Saturday, when the total of each is $8,000. The *maximum* excess of payments over collections in this case is $4,000. This $4,000 is the amount of working capital needed to carry a payroll under the given conditions. However, although a payroll may be tolerably uniform, as above assumed, there is usually less uniformity in the collection "curve." Where payments must be made for freight, stores and supplies, insurance premiums, rents, etc., the payment "curve" itself becomes very irregular. Hence there arises what may be well termed a financial peak load on the working capital. Assistance in such instances may, in part, be had from banks, but should, in part, be supplied by the company itself.

To apply this method correctly it must be assumed that the company is starting its payments and collections with a clean slate. In other words, it would be erroneous to take the *existing* curves of weekly collections and payments, for they might both be nearly identical and approximately horizontal lines. The payment curve must be started at the first of any given month and must be built up exactly as above indicated. Then the collections for the service rendered in *that* month must be built up. To do this in the case of most companies is by no means easy. In the case of some companies it is impracticable to trace every collection to the particular period of time under consideration. Moreover, other complications arise, such as flow from the apportionment of the collections. Nevertheless, a complete understanding of the above given method is essential if there is to be a correct application of any other method; for every other method must, in final analysis, be a rough and ready way of arriving at a result that will be approximately the same as that attained by this theoretically correct method.

If it is desired to plot a diagram showing payment "curves" for each class of expenditures, this may be done; and a corresponding collection "curve" may be plotted. In doing this it is necessary to prorate the collections according to the various dispositions to be made of all the income—for wages, materials, depreciation fund, taxes, interest, etc. When this is done it is seen that collections for taxes, interest and the like are usually made in advance of their respective payments; but it must be remembered that such accumulations are, in essence, funds that the company holds in trust. Tax collections are held in trust for the government. Interest collections are held in trust for the bond owners and others from whom the company has borrowed capital. This fact is often reflected properly in the monthly balance sheets under current liabilities "accrued but not due." But in studying such liabilities in relation to their bearing upon working capital, care must be taken to ascertain their *average* and not their maximum. Furthermore, it should be remembered that funds held thus in trust by a company might be immediately paid out to some other trustee or direct to the real owner; and in such event the depletion of cash balances in the banks would make it incumbent upon the company to raise cash from other sources in order not to be living from hand to mouth.

Every large company operating over an extended territory utilizes the facilities of local banks. Daily collections are deposited in these numerous local banks, and these banks usually serve also as depositories for the checking accounts of the local managers, etc. For all this clerical work, etc., the local banks usually receive their pay in the form of the profit that they derive from the cash left on deposit with them. In Pennsylvania the Bell Telephone Companies, for example, deal with about 222 banks.

Stores and Supplies.—This item of working capital includes those materials, "plant units" and supplies on hand for use in operating the plant and making ordinary improvements and additions thereto.

Receivables in Excess of Payables.—The amount by which accounts receivable exceed accounts payable is, of course, a measure of the lag of collections behind payments. But that it may not be a deceptive measure of this lag it is necessary to exclude all receivables and payables that may be classed among the investment assets and liabilities. Thus, if one operating utility company owes an affiliated utility company, and if this debt is carried as open account, it will appear as an account payable on the books of one company and an account receivable on the books of the other company. An investment not in its own plant is not on *operating* account receivable, so far as working cash capital is concerned.

When an *account receivable* becomes due and is not paid, an interest bearing note is frequently accepted, and the amount then appears among *bills receivable*. Since bills receivable are really an investment (being interest bearing), they should be eliminated in estimating working capital. In like manner bills payable should be eliminated, for they are an evidence not of working capital but of a lack of sufficient working capital. In other words, a company with sufficient working capital is able to discount the bills rendered to it.

Normal Amount of Working Capital.—A study of a large number of utility commission decisions shows that the working capital (cash plus stores and supplies) allowed as reasonable for utility companies has usually been 4 to 5 per cent of the cost of reproducing the physical property. Small companies normally require a larger percentage than large companies.

Appraisers not infrequently estimate that the working capital should normally be 1½ to 2 months gross operating revenue.

Troubles from Abnormally High Coloring in Rhode Island Water Supplies.

(Staff Abstract.)

Owing to the extremely low rainfall during the past few years, many swampy areas on the watersheds of certain Rhode Island water supplies have become very dry, and large amounts of soluble organic matter have been stored up in them which would ordinarily have been gradually dissolved out under normal conditions. During the heavy rains of the past summer, however, these swamps have again been flooded and considerable amounts of this stored organic matter have been dissolved, imparting to the water an exceptionally high degree of color. For this reason, there has been considerable complaint as to the objectionable appearance (high color) and vegetable taste in certain water supplies which are drawn wholly or in part from such swampy sources. Waters of this nature when drawn from unpolluted sources are entirely safe for drinking, even though the appearance and taste may make them objectionable to sensitive persons.

On certain of these water supplies filters have been installed to remove the objectionable color from water which is drawn from swampy areas. In some instances, however, it has been very difficult to adjust the filtration process to meet the sudden changes in the character of the water which have followed heavy rains, especially when such changes occur during the night, and for this reason the filtered water supplied to the consumers has contained a noticeable amount of color for a short time. Such a condition during the month of August, 1915, gave rise to complaints that one of the water companies was pumping unfiltered water into the mains.

From October report of Mr. Stephen De M. Gage, chemist and sanitary engineer of the State Board of Health of Rhode Island, Providence, R. I.

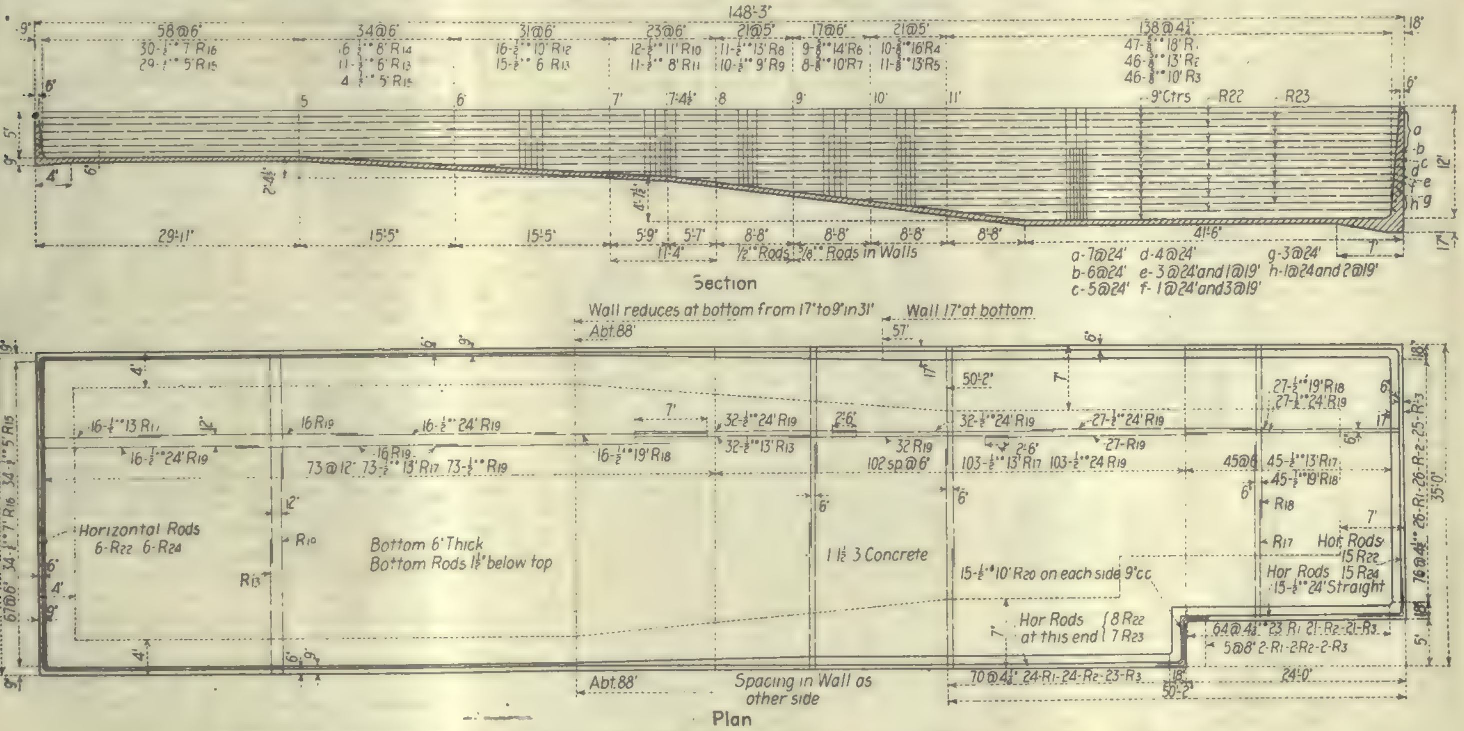
Design Features of Reinforced Concrete Swimming Pool at Riverview Park, Chicago.

(Staff Article.)

The reinforced concrete swimming pool, here illustrated and described, was built in the Creation Building at Riverview Park, Chicago, during the spring of the present year. The pool is used for aquatic exhibitions as an amusement enterprise. It was designed to provide room for swimming animals, from dogs to elephants, including horses.

DESIGN.

The pool is 148 ft. 3 ins. long by 35 ft. wide, over all dimensions. The depth ranges from 5 to 12 ft. The normal thickness of the bottom is 6 ins. This is increased to 9 ins. at the shallow end of the pool and to 17 ins. at the deep end, as shown in the longitudinal section herewith. The end walls have a thickness ranging from 6 to 9 ins. at the shallow end and from 6 to 17 ins. at the deep end. The side wall thicknesses vary between the same limits as those named for the end walls. The pool, as stated, is located within a building and the offset at one corner of the pool was made on account of the obstruction offered by a footing of one of the columns supporting the roof of the building. The capacity of the tank is about 450,000 gals.



Plan and Section of Reinforced Concrete Swimming Pool at Riverview Park, Chicago.

The pool, which is of reinforced concrete construction throughout, contains 220 cu. yds. of concrete. The contract price, exclusive of excavation, was $3,700. The reinforcement used is shown on the plans and in the following tabulation:

Rod mark.	No. of bars.	Diam., ins.	Length of bars in ft.
R1	122	⅝	18
R2	119	⅝	13
R3	117	⅝	10
R4	20	⅝	16
R5	22	⅝	13
R6	18	⅝	14
R7	16	⅝	10
R8	22	½	13
R9	20	½	9
R10	24	½	11
R11	22	½	8
R12	32	½	10
R13	52	½	6
R14	32	½	8
R15	100	½	5
R16	94	½	7
R17	276	½	13
R18	106	½	19
R19	452	½	24
R20	30	½	10
R21	15	½	10
R22	37	½	24
R23	14	½	24
R24	21	½	13

All rods are bent around intersections of walls or of walls with the floor. The bends are to a radius of 6 ins. In each case the short end of the bent rod terminates in a hook. The upper 7 ft. in depth of the tank drains by gravity to a sewer. A small electrically-driven centrifugal pump is provided to pump out the balance of the water in about 3½ hours.

CONSTRUCTION.

The form work was all done in one week. One 8 hr. shift was worked per day. The concrete was all placed in 2½ days. No waterproofing compound was incorporated in the concrete but as soon as the forms were removed the inside surfaces were given three coats of Ironite. These coats were applied in 2 days' time. One leak developed after the pool was filled. It was located at the junction of the sidewall and the floor. The leakage, which amounted to ¼ in. in level per day, was not large enough to warrant emptying the pool for making repairs. After two or three weeks' service the leak silted up and the flow from this point ceased. The pool is filled with the comparatively clear water drawn from the Chicago mains.

All the concrete was mixed in a ¾-cu. yd. batch mixer set about 40 ft. outside the building. A runway was built up leading from the mixer to the forms. Concrete was conveyed from mixer to forms in Ransome concreting buggies holding 6 cu. ft. each. Two extra men were required to help in pushing the buggies up the incline. The concrete in the floor was all chuted to place—the buggies mentioned discharging into the chute. An 8-ft. wide platform was constructed all around the wall forms and the buggies, running on this platform, were dumped directly into the wall forms.

The forms were made up of panels 2 ft. wide by 15 ft. long. The contractor's labor cost for placing the concrete was $1.20 a cubic yard. The form labor cost 15 cts. a square foot. Carpenters were paid 70 cts. an hour and laborers 40 cts.

This pool was designed by Benjamin E. Winslow and was constructed by L. J. Mensch of Chicago. We are indebted to Mr. Mensch for this information.

Comparative Merits of Four Types of Location of Underground Utility Lines.

(Staff Abstract.)

Chicago's first utilities gallery is now under construction and will be described in this department in our next issue. By way of introduction to a consideration of that gallery a general survey is here made of the comparative merits of the four general methods of locating the underground portions of public utilities, such as pipe lines, tubes, ducts, etc. In this country the practice of locating public utility structures beneath the pavements is almost universal. The present article briefly outlines European practice in this particular and draws some conclusions applicable to American conditions.

The various methods of handling public utility structures may be divided, according to the method of location, into four principal classes as follows: (1) Location beneath the pavements. (2) Location beneath the sidewalks. (3) Location in large sewers. (4) Location in pipe subways or galleries.

LOCATION BENEATH THE PAVEMENTS.

Placing all public utility structures beneath the pavements independently of each other is the system employed by all American and most English cities. Everybody is familiar with the results of this system in large cities, especially those having many high buildings. The endless tearing up of expensive pavements, the interference with business and pleasure and the consequent high cost of maintaining the systems are well-known facts which have often been the subject of unavailing protests. The sub-pavement congestion in some cities is so great that it seemingly calls for radical changes in the near future.

The evils produced by different utilities when placed beneath the pavements are relative. Sewers generally have been placed beneath the center of the street in all countries, since, when properly designed, they require but little subsequent attention.

LOCATION BENEATH THE SIDEWALKS.

In general, it can be said that the cities of France, Italy, Austria and Germany locate all utilities, except the main sewer, beneath the sidewalks. In the large cities of these countries the space between the building line and curb line is not excavated, as is the case in American cities. One may conclude offhand that locating the utilities in the sub-sidewalk space simply transfers the difficulties of their maintenance from the street to the sidewalk, but it is believed that a further consideration will show that some real advantages are gained.

In all of these cities a very complete system of regulations for locating the utilities are enforced. Exact locations which vary with the width of the sidewalk are prescribed, so that knowing the width of the sidewalk, one may locate with precision any given utility. In this respect, the regulations of Munich, Dresden and Berlin are notable. It should be mentioned that in France, Italy, Austria and Germany the majority of the utilities are owned either by the municipality or the state, but there seems to be nothing in their regulations which would make them inapplicable to privately owned utilities.

The expense of getting at the utilities is materially lessened by reason of the fact that the sidewalk pavements are all of light construction, no concrete or cement pavements being employed. In France and Italy a tar or asphalt composition, similar to our asphaltic concrete and from 1 to 2 ins. in thickness, is used. This pavement is laid directly upon the earth. Considering the light construction, its durability is remarkable. In Austria and Germany these tar and asphalt pavements, together with brick and stone blocks, are employed. In Berlin the sidewalk pavements are of large stone blocks, with one or two strips of pavement about 3 ft. in width of small stone cubes, or "Kleinpflaster." This small stone cube pavement is designed to permit any leaking gas to escape and also to allow air to reach the roots of trees planted near the curb lines. All openings made for repairs or extensions are repaired immediately. The earth is replaced and carefully tamped and the sidewalk rebuilt. It is not uncommon to see a large section of sidewalk taken up in the morning and by evening so skilfully replaced that it would be difficult to tell where the opening had been made. European engineers cannot understand why temporary repairs, so usual in America, should be tolerated.

A notable characteristic of all the cities is the accurate system of record maps they keep. Drawn to scale and portrayed in distinguishing colors, the exact size, location, depth below surface, grade, etc., of all utilities in each street are indicated. All utility work is required to be performed during the summer months. A new street pavement once laid, no openings are permitted for periods varying from five to ten years. Such a statement is almost beyond belief when, in this country, we see pavements torn up in from five to ten days after completion.

The municipal officials who administer the public utility regulations are chosen on merit and their positions are permanent. As an illustration, Max Niedermayer, in charge of utilities in the city of Munich, has been in the department 40 years.

The advantages which are claimed for the location of utilities beneath the sidewalks may be summarized briefly as follows:

1. It costs less to remove a cheap sidewalk than an expensive pavement. In other words, the maintenance cost is lowered.
2. It is maintained that utilities placed beneath the sidewalks have a longer life than those placed beneath the pavements, due to the absence of shocks and vibrations from overhead traffic, settlement of the earth, etc.
3. The interference with pedestrian traffic is negligible as compared with vehicular traffic and causes no economic loss.
4. The installation of transportation subways is made considerably less expensive where no utilities have to be supported and maintained in service during construction.
5. Expensive pavements are not destroyed and their normal life reduced.
6. The absence of the large number of manholes and special work is a real asset.
7. The expense of maintaining utilities being less, the municipality can obtain lower rates for the service furnished.

LOCATION IN LARGE SEWERS.

The sewers of Paris are famous throughout the world and need not be described at length. These sewers are really large egg-shaped utility galleries with a rectangular sewage channel running through the center or at one side in the smaller sewers. They vary in size from about 7 to 27 ft. in diameter. The large sewers are provided with narrow-gage tracks for the transportation of pipes, cleaning apparatus, etc. The piping systems are carried upon cast iron supports set upon either side of the sewage channel. The telephone wires, power wires, etc., are supported upon brackets attached to the walls of the structure.

Perforated manhole covers, allowing for ventilation and permitting the ingress of workmen, are provided at intervals. The air in the sewers is fresh, although a slight musty odor associated with sewage is noticeable.

Access to the homes from the sewers is provided by a series of small side tunnels running to the building line, where they are closed by a wooden wall, which prevents workmen from entering private buildings and citizens from entering sewers. The sewers carry the main services of water, telephone, telegraph, electric light and power, and pneumatic tubes. Gas mains are not carried, apparently through the fear of possible explosions. The gas mains are buried near the curb in narrow streets and in the sidewalk space in wide streets. The sub-sidewalk space often carries small distribution services from the mains located in the sewers. The streets are noticeable for the lack of any evidence of disturbance of the pavement for public utility work and for the absence of manholes.

PIPE SUBWAYS OR UTILITY GALLERIES.

The first pipe subway was built in connection with the creation of Garrick street in London in 1861 and was the result of a competition instituted to discover the best means of obviating the expense occasioned by maintaining utilities beneath the pavements. In the creation of new streets since the building of this gallery, pipe subways have generally been provided, so that today there is a total of 8.2 miles of pipe subways in the city of London, occupying 31 different streets. This mileage constitutes about 75 per cent of the total mileage of pipe subways in the world. Since these pipe galleries have in all cases been built in connection with new streets, their cost—which has varied from $17 to $40 per lineal foot—cannot be taken as a criterion of what the cost would be in a street where the utilities have already been installed independently beneath the pavements. The subways vary in size from 4 x 8 ft. to 12 ft x 7 ft. 8 ins., the large majority of all subways being 12 ft. in width and 7 or more feet high. The location of the subways has generally been beneath the center of the street, with laterals extending to the property line, but in some cases, notably the Holborn galleries and the new Kingsway and Aldwych galleries, the location has been in duplicate beneath the sidewalks.

The ownership of utilities in London is similar to that existing in the average American city. With the exception of the sewers, a part of the water supply and a few of the street car lines, all utilities are privately owned.

The installation of utilities in the pipe subways is provided for in the regulations of the Public Health Department, which state that where subways exist in the streets they must be utilized by the authority or company requiring to lay additional pipes, conduits, etc., and no opening except for conducting mains into or from subways will be permitted in such streets.

The pipe subways in Aldwych and Kingsway, constructed in 1906, are the most modern of the London galleries. In their general features they may be considered typical of these facilities as used in London, Nottingham, St. Helens and Glasgow. In cross-section they are 12 ft. wide, 7 ft. 6 ins. high, and with a semi-circular roof, and are constructed of two rings of brick-work backed by concrete. The floor is covered with 3 ins. of gravel. The large pipes are supported upon pipe rests upon this floor, the small pipe laid directly upon the floor, while the conduits and cables are carried on a system of iron brackets attached to the brick-work. All pipe and conduit are so arranged that a clear way of about 2¾ ft. is left through the center of the gallery. Access to the subways is obtained through gratings located in the sidewalk, some of which are of suitable size to permit long lengths of pipe, conduit, or cable, to be lowered. Ventilation is furnished by perforated cast iron covers 2 ft. in diameter, placed at 75-ft. intervals. Five cross-pipe subways, 7 ft. 6 ins. wide by 7 ft. 6 ins. high, carry utilities from the main subways in Aldwych and Kingsway to the intersecting streets. Lateral service to the buildings is conducted through 12-in. glazed pipe placed at 10-ft. intervals. Six-inch house connections with the sewers, which were placed beneath the center of the galleries, are provided at 30-ft. intervals. The subways above described are constructed on both sides of Aldwych and Kingsway beneath the sidewalk, the center of the street being utilized by a street car subway. The present occupancy includes two 16-in. water mains, an 8-in. gas main, a 6-in. water main, two 3-in. pipes with electric cables, a 2-in. high-pressure gas main, through ducts for street railway cables 6 x 12 ins., through ducts for electric cables 4 x 8 ins., and several lead covered telephone cables. The amount of utilities carried could be easily increased several times without producing congestion.

Although about one-half of the London pipe subways are under the control of the London County Council and the remainder under the control of the Corporation of the City of London, the regulations for use of the subways enforced by each body are practically identical. These regulations apply chiefly to the manner of doing work in the subways and provide in brief for the most rigid municipal regulation. An examination of the rates charged different utility companies for the use of the pipe subways shows that for the majority the rates vary in amount with each subway and bear but little relation to the length of subway occupied. A further discrepancy is found in the division of the utility companies into classes; water and gas companies, having the power to break up streets, being charged rates which are only from 1/10 to ½ as much as those charged other companies. These discrepancies have been recently recognized, for at the time of the writer's visit a new schedule of rates, worked out upon a unit basis and equalizing the charges for occupancy made to the different companies, was being proposed for adoption in place of the present rates. The basis taken for figuring the new rates was the amount of money saved the companies by the use of the subways, capitalized at 4 per cent.

Several representative pipe galleries were inspected and the engineers in charge interviewed. It was found that all the ordinary utilities, such as high and low pressure water, high- and low-tension electric cables, high and low pressure gas, sewers, pneumatic tubes, etc., are carried. About one-half of the galleries are illuminated by electric lights and the remainder by open gas jets often in close proximity to gas mains or high-tension cables. Although gas mains are carried in the pipe subways of London as well as those of St. Helens, Nottingham and Glasgow, no explosions or accidents have ever occurred. Daily inspections of each London pipe subway by municipal officials insure against the possibility of any leaks or other defects developing. The air in each subway was fresh. The condition of all utilities was also notable for the absence of any rusting or other evidences of deterioration. In addition to the keys to the subways kept by the municipal engineers, the police and fire brigade stations are also provided with keys for use in cases of necessity.

A comparison of the total cross-sectional area of utilities found in a number of typical London pipe galleries with the amount existing in some of the congested downtown streets of Chicago indicates that Chicago streets have from twice to four times the amount of utilities that London's crowded streets carry.

This difference is easily explained by the greater height of buildings found in the downtown district of Chicago, as compared with the low, uniform building heights of London.

The pipe subways of Nottingham and St. Helens, which in each city total about one-half mile in length, were also inspected. Those of Nottingham were built in connection with the creation of new streets, while those of St. Helens were built in connection with the rehabilitation of several streets. In both cities they were modeled after the London pipe galleries and therefore present similar features. In these subways also, gas mains are successfully maintained. Although the city of Glasgow was not visited, it may be mentioned that it has a small pipe subway 345 ft. in length in Albion street between Trongate and Bell. This subway was built in an old street and cost but $17 per lineal foot.

The power of excess condemnation possessed by English cities has been of greatest value in enabling them to build pipe subways in connection with new streets. The sale of property after the completion of the improvement at an increased value often pays a large part, if not all, of the cost of the improvements.

LESSONS SUGGESTED BY EUROPEAN PRACTICE.

1. There is need of more strict system of regulations regarding the placement of public utility services. Such regulations should be drawn and enforced with the basic idea of avoiding duplications in the systems and conserving the available space for location to the greatest extent. In the regulations each company should be required to submit preliminary plans for approval, showing the work as proposed and its relation to other work in the street, as well as final plans showing the work as constructed in relation to other work.

2. The enforcement of the city's regulations should be by an officer of technical training and experience in public utility work, whose term of office shall depend only upon meritorious service and be independent of changes wrought by politics.

3. An accurate system of record maps should be kept, showing all utilities in each street, together with all necessary information as to grades, depth below surface, etc.

4. There is need of greater use of the sub-sidewalk space generally for the location of public utility structures. Whether the utilities are buried in unexcavated space or the excavated sub-sidewalk space is used as a gallery, a saving in their maintenance cost may be effected.

5. In large cities, where the sub-sidewalk space is used by the buildings or their tenants, legal steps should be taken, if necessary, to recover this space for public use.

6. Studies should be made to determine whether the savings in maintenance cost, which will be made by locating utilities in the sub-sidewalk space when used as a gallery, will justify charging the companies a rental for this space.

7. Gas mains may be carried with safety in a gallery which is well ventilated and subject to daily inspection.

8. Utility galleries, such as are used in London, or large sewers, such as are employed in Paris, are not generally applicable to American cities because of their high first cost. Utility galleries may be advisable in connection with subway construction or in cases of extreme congestion where independent placement has used all the available space. The savings to the utility companies and the public should be sufficient to pay the fixed charges and maintenance of the galleries plus the cost of placing the utilities in the galleries, if a general system is to be justified.

9. Where it is evident that savings will be made by locating utilities in the sub-sidewalk space, the city should take steps to obtain the necessary legal power to compel the use of this space by the utility companies in case the companies will not agree to locate their services in the space.

10. Where the savings to the public and to the companies do not prove sufficient to justify the immediate removal of the utilities from the street to the sub-sidewalk space, a plan may be devised whereby all extensions or additions to the systems will be placed in the sub-sidewalk space and all work in the streets will be placed in the sub-sidewalk space when it has become sufficiently depreciated to justify renewal.

ACKNOWLEDGMENT.

Realizing that the experience of some of the larger European cities in dealing with underground public utility structures might be of value, the Chicago Commission on Downtown Municipal Improvements sent its Secretary-Engineer, Mr. Louis A. Dumond, to Europe in the spring of 1914 to make investigations along this line. The present article, taken from a contribution by Mr. Dumond to The American City, summarizes the results of the investigations so made.

Instructing Firemen at Philadelphia Water Pumping Stations.

(Staff Abstract.)

Regular classes were carried on, during 1914, at some of the Philadelphia water works pumping stations for the benefit of the fireroom forces. The following is a synopsis of one of these weekly talks as summarized for the bulletin board:

Talk No. 4.—Last week the chimneys smoked more than necessary. The bar was put in the fire too much and green coal was pushed down too soon toward the dump grate. Now in Talk No. 2 we took up the different kinds of gases given off when coal is heated. If the carbon which is in these gases meets and unites with only a small amount of oxygen in the air a mixture of gases is formed which burns to CO. If the carbon meets and unites with a larger amount of air, the mixture which is formed burns to CO_2.

When CO is formed the heat which is developed by the burning is only about 4,400 B. T. U. per pound of carbon. When CO_2 is formed in the burning about 14,600 B. T. U. is formed, or more than three times as much heat. If CO goes away and up the chimney just that amount of possible heat is lost. CO is the gas that is made by the United Gas Improvement Co. to sell at $1.00 per 1,000 cu. ft. Think of the waste if we let gas which is worth $1.00 a thousand cubic feet go up the chimney. This may seem absurd, but it is a fact just the same. When you put the bar in the fire and push a large amount of green coal down to the dump grate you let the light gas distill off so quickly and in such large amounts that it has no time to take up the proper amount of oxygen. The result is that a great deal of unburned carbon in the CO gas goes up the stack in great clouds of smoke.

The object of these gatherings, as described in the 1914 report of M. L. Cooke, Director of the Department of Public Works, is to bring to the attention of the firemen lessons which may be drawn from incidents and happenings of the week with a view to increasing the interest of the men and thereby effecting economies.

Automatic Control of New Filters at Baltimore.

(Staff Abstract.)

In pumping water and in the application of chemicals and control of water filters, it is very desirable for economic reasons, simply to meet a city's needs for water hour by hour without shortage or excess. This is done at the new Montebello filters of the Baltimore water works. The filtered water reservoirs are the direct source from which the city's supply is taken, and if the water level in these reservoirs drops below a certain predetermined point, the rate of water passing through the filters is automatically increased, and if the water level rises the rate of filtration will gradually diminish until a certain high level point is reached when the filters will entirely shut down. If the filters were not controlled automatically, it would be necessary to have certain units standing idle part of the time, and before the output could be increased they would have to be put in commission. With the automatic control of the filters, it becomes almost imperative to have some similar way of controlling the pumps. A pump operated by an alternating current electric motor is run at a constant speed and, therefore, any variation in the volume of water discharged must be controlled by other means than the motor. This is accomplished by means of a device which opens or closes a large hydraulic valve on the discharge line, as the water rises or falls in the stilling chamber into which the pump discharges.

Another feature of very great importance in the operation of the filter plant is to have the chemicals applied at the proper rate. This is accomplished in the following manner: All the water entering the filter plant passes through a Venturi meter, which has a recording device located in the office of the Head House. Attached to this recording device is a small electric motor which works synchronously with a similar motor on the chemical feed controllers. By means of these motors, every movement of the indicator hand on the dial of the meter registers a similar movement in the opening or closing of an orifice under the chemical feed controller, thus admitting to the water chemicals in exact ratio to the amount of water passing into the plant. It can thus be readily seen that no matter how large or small a volume of water is being consumed, the right proportions of chemicals will be added.

From a pamphlet on the Montebello Filters by Mr. James W. Armstrong, Engineer Filtration Division, Baltimore Water Department.

Meterage at Pasadena, California.

(Staff Abstract.)

Meter Endurance Test.—The water department of Pasadena, Cal., is conducting an endurance test of all the standard makes of meters, by which it is hoped to develop the weak and strong points of each make and type of meter. The meters are set at one of the pumping stations where it is possible to pass a large quantity of water through them continuously, with no waste of water whatsoever, and with no other expense than the actual testing of the meters for accuracy which is done about every 25,000 cu. ft. The record of the efficiency of each meter is platted on a curve showing its variation after successive volumes of 25,000 cu. ft. pass through it. A record of all parts worn and cost of replacements necessary is figured in order to show the total cost per meter of registering 1,000,000 cu. ft.

Effect of Meters on Consumption.—When the city bought out six privately owned water companies in 1912 it came into possession of about one-half the water service within the limits of South Pasadena, containing about 650 flat rate services and only 5 metered services. On July 1, 1914, a Venturi meter was placed on the force main leading to South Pasadena so the exact amount of water supplied could be determined.

The first month showed that the works were supplying about twice as much water per service as in Pasadena and receiving less in water revenue per service. Therefore sufficient meters were immediately ordered to place one on every service, for two reasons: first, to conserve the water actually wasted by the flat rate consumers; and second, to increase the water revenue.

The Venturi meter readings for the month of October, 1914, being the first month after the completion of the metering, showed a reduction of 62.3 per cent over that of July before the meters were placed. There was, however, during the same period a general reduction of 21.0 per cent due to change in climatical conditions, making an actual net saving in water supplied to the South Pasadena reservoir of 41.3 per cent attributable to meters only. During the same period there was also a considerable increase in the water revenue without any change whatsoever in the rate ordinance.

While the general effect of the metering of flat rate services has hardly been questioned it is very fortunate that the department has been able to obtain the above definite figures. The metering of all flat rate services should proceed as rapidly as possible until the entire system is 100 per cent metered. At the time of the purchase of the systems by the City in November, 1912, 79 per cent of all services were metered, while at the present time 96½ per cent of all services are metered.

From second annual report Pasadena Water Department. M. H. Salisbury is Commissioner of Municipal Utilities and S. H. Morris is Chief Engineer.

Commissary Department of Philadelphia Bureau of Water.

(Staff Abstract.)

The newly formed commissary department of the Philadelphia Bureau of Water furnishes hot coffee and lunches to the men detailed on street work at night during the winter months. A description of this innovation by Arthur C. Merrill, superintendent of meters, is quoted in the 1914 annual report of Morris L. Cooke, Director of the Department of Public Works, as follows:

The establishment of a commissary department in the Bureau of Water to provide for the men engaged in emergency work is a step in the right direction. It has been installed at a very small cost and in addition to decreasing the hardship required of these men at such times, it will return many fold its cost by giving each man an increaseed efficiency.

Work of this nature usually comes in severe weather and invariably requires continuous attention both night and day until the job is completed. Unless the break has occured near a place where food can be bought during the night, the men have been obliged to practice Christian Science and believe that they were not hungry and did not need warm drink unless some thoughtful citizen in the neighborhood took pity on them and made a pot of coffee and some sandwiches.

Happily this condition is now ancient history and the Water Bureau, while looking out for the welfare of its workmen, has decreased the time which any section of the city might be deprived of its normal water supply through breaks in its distribution system.

A Flow Regulating Device for Water Supply Tanks.

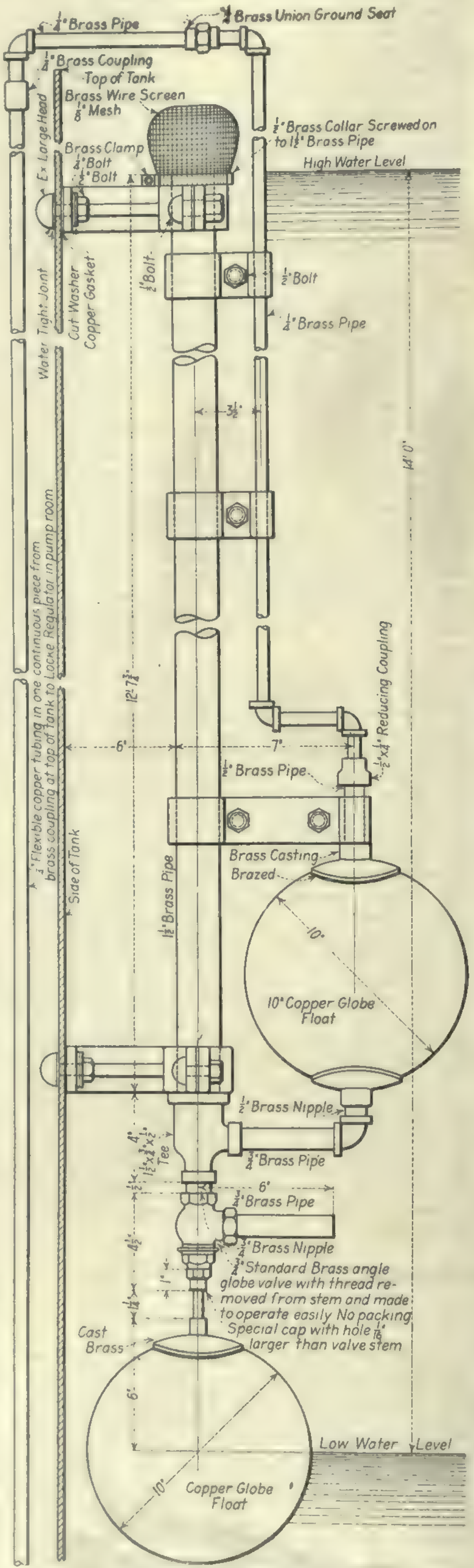
The device illustrated herewith is designed to stop and start pumps discharging into water supply tanks as the water level rises and falls to certain limiting levels.

Essentially the apparatus consists of a brass pipe of a length equal to the distance between high level and low level of the water in the tank. The upper end of this pipe is supplied with a strainer, and a valve and copper float are attached to the lower end. Near the lower end of the pipe a fitting is provided and to this an air reservoir is attached. From the top of this reservoir a pipe is carried to the top of the tank and thence, by a flexible copper tube, to a damper regulator located near the supply pump. The damper regulator is used to actuate a balanced valve or other device for starting and stopping the supply pump.

The operation of the mechanism is as follows: The water rising in the tank to the top of the pipe overflows into it and compresses the air in the air reservoir. The pressure due to the height of the water in the pipe is transferred through the flexible copper tube to the damper regulator and the regulator actuates the pump controlling mechanism and stops the pump. This pressure is held constant until the water in the tank falls to the bottom of the pipe, when the float valve opens and allows the water to escape, relieving the air pressure. Then the damper regulator acting in the usual manner actuates the controlling mechanism and starts the pump.

This type of apparatus has been in successful operation for about four years. It was designed and installed by the Samuel M. Green Co., Engineers and Architects, Springfield, Mass.

Tuning Up the Baltimore Filters.—The testing out of the various devices and pieces of apparatus in the new Montebello water filtration plant at Baltimore, commonly called the tuning up process, required much time and patience. Only those who have placed such a plant in successful operation can have any adequate conception of the multitude of things which can happen to make trouble after all the details are supposed to be in perfect working order.



Detail of Green Water Level Controller Installed at Holyoke, Mass.

The rated capacity of the plant is 128,000,000 gals. per day. The aggregate capacity of the various basins and reservoirs constructed in connection with this work is approximately 67,000,000 gals. These basins had to be filled, drawn, inspected and repaired several times before they were finally ready for service.

In the plant there are about 60 sluice gates, 300 valves of 4 ins. and over in diameter, 1,000 small valves, several thousand feet of small piping, and over 800 tons of cast iron pipe and specials. All of these gates, valves and pipe lines had to be tested and made tight under pressure.

There are 45 electric motors installed at various points in the plant. The majority of the motors are connected with devices that were erected for the first time at the plant without having had the preliminary shop test. These all had to be tried out, adjusted and readjusted, sometimes many times before they operated perfectly. There are 53 recording gages, for different purposes, each of which is operated by clockwork and each of which had to be separately adjusted and regulated.

Engineering and Contracting

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The Lighter Side of Engineering and Contracting

Thanks to the Periodical Spree.

A TUNNEL contractor who secured a contract for a long railroad tunnel in Arizona experienced considerable trouble with his contract. The first month revealed the work was carried on at a loss of $5,000. The second month indicated a still greater loss. His chief office accountant stationed on the job had furnished the contractor with monthly cost sheets for the two months' work with glaring figures in the "Red." The contractor urged that the third month's report must show up entirely in the "Black." However, the head tunnel foreman informed the accountant a loss would be evident again. In the meantime an old superannuate of the contractor's, in charge of the commissary, went on one of his periodical sprees. He invaded the commissary in search of alcoholics, drinking all of the lemon extract in stock; then, proceeding into the accountant's office, he made way with all the red ink. The next day he landed in the camp hospital with a full-sized case of the D. T.'s. The monthly reports were just being closed out, but no red ink was available to show the results of the work. The reports reached the contractor rendered entirely in the "Black." He was very much elated that the work was finally being performed at a profit. However, several days later a letter followed, explaining the discrepancies were not properly shown, as there was no red ink in the camp to indicate the true reflections of the figures.—C. A. E., Los Angeles, Cal.

The Bluff that Failed.

PAT was a new man in camp. Saturday night the boys were lined up to the bar and just as Pat poured his whiskey a "friend" yelled, "Fire out in front." Pat ran to the door, looked out and returned. His whisky was gone! Pat ordered another. "Man dropped dead," yells another "friend" rushing in through the door. Pat satisfied his curiosity and found on his return that his liquor had again disappeared. "Some joker," says Pat, "but I'll fool 'em, if they ever spring that trick on me agin." Pat called for his drink and then wrote on a card, "I spit in this glass," and placed the card over the well filled tumbler. Pat walked to the door in response to another "call" and returned. He lifted the card and was about to "partake" when he spied beneath his own warning the uncertain scrawl of some "friend"—"So. did I."—H. J. F., Chicago.

Why the Farmer Climbed the Fence.

THE owner of the first automobile in Richmond, Ky., was driving through the hills at some distance from town one day when he noticed a farmer had stopped his horse a few rods in front and was looking very intently at the approaching car. In a moment the son of the soil jumped hurriedly out of the wagon, climbed over the rail fence and stood there. One of the occupants of the car went ahead to hold the horse while they passed. The horse did not seem at all concerned and while waiting for his friend to get in the driver remarked to the farmer: "Your horse didn't seem much afraid. Guess he never saw an automobile before." The farmer replied, "He hain't got nothing on me. I never did either."—A. P. R., Chicago.

Well Meant Advice.

H. B. KIRKLAND, the Chicago concrete specialist, was waiting at the elevated railway station the other night. An inebriated individual had stood on the L platform and watched several trains pass when the colored gentleman who acted as janitor and general platform scavanger finally became interested and approaching the swaying man said, "If yo' all is planning to go somewhere, you bettah get on the train. Dis yere platform don' go no where, it jus stays right yere all the time. Yo' got to take de train to go anywhere!" The man took the next train.

The Long and Short of It.

MIKE GRADY, the sewer contractor, at one time had in his employ two Irishmen who, on account of their size, were nicknamed the long and short of it. One of them was some inches over 6 ft. in height while the other was not much over 5 ft. One day these two men were trenching for a sewer line. The foreman noticed that one of them was handling a great deal more dirt than the other. So he yelled at the big fellow: "Look here, Pat, how is it that little Johnnie Fallon, who is only half as big as ye, is doing twice as much work?" Pat looked at the diminutive Johnnie and then replied: "Faith why shouldn't he, ain't he nearer to it?"

"Seein' Things."

A NORTHERN contractor specializing in levee work invaded Southern territory. He succeeded in obtaining several good contracts in Louisiana, one of them requiring that a large job be undertaken during August. The contractor found the sultry atmosphere along the "Old Mississippi" almost unbearable and one hot August afternoon while cherishing within his mind James Whitcomb Riley's old poem, "The Old Swimmin' Hole," he inquired of Sam Jackson, a colored levee worker, where he could enjoy a good swim. Sam showed him a secluded swamp-like pond in the nearby timbers. The contractor said, "Well, Sam, this pond must be free from snakes." "Yass suh, Boss," replied Sam, "Der's narry snake in dat hole." The contractor after enjoying his swim returned to the camp much refreshed. Sam immediately inquired of his Boss how he enjoyed himself. "Immensely," replied the contractor. "And I never saw a single snake. But, Sam, what was all those black logs floating around in the pond." Sam, snickering, replied, 'O'h, dem's only alligators, Boss, dey feeds on snakes. Dat's why you neber seen any."—C. A. E., Los Angeles, Cal.

Good Bait Anyway.

THE following story was told at a recent informal meeting of engineers at Richmond, Va.:

A man in North Carolina, who chose to do a day's work occasionally to secure booze while his wife toiled to support him, wandered off one day, fell in a stream, and was drowned. After several days' searching and dragging the river, his body, with catfish clinging tightly to his toes and fingers, was found and brought ashore. Shortly after his wife arrived at the scene. With arms akimbo she viewed the body some time, then said: "Bring the fish on up to the house and set him again."—S. E. R., Richmond, Va.

Safety First.

A WELL known consulting engineer of New York City was colonel of a Pennsylvania regiment during the civil war. In one of the battles he noticed that an Irish private stuck very closely to him. Finally impelled by curiosity he had the soldier brought before him. "Dugan," began the officer, "you've stood by me nobly this day." "Yis, sor," replied Dugan, saluting. "Me ould mother sez to me: 'Me boy, stick to the colonel and ye'll be all right; thim colonels niver get hit.'"

Otherwise a Perfectly Good Mayor.

THE mayor of an important Indiana city was recently impeached. Thirty-five charges were brought against him including: Misuse of city funds and city property, padding the city payroll, extortion of money from city employes for private use, non-payment of debts, excessive use of liquor, making false charges against aldermen, bringing liquor and causing liquor to be brought into the city hall, possession of immoral and corrupt traits of character, drunkenness, tax dodging, and bearing a bad reputation for truth and veracity. This miscreant even levied tribute against the Jitney Drivers' Union.

Skinner Mulvey says: I'm going back to Red Eye for old home week. They're advertising as a special attraction a total eclipse of the sun. The man who always says I can't is about as useful as a clock without hands.

CURRENT NEWS

The Doings of the Week.

Industry and finance received no set backs during the past week. Commercial progress included more gratifying factors as a basis for sustained advance. The National City bank of New York in its November letter states that reports of business improvements are coming from all parts of the country and that the contrast they make with conditions a year ago are calculated to inspire the most profound sentiments of relief, satisfaction and gratitude. Robert S. Lovetts, chairman of the Board of Directors of the Union Pacific R. R., also is optimistic as to the future. In an interview last week at Denver he predicted a great business boom. He stated the railroad business was looking up and that he believed the gain would be maintained for a long time. Referring to his own road he added: "It would not be unfair to assume that if business continues to improve we shall be obliged to make extensions." This last statement is significant, for officals of the leading railways have been reluctant heretofore to admit even a possibility of undertaking important new lines or extensions. In the construction field there has been no great activity during the past week in offering new work for bids. Several good sized jobs, however, did reach the call for bids stage, and a number of other large projects were advanced, so that the taking of bids on them is now only a question of a few days. In the building field there is considerable activity and the sharp improvements of the past three months are well maintained. In the iron and steel trade there was a further accumulation of heavy contracts, and prices on many steel commodities were advanced. Rail contracts included 175,000 tons for the Pennsylvania R. R. and 100,000 tons more for export. Boston & Maine, Maine Central, Chesapeake & Ohio and Missouri, Kansas & Texas placed rail orders. Contracts for 240,000 tons of bars, plates, shapes and axles were placed by car builders, and they received orders for 21,000 cars, including 7,000 additional for the New York Central Lines. Contracts also were awarded for 20,000 tons of steel for building and bridge work and 50,000 tons of steel plates for shipyards. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Oct. 27 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Oct. 27. Cts.	Oct. 20. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.559	1.559
Iron bars, Pittsburgh........	1.45	1.40
Iron bars, Chicago............	1.45	1.35
Steel bars, Pittsburgh........	1.50	1.45
Steel bars, New York........	1.669	1.619
Tank plates, Pittsburgh.....	1.50	1.45
Tank plates, New York......	1.669	1.619
Beams, etc., Pittsburgh......	1.50	1.45
Beams, etc., New York......	1.669	1.619
Skelp, grooved steel, P'gh..	1.45	1.40
Skelp, sheared steel, P'gh....	1.50	1.45
Steel hoops, Pittsburgh......	1.75	1.50
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.10	2.00
Galv. sheets, No. 28, P'gh....	3.50	3.50
Wire nails, Pittsburgh.......	1.85	1.85
Cut nails, Pittsburgh........	1.80	1.70
Fence wire, base, P'gh......	1.70	1.70
Barb wire, galv., P'gh.......	2.70	2.70

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over 1.50 cts

Railways.—A small amount of railroad construction came up during the past week. The Santa Fe System opened bids for reconstructing 20 to 30 miles of line in Texas, damaged by the recent tornado. Bids also are understood to have been taken on two or three small betterment jobs by other railrailroads. Engineering work is now underway for several new projects, but it probably will be some time before any of these reach the construction stage. The Philadelphia & Reading Ry. is asking bids for reconstruction of coal yards at Emerald St., Philadelphia, Pa.; the Public Service Commission of New York City also is calling for proposals on two contracts, one of them calling for the installation of tracks for the Steinway Tunnel Rapid Transit Ry.

Roads and Streets.—No particularly large state highway jobs reached the call for bid stage last week. Several good sized paving contracts, however, came up for advertising. Miami, Fla., is asking bids on 15,000 sq. yds. asphaltic concrete and 100,000 sq. yds. of sand and asphaltic oil paving; Greenwood, S. C., opens proposals Nov. 10 on 60,000 sq. yds. of pavement. The County Commissioners at Dothan, Ala., are asking bids for the construction of 42 miles of road; County Road Commissioners at St. Joseph, Mich., are calling for proposals on 48½ miles of water bound macadam to cost about $340,000; County Commissioners at Hondo, Tex., are advertising 20 miles of gravel road; Talbot County, Maryland, is calling for bids on 5 miles of state aid highway. Bids were opened by New York State Highway Commission on 29 contracts, the largest job calling for an expenditure of about $140,000. R. L. Peters, Knoxville, Tenn., was awarded $150,000 contract by Pike Commissioners of Cocke County.

Bridges.—No large bridges appear to have been advertised during the past week. The County Commissioners at Caldwell, Idaho, are asking bids on a $17,000 to $18,000 steel structure. F. C. Mueller & Co. at $131,939 was low bidder on the Choteau Ave. viaduct, St. Louis, Mo.

Drainage and Irrigation.—No particularly large new jobs either in the drainage or irrigation fields came up for advertising the past week. Drainage District No. 3 of Victoria, Tex., awarded a $190,000 contract to U. B. McCurdy. W. P. Bulloch Co., Kansas City, Mo., secured the contract for 15 miles of canals and 90,000 cu. yds. levee for the Atchafalaya Levee and Drainage District. Bids were opened by the U. S. Reclamation Service for excavation for the Ironstone Canal, Uncompahgre Project.

Water Works.—One of the largest pipe line contracts of the past two or three months was advertised last week. The work calls for the construction of 11 miles of 72 in. steel pipe for Jersey City, N. J. This city also is asking bids for furnishing and laying double line of 48 in. pipe under Passaic and Hackensack Rivers. Lynn, Mass., opens bids Nov. 9 for the construction of its Ipswich River pumping station. Melrose, Wis., is asking bids for water works, and West Frankfort, Ill., is doing likewise.

Sewerage.—Principal new sewerage job reaching the call for bids stage last week appears to be the work for Sandusky, O. This calls for intercepting sewer No. 2, estimated to cost $98,000. Greenwood, S. C., is asking proposals on 10,000 ft. of 12 in. to 20 in. storm sewer. Idaho Falls, Idaho, awarded an $18,000 contract for sanitary sewers; Ogden, Ia., let a $38,000 contract for a sewer system; Algona, Ia., awarded contract for three sewers to cost $17,500.

Rivers and Harbors.—Bureau of Yards and Docks has readvertised for bids for dredging at Norfolk, Va., navy yard, the work involving some 700,000 cu. yds. of excavation. The U. S. Engineer at Philadelphia, Pa., is calling for proposals for dredging in the Delaware River, requiring 2,350,000 cu. yds. of excavation. Portsmouth, O., opens bids Nov. 17 on the second section of its flood protection wall requiring 7,670 cu. yds. of reinforced concrete.

Financing Irrigation Projects.

In the last few years numerous irrigation districts have been organized in the states of Oregon, Washington and California. The engineering work for most of these projects has been completed and in many cases bond issues for carrying out the developments have been authorized. Under present financial conditions, however, the district bonds are not sold readily for cash, and as a consequence a large amount of construction work is being held in abeyance. There now seems to be good indications that several of these districts will carry out their undertakings. Negotiations are pending on several projects for construction on the basis of the exchange of bonds for work and materials. If this plan of financing is successful contractors will find plenty of use for their idle outfits.

Mexico.

Mexico will offer a rich field for the engineer and the contractor when normal conditions are restored. In the last four years there has been practically no industrial or constructional activity in the Southern Republic. Factories have been burned, mines abandoned and railways destroyed, during the revolutions and counter revolutions that followed the resignation of Diaz. It is estimated that it will take at least two years to get some of the railways in safe working condition. Bridges have been blown up and long stretches of road bed put out of commission. The reconstruction of the railroads alone will require the expenditure of many millions of dollars. The recognition of the Carranza government by the United States already seems to have made a change for the better. Immediately following this action New Orleans bankers agreed to finance this year's Mexican sisal crop to the extent of $10,000,000. The Constitutionalist government sent out orders for many millions of feet of timber, placed dredges at work at Tampico harbor, and approved the plans for a new $1,500,000 union station at Mexico City. These are the first reports of industrial and constructional activities in the republic for some months and consequently are most encouraging. It, of course, will be some time before normal conditions are restored in Mexico, but when they are there will be something doing in the construction line.

Bond Issues at November Elections.

The elections to be held this month in various states are of much importance to contractors. An unusually large number of bond issues for state, county and municipal improvements will be voted upon. In addition several private projects, involving great construction undertakings, will be submitted to the citizens. The voters of Cleveland, O., will take action on the granting of franchises for the building of two railway terminals, the total estimated cost of which is in the neighborhood of $30,000,000. In New York state a $27,000,000 bond issue for the completion of the state barge canal will come before the electorate. The voters of California will pass upon a $15,000,000 bond issue for completing the state highway system. A considerable number of municipalities will vote on large issues of securities for carrying out construction undertakings. Cincinnati and Pittsburgh alone propose bond issues amounting to over $7,000,000. Favorable action on the bond issues and franchises will mean the undertaking of a large amount of public and private construction.

A $3,000,000 RIVER IMPROVEMENT PROJECT.

Proposed by Fall River, Mass., for Quequechan River.

Involves 100,000 Cu. Yds. Concrete, and 75 Miles of Sewers.

A $3,000,000 construction project is now under consideration by the city council of Fall River, Mass. This development provides for the abatement of the Quequechan River nuisance, considered one of the most pressing problems in sanitation in Massachusetts today. The cotton manufacturing business of Fall River, with its 4,000,000 spindles, has developed along the banks of the Quequechan River. This serves as an outlet from the Watuppa Ponds, aggregating in area the largest body of fresh water in the state, and standing at a level of 130 ft. above tide water which is only about 2 miles distant. Through the damming of the stream and the overflowing of the flats, constant discharges of hot and oily water from the distant mills, as well as the surface water from the higher ground, an area in some places 2,000 ft. wide has been converted into a nuisance. To suggest a remedy for these conditions and a plan for improving the Watuppa Ponds, the Watuppa Ponds and Quequechan River Commission was created in 1913. The commission retained the firm of Fay, Spofford & Thorndike, Boston, Mass., as Consulting Engineers. The report of this commission and its consulting engineers was submitted recently to the city council.

Under the scheme of improvement presented in this report, works have been designed to provide for the improvement of water supply to the mills, for the complete utilization of all available water by development of increased storage capacity in one of the ponds and the abatement of the nuisance of the Quequechan River. In general the proposed improvement provides for the following:

The construction of a main conduit which together with its branches will provide an adequate supply of clean cold water to the mills; the return of the hot water discharge from the condensers of the mills above the dam to a supply pond where, after purification and cooling, it will become available for use again; a change in the point of discharge of surface water and overflow from the pond; the construction of a system of drains for surface water to afford relief to the existing overtaxed combined sewers; the construction of additional sewers to take the sewage and wastes from the mills and other buildings along the river valley, which now pollute the stream; the construction of a outfall sewer and the filling of the entire area of the Quequechan River flats, and thereby not only abolishing the nuisance, but making available for industrial purposes, or other uses, a large tract of land, the value of which will offset in part the cost of the proposed improvement.

It has been recommended that the flats be filled in with gravel filling, preferably brought in by rail from points along the line of the connecting railroads. It is shown, however, that it will be possible to obtain filling from the bed of one of the ponds by hydraulic dredging methods. In the scheme proposed by the engineers the separation of storm water and sewage is to be gradually extended throughout the river valley, and a complete system of drains for surface water has accordingly been planned. New sewers must be constructed at the outset to care for mill sewage and other existing pollution of the river, as well as to provide for sewering those portions of the valley which may be built up after the improvement is accomplished.

In considering the question of water supply to the mills the first problem to be solved was that of providing an adequate supply of cold water in place of the limited supply of hot water now available. The only satisfactory solution of this problem was found to be that of keeping out of the river the hot water discharge from the mills, collecting it in an adjacent channel, clarifying and cooling it, and discharging it into the supply pond for further use. An enclosed conduit placed wholly underground at such level as to develop the maximum available storage of the pond, and at the same time always flow full, was found to be the most economical type of construction for supplying cold water to the mills.

The location of the cold water conduit under ground makes it both feasible and economical to build a channel for the return of the hot water above this conduit, thereby saving the expense of foundations for the hot water channel. This latter channel to be set at high elevation with the surface of the water in it, though below the outlets of the mill condensers, will always be above the level of the pond so that the hot water may be discharged into the latter without pumping. Between the hot water and cold water conduits at these respective levels there would remain a space otherwise wasted which has been advantageously utilized for a surface water conduit. This surface water conduit serves not only to dispose of the storm water drained from the Quequechan valley watershed, but also to draw down the level of the ponds in times of flood, thereby permitting the cold water conduit to be made of smaller size than would be necessary if it alone were to care for the flood discharge of these ponds. The incorporation of these three channels in a single structure has resulted in the design of the three-level type of conduits. The estimated cost of the project may be summarized as follows:

Total Construction Cost.—Cost of all works to be built at outset, including main and branch conduits with their accessories, sewers and drains, and the filling of the Quequechan River flats	$2,592,505
Damages.—Total amount of damages to be incurred in carrying out the improvement, including damages on account of the taking by the city of the entire area of flowed flats, cost of other land required for the proposed works, adjustment of riparian rights, and damages to be allowed to such parties as will be damaged in carrying out the improvement	100,000
General Expenses.—Cost of the priliminary investigation, administration, interest charges, and the like, incurred prior to completion of construction	250,000
Total gross cost	$2,942,505
Per Contra.—Commission's estimate of the value after filling of those portions of the Quequechan River flats acquired by the city which will become available for sale—146 acres in extent	800,000
Total net cost	$2,142,505
Benefits.—Deduct amount of benefits to be assessed "against all the property or estate which may be specially or peculiarly benefited by the construction of the canal and other works hereunder," as noted in apportionment of cost above	1,000,000
Total net cost to the city of Fall River of the improvement to be provided at the outset	$1,142,505

The engineers plan that in the construction of the main conduit, except in rock excavation, the base below the level of the bottom of the surface-water conduit will be made broad and heavy to resist possible unbalanced lateral pressure on the side and possible upward pressure from water underneath. In this lower section, mass concrete is used with but a small amount of steel reinforcement, a type of construction which may be readily built within a cofferdam in the waters of the river, if desired. Above the base the vertical side walls and floors of the surface-water and hot-water conduits are of thin, reinforced concrete construction of economical type.

In the larger sections of conduit, where the side walls are widely separated, a center reinforced concrete wall is used as an intermediate support for the floors of the surface-water and hot-water channels; openings are to be provided at suitable intervals in these center walls of both the surface-water and cold-water conduits to equalize the flow of water. The hot-water conduit is covered throughout with a reinforced concrete roof.

Where the conduit is built in rock excavation, a much smaller base section it proposed. At these points, only enough rock is to be excavated to provide for the construction of a suitable concrete lining.

No piles will be used for the support of the structure except in specific cases noticeable along the main conduit where soft material is found for a considerable depth. The drainage conduits will as a rule be similar in general construction to the main conduit. At suitable intervals in both the main and drainage conduits provision will be made for expansion, care being taken that the joints shall be properly water-tight. Provision is also to be made for the expansion of the hot water conduit independently of the remainder of the structure beneath it, as that conduit is subject to greater variations in temperature than the surface-water or cold-water conduits. Not only will the hot-water conduit be separate from the surface-water conduit by horizontal expansion joints, but the reinforced concrete beams supporting its roof are to be cast independently of the wall, and the roof slabs are to be independent of both.

The mills are connected to the main or branch conduits by intake and discharge pipes. As a rule, each intake pipe consists of a reinforced concrete pipe running from the present intake pipe of the mill to a manhole at the side of the conduit. This manhole is so designed that the water can be taken from either the cold-water or surface-water conduits, or both, the gates being controlled from a small concrete house built on top of the manhole. The concrete pipe is laid at such a level that it can still supply water if conditions should arise for unusual lowering of the level of the supply pond.

It is estimated in round numbers for the main and branch conduits that the total amount of concrete required will be approximately 100,000 cu. yds. The estimated cost, including allowance for excavation forms, etc., but exclusive of reinforcing steel, will be approximately $900,000. Over 4,000 tons of steel reinforcement will be required, costing approximately $250,000. These figures do not include the concrete reinforcing steel proposed for the sewers and drains.

The completed scheme contemplates about 60 miles of sewers and 15 miles of storm water drains. Much of this construction will range from 24-in. to 84-in. reinforced concrete lock joint pipe, while there are many sections ranging from 20 to 30 sq. ft. in area. As a part of the construction there will be a tunnel a mile long with a cross section 5 ft. by 6 ft. 3 ins.

In accordance with the Act under which the investigation and report were made, positive action upon it by the City Council is required within 30 days after its receipt by that body, but in order that all parties interested may have further time for a consideration of the matter it is quite probable that the City Council will vote to refer the report back to the Commission for further study, and that final action will not be taken for perhaps two or three months. In any case the work is not likely to reach the construction stage until next spring.

A $400,000 Water Works Undertaking in Cuba.

The Caibarien-Remedios Water Works Co. of Caibarien, Cuba, has appointed as its fiscal agents J. G. White & Co., Inc., 43 Exchange Place, New York, and awarded contract for the engineering to The J. G. White Engineering Corporation, of 43 Exchange Place, New York.

Construction is to be started immediately, and will probably be completed within one year. It is to be a gravity system water supply, from a series of springs, the main pipe line extending from the springs, through Remedios, to the city of Caibarien. In all, the system will require approximately 37 miles of pipe line to properly cover the two cities, and the cost of the entire development will be between $400,000 and $450,000.

Caibarien is located in the Province of Santa Clara, on the north coast of Cuba, and is one of the largest shipping ports on the island.

NEW WATER SUPPLY FOR ONEIDA, N. Y.

Expenditure of $500,000 Proposed.

Storage Reservoir, Service Reservoir, 22 Mile Pipe Line.

A new water supply development, calling for an expenditure of about $500,000, is under consideration for Oneida, N. Y., a city of about 16,000 population. Preliminary report on the project was submitted early in September to the Board of Water Commission, by Frederick J. Wagner, C. E. Nothing further, however, can be done until a bond issue is authorized by the citizens.

The new development proposes the securing o a gravity supply from Florence Creek in the town of Annsville, Oneida County. The watershed is located nearly due north of Oneida and has available 17.2 square miles of run-off area. This territory is sparsely settled. The proposition comprises a dam with crest elevation of 915 ft. above tide, with an impounding reservoir connected by a 20 in. and 18 in. cast iron pipe line with a service reservoir of water surface elevation 670 ft. above tide, located on the hills south of Oneida. The flow through the pipe line would be controlled by an automatic regulating valve. The general elevation of the city is 440 ft. above tide, and with a service reservoir at elevation 670 ft. above tide, the static pressure would be approximately 100 lbs. per square inch.

The dam will be located about 1,500 ft. up stream from the hamlet of Glenmore, and will impound about 70,000,000 gals. of water. The dam will be 28 ft. high and will have a total length of 290 ft. of which length 75 ft. will be concrete construction and the remainder earth fill with concrete wall. The estimated cost of the dam is figured on a base of sufficient width to allow of raising the crest an additional 10 ft. thus impounding approximately 200,000,000 gals. The storage reservoir will extend upstream nearly 1 mile and will cover about 33 acres in area.

The service reservoir will be located on the hills south of Oneida and will be 21.6 miles distant along the pipe line for the dam above Glenmore. It will have a capacity of 12,000,000 gals, which is approximately a supply for the city for one week. This reservoir is to be an earth basin with side slopes of 1 or 1½, paved with stone, and equipped with spillway, valves, drains, gate house, etc.

The cast iron pipe line will extend across country to Fish Creek, crossing this about 4,000 ft. easterly of Taberg. It will then run in a general southerly direction to a crossing of the R. W. & O. R. R. near Humaston Station. From here it will follow the general direction of the highway to Wood Creek, and then extend to the Barge canal crossing it about 3,600 ft. westerly from New London; from here it runs in a straight line until it intersects with Lake St. about 5,000 ft. northerly from the New York Central & Hudson River R. R. From this point a 16 in. main will extend southwesterly to Willow St. and along this street to the West Shore R. R. and thence southwesterly to the service reservoir.

The estimated cost of the development is $479,000. This includes the cost of extra labor and material for the various streams, canal and railroad crossings, the necessary air gate, blow off and regulating valves, together with a Venturi meter. In addition the cost of a system of purification by chlorine gas is included. It is proposed also to add to the present distributing system by connecting a 16-in. main at Labor St. and making connections at other streets with the following:

5,480 lin. ft.		16-in.
6,580 lin. ft.		12-in.
3,776 lin. ft.		10-in.
3,250 lin. ft.		8-in.
11,525 lin. ft.	(new and relaid)	6-in.
3,500 lin. ft.	(relaid)	4-in.

The estimated cost of these additional mains in the city is $38,000. The approximate estimated cost of the new water supply is as follows:

Right-of-way, damages, etc.	$ 27,321
Pipe line, including valves, meters, etc.	328,946
Dam	55,000
Service reservoir	21,189
Chlorimator	2,000
Contingencies, 5%	21,723
Engineering, inspection and general supervision, 5%	22,809
Total	$478,988

In preparing the above estimate the cost of pipe has been computed at $23 per ton and lead at 4¾ cts. per lb. Wm. M. Baker is President of the Board of Water Commissioners of Oneida, N. Y., and Henry M. White is Superintendent of the Water Department.

A $1,000,000 Irrigation Project in Washington.

At the present time negotiations are pending for the construction of the Brewster Irrigation District project by the exchange of bonds for work, materials and equipment. This project, as noted in our Oct. 20 issue, is located in north central Washington in Okanogan County, and embraces an area of 19,500 acres along the Methow, Columbia and Okanogan Rivers. Good transportation facilities exist by rail and boat from the two towns, Pateros and Brewster, which latter town is the headquarters for the District and is situated 70 miles north of Wenatchee on the Columbia River.

Bonds to the extent of $1,2500,000 have already been voted, and all the transactions—formation of the District, voting of the bonds, etc.—have all been confirmed by the Superior Court.

The construction of the project involves a long main canal from the Methow River to the Brewster Flats, approximately 40 miles in length, for which approximately 13,000,000 ft. B. M. of lumber, about 10,000 lin. ft. of wood stave pipe, 5,000 bbls. of cement are necessary, in addition to the excavation of about 500,000 cu. yds. of earth, gravel and solid rock and the driving of 1,500 ft. of tunnel. The construction of the lateral system includes the excavation of approximately 200,000 yds. of material, the placement of 5,000,000 feet of lumber, the installation of one power plant and three pumping plants, in addition to the installation of 200 small wooden structures.

The cost of the project has been estimated, on the basis of wood flume construction throughout, at $1,069,000, or $71.27 per acre, on the basis of 15,000 acres irrigated, for which the system has been planned. This cost is increased to $83 per acre on the basis of metal flume construction throughout in place of wood for the main canal. Including the cost of financing, which has been estimated at 10 per cent on the basis of wood and metal flume, respectively, these figures become $79 and $92 per acre, respectively.

The Directors of the District are Dr. C. R. McKinley, President; J. E. Bassett and Amos Tupper and R. W. Hunner, Secretary. The headquarters are at Brewster, Wash.

O. Laurgaard, 410 Railway Exchange, Portland, Ore., is Consulting Engineer.

A $1,300,000 Sewer System for Allentown, Pa.

The Council of Allentown, Pa., a city of about 64,000 population, is now considering the selection of a site for the proposed sewage disposal plant. The plant would be constructed in connection with the new sewer system now in contemplation by the city. A supplemental report on the estimated cost of this system was submitted Oct. 15 to the City Council by Charles D. Weirbach, City Engineer. According to this, the estimated cost of the sewerage with disposal plant on the Kohler Farm is $1,318,250; with plant on Klines Island the estimated cost is $1,387,500. No further steps toward construction will be taken until the question of disposal site has been finally decided.

The estimated cost of the improvement with disposal plants at the Koehler's and Island sites are as follows:

Collecting system:	Koehler's site.	Island site.
Vitrified and cast iron pipe sewers	$670,000	$685,600
Concrete sewers, including interceptors and outfall sewers	115,000	64,400
Vitrified and cast iron pipe sewers to cover extensions, etc.	150,000	150,000
Disposal plant, including settling tanks, sprinkling filters, resetting basins, etc.	225,000	225,000
Pumping station building and equipment	60,000	72,000
Auxiliary pumping station and equipment	....	12,000
Protection Against Floods	....	84,500
Bridges and roads	7,000	1,000
Value of site	21,250	42,000
Pumping station site, additional lands, right of way, etc.	20,000	1,000
Contingencies	50,000	50,000
Total	$1,318,250	$1,387,500

The estimates for the disposal works are based upon 2-story settling tanks, sprinkling filters and resettling tanks, etc. A steam pumping station and equipment for both sites is provided for in the estimates. The Koehler site will involve pumping about 50 per cent of the sewage against a head of about 70 ft., while the Island site will require pumping all of the sewage against a head of about 30 ft.

The flood protection item in the estimate covers the construction of an earthen dike carried about 4 ft. above extreme high water, the outer edges being protected by stone riprap. It is probable that 75 per cent of the earth needed for dike construction will have to be secured from sources outside the limits of the island.

Developments in Mexico.

During the past three years there has been very little constructional or industrial activity in Mexico. Recognition of the Carranza government by the United States seems to have brought a change for the better in the commercial and financial affairs of the Southern Republic. Already there are many indications of this.

Lumber dealers on the Pacific Coast have received specifications from the Constitutionalist Government covering several million feet of lumber wanted in the form of ties and stringers for railroad construction. This material is desired for the reconstruction of railways, probably primarily for military purposes. It is announced from the city of Mexico that Carranza has approved the plans for a new union station in the capital and that construction work will be started in a few weeks. Plans for this structure were made before the revolution. It will cost about $1,500,000 and will replace a number of small stations which serve the various lines entering the city from different parts of the republic. There also will be a union freight station. The improvement plans call for a rearrangement of the terminal facilities of the capital. The Southern Pacific interests also are understood to be planning an early start on certain repairs to their property where possible. One shipload of ties, over 1,000,000 ft. in all, will be delivered at Guaymas in a few days. The Southern Pacific, by the way, has announced its intention of building a direct line to the City of Mexico.

The Constitutionalist Government now has dredging underway at Tampico with a view to allowing vessels of the deepest draft to enter the harbor without difficulty. The entire National system of railways is now under Constitutionalist control, with the exception of a small stretch between Jiminez and Juarez in Chihuahua. All shops are being opened and repairs to rolling stock hastened. One contract for 1,000,000 ties already has been placed.

The longest and heaviest steel rivets ever employed on a bridge are being put in the new Hell Gate bridge of the New York Connecting Railroad, it is stated by Gustav Lindenthal. The largest are 1¾ in. in diameter and pass through steel plates which combined are 9 in. thick. On the present Quebec bridge the heaviest are 1⅛ in. in diameter.

NEWS LETTERS

St. Louis Items.

Richard K. Papin, who has been representing the Davenport Locomotive Co., informs us that they are going to close their office in St. Louis and in future will be associated with the Walter A. Zelnicker Supply Co. Will still continue to handle the Davenport Locomotives in addition to all kinds of supplies and equipment.

Seventeen bids for constructing the new Chouteau Ave. viaduct were opened Oct. 22 by the Board of Public Service. F. C. Mueller & Co. was the lowest bidder, $131,939. The highest bid was $218,003, submitted by the Koss Construction Co. The viaduct will extend on Chouteau from Vandeventer Ave. to Tiffany St., and will span the Missouri Pacific and Iron Mountain tracks. The cost will be borne by the railroads. The estimated cost by the Board of Public Service for the portions of the work included in the bids opened was $168,000. This does not include the brick railings on each side of the viaduct roadway.

A. L. Cook, Ottawa, Kan., has 25,000 yds. of machine work on the Santa Fe R. R. in Kansas to sublet. Free transportation over the Santa Fe Lines.

If a plan for the diversion of the floodwaters of Richland Creek in Belleville, Ill., suggested by John Taylor, a retired coal operator, is carried out, the city will be bisected from north to south by a tunnel. Taylor thinks his plan to drop the creek into a tunnel 30 feet under ground and of large dimensions, where it enters the city on North Illinois St., and an opening for emergence at the point where Illinois bisects the southern city limits, is not only feasible but more practical than following the five miles of winding course the stream takes through the city. This proposed tunnel would be about a mile long. The joint City and Commercial Club Committee which is handling the question will study Taylor's plan and have an estimate of cost made.

Keating Bros. expect to finish their county road work at Taylorville, Ill., in a couple of weeks.

The new by-product coke-oven plant of the Laclede Gaslight Company was inspected last Saturday by members of the Associated Engineering Societies of St. Louis, under the auspices of the Engineer's Club. The party, which consisted of 125 persons, made the trip in four parlor cars on the United Railways Company.

Dudley Smith came in from Benton, Ill., hunting work for his 10-team outfit, which is about through at that point.

The Capitol Building Commission announced on Oct. 23 that the specifications soon will be ready for bidders on the construction of the "terrace" or 25-foot driveway to extend around the new Statehouse. The masonry and concrete work will cost approximately $75,000. The contract is independent of the construction of the building. Much work will be involved in the rearrangement of the Statehouse grounds, but these contracts will not be considered until some time next year.

John Kenney, Windsor Hotel, Hannibal, Mo., has 80,000 yards of levee work opposite there to let in quantities to suit outfits or will hire teams by the day.

The Mississippi River Commission will meet for its usual fall session on board the steamer Mississippi at St. Louis, Nov. 18. The commission will make an inspection trip from St. Louis to New Orleans, and will give public hearings in St. Louis and at points along the route on matters connected with the improvement of the Mississippi River. Anyone who may wish to meet the commission in connection with river improvement or levee work is requested to communicate with its president, Room 1322 International Life Bldg., St. Louis, by Nov. 12.

A. W. Nyquist, representing the Eymon Continuous Crossing Co. of Marion, Ohio, was here last week demonstrating their new Interlock Continuous Crossing to the different railroad managers in this city.

The Wood River Drainage Commissioners of Wood River, Ill., expect to petition the County Court this week for permission to make a new assessment of the property in the district to raise funds to put through the drainage system as originally planned.

F. A. Voorhees of Alton was awarded the contract for erecting a building for the Alton State Hospital to cost $71,600. John Moroff of Kankakee was awarded the contract for another building for $30,248, and A. W. Stoolman of Champaign was awarded a third contract for $17,280.

Big Riley of Clapp, Norstrom & Riley, Chicago, spent a day at the stock yards here looking for feeders, which he intended to ship to his father's farm in Wisconsin. Riley left for Omaha expecting to buy more cattle there.

Water Commissioner E. E. Wall announced Oct. 21 that the Board of Public Service would introduce at the Board of Aldermen meeting a bill for an appropriation of $300,000 of the Water Department funds to build a 36-inch main from Bissell's Point to the Compton Hill reservoir. The main will be 27,000 feet long. It will give the district service by the Compton Hill reservoir a higher water pressure, and will increase the reservoir's capacity from 60,000,000 to 80,000,000 gallons. The reservoir serves about two-fifths of the city, including all the district south of Mill Creek Valley and some of the downtown section. With this appropriation the Water Department will have spent $1,016,000 this year for improvements. To build a reservoir roof at Baden and Bissell's Point, $290,000 has been appropriated, and $425,000 for enlarging and reinforcing the Compton Hill Tower. Water Commissioner Wall said the Compton Hill district has not had sufficiently high water pressure for the past twenty years and this water supply was one of the first to become low during the hot weather when greater quantities of water are used. There is but one direct main to the tower from Bissell's Point at present.

A. B. Koenig.

Water Front Improvements at Brooklyn, N. Y.

The Public Service Commission for the First District of New York City and the New York Dock Co. have perfected an agreement which, it is estimated, will save the city of New York at least $500,000 in the cost of construction of the new subways and will result in the immediate expenditure of at least $1,250,000 by the company for the improvement of the Brooklyn waterfront between Fulton St. and Atlantic Ave. The improvement contemplates the replacement of the existing piers, which are about 400 feet long, by five new piers, which will be from 540 to 750 feet in length, more than doubling the capacity of the piers and making possible the accommodation of much larger vessels than can be taken care of with the present pier space. Incidentally, three of the new piers will be erected over the existing subway tunnel is Joralemon St., and the two new subway tunnels in Montague and Clark Sts., so that absolute protection will be afforded for these tubes. The agreement provides for the purchase by the city of casement rights for the new subway at the foot of Clark St., Brooklyn, for $275,000, and that the dock company will agree to pay at least $75,000 for property owned by the city at the foot of Montague St. and at least $25,000 for property owned by the city at the foot of Joralemon St., Brooklyn.

Buying by the Railways.

Railroads buying the last weeks of October reached the proportions of the "flush times" of a few years ago. In the week of Oct. 23 rail orders amounting to about 200,000 tons were placed for delivery next year. Up to the present business of this character has amounted to over 600,000 tons. The Russian government during the past week added 85,000 tons to its orders given previously to the Lackawanna Steel Co., and sent out inquiries for another 50,000 tons. Definite inquiries for its 1916 rail needs have been made by the Pennsylvania R. R. and orders for 175,000 tons placed.

A few of the rail, car and locomotive orders placed in the last few days were as follows: Santa Fe System, 30 Mikado locomotives, 4,000 cars, 10,000 tons rail; Illinois Central, 59 locomotives, 1,000 refrigerator cars, 55,000 tons rail; Baltimore & Ohio, 1,000 hopper cars, 500 box car bodies; Central of Georgia, 500 fruit cars and 500 box cars; Philadelphia & Reading, 2,500 cars; Great Northern, 2,000 tons rail; Pere Marquette, 17,000 tons rails; Wabash, 7,500 tons rails; Monon, 5,000 tons rails; Western Maryland, 1,000 hopper cars; Central of New Jersey, 2,500 cars of various types. Other railroads, including the New York Central Lines, Louisville & Nashville, Norfolk & Western, also came into the market with larger orders or inquiries.

National Water Law.—The special committee of the American Society of Civil Engineers on "A National Water Law" will hold a meeting in Chicago on Nov. 4 to 6, inclusive, at the rooms of the Western Society of Engineers, 1735 Monadnock Block. The committee consists of the following: F. H. Newell, chairman, professor of civil engineering, Urbana, Ill. Charles W. Comstock, formerly state engineer of Colorado, First National Bank Bldg., Denver, Colo. Geo. G. Anderson, consulting engineer, 1443 Fuller Ave., Hollywood, Cal. Clemens Herschel, 2 Wall St. New York. W. C. Hoad, professor sanitary engineer-50,000 tons. Definite inquiries for its 1916 ing, Ann Arbor, Mich. Robert E. Horton, consulting hydraulic engineer, 57 Pine St., Albany, N. Y. John H. Lewis, state engineer, Salem, Ore. Chas. D. Marx, president Am. Soc. C. E., Stanford University, Cal. Gardner S. Williams, vice-president Am. C. E., Ann Arbor, Mich. The subject under consideration is one of great importance to the citizens of the United States as a whole, and has to do with the future development and best use of the water resources of the country in municipal and domestic supply, power, irrigation, drainage, stream pollution, etc., involving many interstate problems.

INDUSTRIAL NOTES

Mr. C. C. Todd, western sales manager of the Central Foundry Co., New York City, has been appointed second vice-president, with headquarters in New York City.

The Sullivan Machinery Co. has removed its St. Louis branch sales office from 705 Olive St. to suite No. 2006, Railway Exchange Bldg., where larger and more desirable quarters have been prepared.

The Garford Motor Truck Co., Lima, O., has opened a branch in Chicago. The new company, which is known as the Garford Motor Truck Co., Inc., has a sales and service station in the building formerly occupied by the Jeffery distributors at the corner of 23rd St. and Indiana Ave. G. A. Crane is manager of the new branch.

To celebrate a record breaking September business, about 30 members of the Detroit Steel Products Co., Detroit, Mich., were the guests of General Manager J. G. Rumney, at a banquet given Oct. 19 in one of the private dining rooms of the Detroit Athletic Club. The September output of the company, including both Fenestra solid steel windows and also Detroit self lubricated springs, also made by the company, was the biggest in the history of the company. At the banquet speeches were made by Mr. Walter S. Russel, president of the Russel Wheel & Foundry Company of Detroit, and by Mr. E. S. Drummond, vice-president of the Detroit Steel Products Co. During the evening, stereopticon views, reproduced from photographs taken by Mr. Rumney on a recent business and pleasure trip throughout the West, were thrown on a screen.

PERSONALS

Mr. L. E. Faulkner, division engineer of the Mississippi Central at Hattiesburg, Miss., has been appointed chief engineer with office at Hattiesburg. Mr. Faulkner entered the employ of the Mississippi Central in 1905 as levelman. He became resident engineer in 1906, and division engineer at Hattiesburg in 1908.

Mr. Gilbert H. Hutchinson has become associated with the Bucyrus Company of South Milwaukee, Wis., as western representative in charge of the recently opened office at 900 Hibernian building, Los Angeles, Cal. Mr. Hutchinson was for six years road foreman for the Central Railroad of New Jersey. For one year he was salesman and since 1907, has been district manager for N. B. Livermore & Co., of San Francisco.

Mr. Edward S. Ault has been appointed city engineer of Marion, Ohio, chosen by civil service examination. Mr. Ault was consulting civil engineer for the Marion Steam Shovel Company for the past four years. His first experience was in railroad location work. Later he was engineer for the American Zinc and Lead Company at Joplin, Mo., and in 1903 became resident engineer for an electric line. From 1905 to 1911 he was county engineer for Marion county, Ohio.

Mr. J. Frank Bowen has been reappointed as superintendent of roads and bridges and city engineer for Manchester, Conn. Mr. Bowen is a graduate of Vermont University and a member of the Connecticut Society of Civil Engineers. He held the position to which he has been reappointed during the past two and one half years, and was formerly first assistant engineer for A. B. Alderson of West Hartford, Conn. His earlier experience was that of assistant engineer for the Vermont Marble Co., for A. William Sperry of New Haven and later for Durkee, White & Towne, Engineers, of Springfield, Mass.

Mr. C. H. Fullerton of New Liskeard, Ont., a civil engineer and surveyor, well known in northern Ontario, has been appointed superintendent of colonization roads in Ontario succeeding Major W. H. Bennett who lost his life at St. Julien. Mr. Fullerton is a graduate of the University of Toronto and has been engaged in general engineering and surveying for the past fifteen years, specializing in municipal engineering and road construction. The proposed colonization roads in the newer portions of the province are expected to encourage the settlement and development of these sparsely settled districts. It is proposed to spend annually about $400,000 in this work.

Mr. Charles H. Vaughn, formerly second vice-president and chief engineer, and Mr. H. R. Hortenstine, formerly contracting manager of the Penn Bridge Company, of Beaver Falls, Pa., have severed their connection with that company and have formed a partnership with Mr. J. O. Childers, formerly with the erection department of the McClintic-Marshall Construction Company. They have purchased the plant and assets of the York Bridge Company of York, Pa., and will incorporate and operate under the name of the York Bridge and Construction Co. The company will have its plant ready for operation before the end of the year, and will engage in the manufacture and erection of steel bridges, buildings, lock gates, coal tipples and breakers and all kinds of structural steel work. The organizers of the new company have each had extensive experience in these lines. Mr. Childers was in charge of erection of the lock gates at the Panama canal.

Mr. Arthur C. Everham has become associated with the Kansas City Bridge Company as engineer of construction. Mr. Everham has been assistant chief engineer for the Kansas City Terminal Railway for the past five years, and was in active charge of construction of the depot and terminals at this point. During the season of 1910 he had charge of extensive construction of dock and terminal facilities at Toledo, Ohio. From July, 1907, to December, 1909, he was assistant tunnel engineer in charge of the construction of the Detroit River tunnels. He also had charge of the general plans and specifications for the construction of the terminal facilities at both ends of the Detroit River tunnel for the Michigan Central railroad. Prior to that time he had several years' experience in subway, retaining walls and other terminal construction work for the same railroad in Detroit. Mr. Everham is a graduate in civil engineering from the University of Cincinnati, class of 1902, and is a member of the American Railway Engineering Association, the Railway Signal Association and of the American Society of Civil Engineers.

Mr. Victor R. Walling, first assistant engineer of the Chicago & Western Indiana, has been appointed principal assistant engineer in charge of construction and maintenance with offices in Chicago. The work now under way of which Mr. Walling will take charge, includes the elevation of the tracks in Chicago from 70th street to 91st street, involving over 45 miles of track and the separation of grades between passenger and freight traffic, the construction of additional yard facilities and much other work of the kind. Mr. Walling graduated from the Kansas State University in 1901, receiving the honorary degree of C. E. in 1911. After leaving college he entered the employ of the Greene Cananea Copper Co. in Mexico and Arizona as draftsman and transitman. The year following he became connected with the Southern Pacific on preliminary surveys and location. He returned to the Greene Company, as assistant engineer, and later became superintendent in charge of railroad, mill and smelter construction and railroad maintenance and operation. He left that company in 1912 to enter the service of the C. & W. I. as first assistant engineer in charge of track elevation, clearing yard and shop construction and the construction of the new draw bridge over the Calumet near Dalton. Mr. Walling is a member of the American Society of Civil Engineers, the American Railway Engineering Association and the Western Society of Engineers.

CONTRACTORS.

The Chennango Construction Co. of Albany, N. Y., has been incorporated to construct highways, roads, streets, bridges, dams, walls, railroads, and buildings under contract and to do dredging and excavating work. The directors are John H. Gordon, president, C. D. Murray, secretary-treasurer, and F. B. Gordon. Mr. John H. Gordon has been engaged in road building and general contracting for ten years past, while Mr. F. B. Gordon has been for more than fifteen years engaged in railroad work. Mr. C. D. Murray is a graduate civil engineer with ten years of experience on roads, canals and storage reservoirs.

The Kansas City Bridge Company of Kansas City, Mo., which has been awarded a contract for 13,000 ft. of revetment work on the Missouri River near Hartsburg, Mo., announces the appointment of Mr. Arthur C. Everham as engineer of construction for the company. He will be in charge of this work and of all the bridge, dike and revetment work handled by the company. Mr. Everham's experience has covered a diversified field, an account of which appears in the engineers' section of this department. The Kansas City Bridge Company has been engaged in similar work for three years past and is now making a specialty of river protection work as well as railroad and highway bridges and heavy sub-structure work. Mr. Alexander Maitland, the president of this company is a civil engineer as is also the vice-president and treasurer, Mr. H. P. Treadway. Both are members of the American Society of Civil Engineers. C. G. Landon and H. K. Webb are contracting agents and J. B. Neely, F. J. Kersting and W. C. Burnham are the engineers for the company.

NEW CATALOGUES

Barometric Condensers.—Paper, 6x9 ins.; 8 pp. Mesta Machine Co., Pittsburgh, Pa.

Bulletin R, describing and showing views of Mesta Barometric Condensers. Gives some data as to cost of installation and economy of operation, and explains the special design features.

Gardner Governors.—Paper, 3½x6 ins.; 12 pp. The Gardner Governor Co., Quincy, Ill.

Shows a number of Gardner standard types of governors and describes their special features. Gives price lists, table of dimensions and cuts of different styles of valve chambers used with the governors.

Portable Tools.—Paper, 3½x6¼ ins.; 20 pp. folder. Stow Manufacturing Co., Binghampton, N. Y.

Bulletin showing a few of the Stow line of portable tools, with data as to size, power requirements, weight, price, etc. List includes electric buffers and grinders, various drills, boring machines and screwdriver, etc.

Motor Trucks.—Paper, 9x12 ins.; 44 pp. International Motor Co., West End Ave. and 64th Street, New York City.

"Mack Trucks in War Maneuvers," is the title of this book, which gives an account of the performance of "Mack" armored trucks at the encampment at Plattsburg. Shows the equipment used and views of operations.

Bulb Sections.—Paper, 5x7¾ ins.; 16 pp. Carnegie Steel Co., Pittsburgh, Pa.

Contains tables and data on bulb angles and bulb beams rolled by the company. Shows ship building bulb angles, British standard and miscellaneous sections, and car-building bulb angles and bulb beams. Shows sizes particularly designed for strengthening tops of steel gondola freight cars.

Steam Shovels.—Paper, 8½x11 ins., 12 pp. Ball Engine Co., Erie, Pa.

Bulletin S-12, descriptive of Erie Revolving Shovels, illustrating and explaining the design features in detail, and the special advantages of the automatic crowding device and the three lever automatic control. Gives specifications for Type "B," shovel, shows views of sewer trenching operations and gives some operating cost data.

Turbine Pumps.—Paper, 6¼x9¼ ins.; 22 pp. Kingsford Foundry and Machine Works, Oswego, N. Y.

Catalogue No. 18, describing details of construction, of Kingsford Type "L" turbine pumps. A two-color sectional view and other photographs illustrate the text. There are also shown special type, "H," designed for heavy work, and type "SL," with split shell, designed for installation where space is limited.

CATALOGUE REVIEWS

Concrete Reinforcing and Furring Plates.—Paper, 6x9 ins.; 82 pp. The Berger Mfg. Co., Canton, Ohio.

The 1915 catalogue, showing Berger's Rib-Trus, Ferro-Lithic Multi-plex Furring Plates and Pressed Steel Cores has recently been received from the Berger Manufacturing Co. These materials are adapted for use in reinforced concrete, roofs, floors, sidings, partitions and other construction work. The catalogue is divided into five parts, headed as follows: "Improved Rib-Trus Section," "Ferro-Lithic Section," "Multiplex Steel Plate Section," "Pressed Steel Cores Section" and "Expanded Metal Lath." Each of these names except the last is a trade mark and is accentuated by being printed in red throughout the catalogue. Each section is sub-divided and indexed. The qualities and applications of the materials are described and data as to sizes, weights or other essential matters are given in tabular form. The catalogue is thoroughly illustrated with photographs, diagrammatic sections, diagrams showing methods of installation and views of typical structures where the products described have been used.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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A Hallowe'en Editorial.

Hallowe'en has long been held the time of all times when supernatural influences prevail, when elfs and goblins prank, when white skeletons trip the dance, when dry bones rattle in old tombs, and hollow voices utter warnings. In harmony with its date the Engineering Record of Oct. 30, therefore, yammers of "published cost data and the contractor." Toward the warning of contractors and the chastening of engineers it pops up a sheet on a broom and in hushed tones repeats: "Stock in trade," "local conditions," "competitors," "beware"! "local conditions," "competitors," "overhead costs," "beware"! "beware"! Three kinds of costs there are, it says. The first kind "is misleading," the second kind is "more misleading than the first," and the third kind is "closely guarded" in secret places. Yet, no! "Nothing can ultimately be hidden in the contracting business." So let all pass with face averted, "especially at present," when competition is keen, lest we see things that "would be used to increase competition even faster than it increases naturally." All this is silly, say you? Of course it is. Hallowe'en is the silly season.

The Importance of Safety Measures.

The large attendance at the recent annual convention of the National Safety Council, in Philadelphia, and the intense interest in safety methods and appliances shown by those attending this meeting, are indicative of a growing realization of the importance of this subject. It has only been within the past few years that employers and employes have been greatly concerned with safety measures, and their interest can be attributed largely to the passage of workmen's compensation laws in many states. Although economic production long ago demanded that both employers of labor and workmen give increased attention to the avoidance of accidents, it was not until these compensation laws had been in effect for some time that the importance of safety measures was generally appreciated. As soon as the employer realized that preventable injury in practically every case meant a definite expenditure on his part, together with a further loss in replacing the services of those injured, there was initiated a systematic study and investigation of accident prevention measures, with the result that the cause of accident has, in many cases, been removed at small expense.

The next step in advance was the installation in factories and shops of safety appliances; and the demand for such appliances has resulted in a new industry of large proportions. It is now possible to secure efficient safety appliances on a competitive basis, although this new industry is capable of large future development.

The solution of the problem, however, did not rest with the installation of safety appliances, as the employer soon found that an educational campaign was required to bring to the workmen a realization that it was to his advantage to use the appliances furnished. It was necessary to convince him that payment of a fixed sum in case of injury was never sufficient to compensate him for loss of time and future incapacity. Some employers deserve great credit for the work which they have done in this direction, but educational work is still badly needed in many plants. A number of firms have made large appropriations for this work, and all have been convinced that the money was wisely expended. Notwithstanding the great advance which has been made in the past three or four years it is claimed by one authority that not more than 250 of the 6,000 foundries in this country are properly equipped with safety appliances. A similar unfavorable comparison might be made in other lines of industry.

Although contractors are giving increased attention to safety measures it is undoubtedly true that they have not kept pace with the advance made by factory and shop owners—judging from the prevalent high rates of accident insurance. The hazards in construction work are generally known to be great, and the need for increased attention to accident prevention measures is correspondingly urgent. It has been shown that many accidents can be prevented by proper inspection and use of the various accessories of the contractor's equipment, and we believe that contractors could speedily force a material decrease in accident insurance rates if they would give concerted and serious thought to safety measures. In fact, with proper care, many contractors would be fully justified in assuming the risk of accident to their workmen. To insure adequate inspection and care it is necessary to mark and record each piece of equipment and to place some competent person in direct charge of the inspection work. Evidently most contractors are still unconvinced that this is advisable, even necessary. The business of contracting has long been recognized as one involving great risks, but contractors are themselves partly to blame for their present unsatisfactory condition as they have made little organized effort to lessen their risks.

Treatment of Wool Scouring Wastes.

An extended article giving a summary of the experiences so far gained in the treatment of wastes produced in scouring wool is published in this number in the Sewerage and Sanitation Section. Some of the results recorded have been observed at experimental plants and others at commercial installations. The article gathers such data as are now available into a summary and shows what methods have been proposed for the treatment of trade waste waters of this class and how these methods have worked out in practice.

The article first describes the processes in which the wastes considered are produced and fully explains the nature and composition of these wastes. In addition to these qualitative data many quantitative data are given.

Three general methods of treatment are considered: (1) The methods used in treating city sewage, whereby all valuable products contained in the liquor are lost; (2) processes involving partial recovery of valuable products combined with domestic sewage treatment methods; and (3) methods which make possible the complete recovery of valuable products. All of these methods of treatment are discussed in detail.

It is shown that the application of domestic sewage treatment methods to the treatment of heavy wool scouring liquor results in failure. Such methods may be applicable where the scouring liquors are much diluted, but such success is accomplished at economic loss since valuable products are totally destroyed which might be recovered by other methods of treatment and made to yield some return on the cost of treatment. Even where grease alone is recovered considerable revenue is realized. In such cases the waste liquors are filtered. There is available one process, known as the Smith-Leach process, whereby the wool scouring liquor is resolved into grease, potash, distilled water, sand and mud. No liquor requiring subsequent treatment remains. The value of the products recovered by this process will yield a fair return on the cost of constructing and operating the requisite works.

The article is a first-rate addition to American literature pertaining to the treatment of industrial waste waters.

Co-operation in Conducting Engineering Investigations and Tests.

At a recent meeting of the American Society of Civil Engineers, in New York, the need for co-operation in conducting experiments of an engineering character was pointed out, and a resolution was offered recommending that the Board of Directors take steps to promote, through the United States Bureau of Standards and the Engineering Foundation, a systematic plan of co-operative tests with the object of preventing duplication and waste. This recommendation is one that will gain the approval of those who have followed closely the experiments and tests made by independent investigators in various engineering laboratories. In some cases elaborate series of tests, involving unnecessary duplications, have been planned and carried out by separate investigators, merely because the subject investigated was a popular one. This is particularly true of tests of reinforced concrete constructions. The result has been that certain phases of the subject have received unnecessary attention and others practically none.

There has been a tendency for one investigator to ignore previous similar tests made by another, or at least not to familiarize himself with what has been done previously. To illustrate, the results of an elaborate series of tests extending over a period of several years were recently presented as a bulletin by a well-known engineering experiment station. These tests attracted widespread attention and were generally accepted as being the first authoritative investigation of this phase of the subject. Sometime later these tests were discussed in a series of articles by a well-known foreign authority, who lamented the fact that so much energy and money had been spent to prove what had already been fully demonstrated by tests performed several years ago by investigators in his country. Furthermore the author of the bulletin above referred to was taken to task for not giving credit to previous investigators. In this particular case we are convinced there was no intent to claim priority unjustly, although the reader of the bulletin probably would infer that no previous comprehensive tests had been made, in that none were mentioned; the author of the bulletin was simply ignorant of the fact that he was largely duplicating previous tests.

One cannot visit a considerable number of our recognized engineering experiment stations without feeling that considerable sums are being unwisely spent in duplicating tests already made or being conducted by other stations. It will generally be conceded that independent tests are sometimes necessary to eliminate the personal equation of the investigator, but this factor is no longer as important as it once was. Formerly, the investigators were inexperienced and the experiments were often performed at the instigation of commercial interests. In general, this is no longer true as most experiment stations now employ well-trained investigators and are provided with sufficient funds to cover investigations made. It is, of course, true that each state has its particular problems that require investigation, but most engineering problems are of general interest and application. We believe it is time that the work of our various state engineering experiment stations be co-ordinated. This can well be done by the appointment of a small committee, consisting of investigators of recognized standing, this committee to serve the various stations in an advisory capacity. In this manner the work could be planned and executed in a systematic manner, each station being assigned the particular kind of work which it is best equipped to perform. The committee could also co-operate with the Bureau of Standards, the Engineering Foundation, and other similar national institutions in seeking to avoid unnecessary duplications, and thus make possible an increased number of new investigations and tests.

BRIDGES

Design and Construction of the Substructure of the Buffalo River Lift Bridge, Buffalo, N. Y.

(Staff Article.)

The Delaware, Lackawanna & Western R. R. has recently completed a double-track lift bridge over the Buffalo River, a short distance east of the present grade crossing of the New York, Chicago & St. Louis, the Pennsylvania, and the Buffalo Creek railroads, Buffalo, N. Y. The construction of this bridge was made necessary by the deepening of the Buffalo River to 23 ft. at mean water level, to permit navigation by vessels traversing the Great Lakes. The bridge replaces two double-track plate girder fixed spans of about 116 ft. each, the elevation of track on these spans being about 18 ft. above mean river level. In the new movable structure the elevation of rail was raised about 22 ft. at the river crossing, to provide an overhead crossing of the tracks of the railroads mentioned above. In locating the new bridge a new channel was cut for the river about 200 ft. east of its old location, to rectify the existing sinuous channel. The construction of the piers for the lift span, which is of the "Strauss" bascule type, involved some difficult and unusual operations, and this article will deal chiefly with this part of the work.

SUBSTRUCTURE DESIGN.

Figure 1 shows the general design features of the substructures. This drawing also shows the location of both the old and new channels of the river.

As shown in Fig. 1, the new structure consists of a 40-ft. girder approach span at the east end, a fixed tower span of 36 ft., a lift span having a length of 125 ft. between bearings, a 116-ft. 6-in. plate girder span, and a 44-ft. girder approach span at the west end. Adjacent to the west approach there is a temporary girder span of 116 ft. 6 ins., which is to be replaced by a fill, this span being over the old channel of the river. The substructure consists of two abutments and four piers. The abutments and one of these piers (adjacent to the west abutment) are founded on piles, while the three main piers of the lift and tower spans are carried to solid rock, which lies about 54 ft. below the mean water level. The abutments are of the gravity type, while each pier consists of two cylindrical shafts, tied together at the top with a reinforced concrete member. The shafts of the west pier have a diameter of 12 ft., a height of 36 ft., and rest on a combined footing. Those of the rest pier of the lift span have a diameter of 12 ft., a height of 86 ft. 9 ins., and are founded on solid rock. The four pier shafts which support the tower of the lift span each have a diameter of 14 ft. These shafts are tied together transversely with reinforced concrete members, each 8 ft. wide by 10 ft. deep, and longitudinally with similar members, each 7 ft. wide by 6 ft. deep. The average height of these piers is about 89 ft. Details of the piers and abutments are shown in Fig. 1.

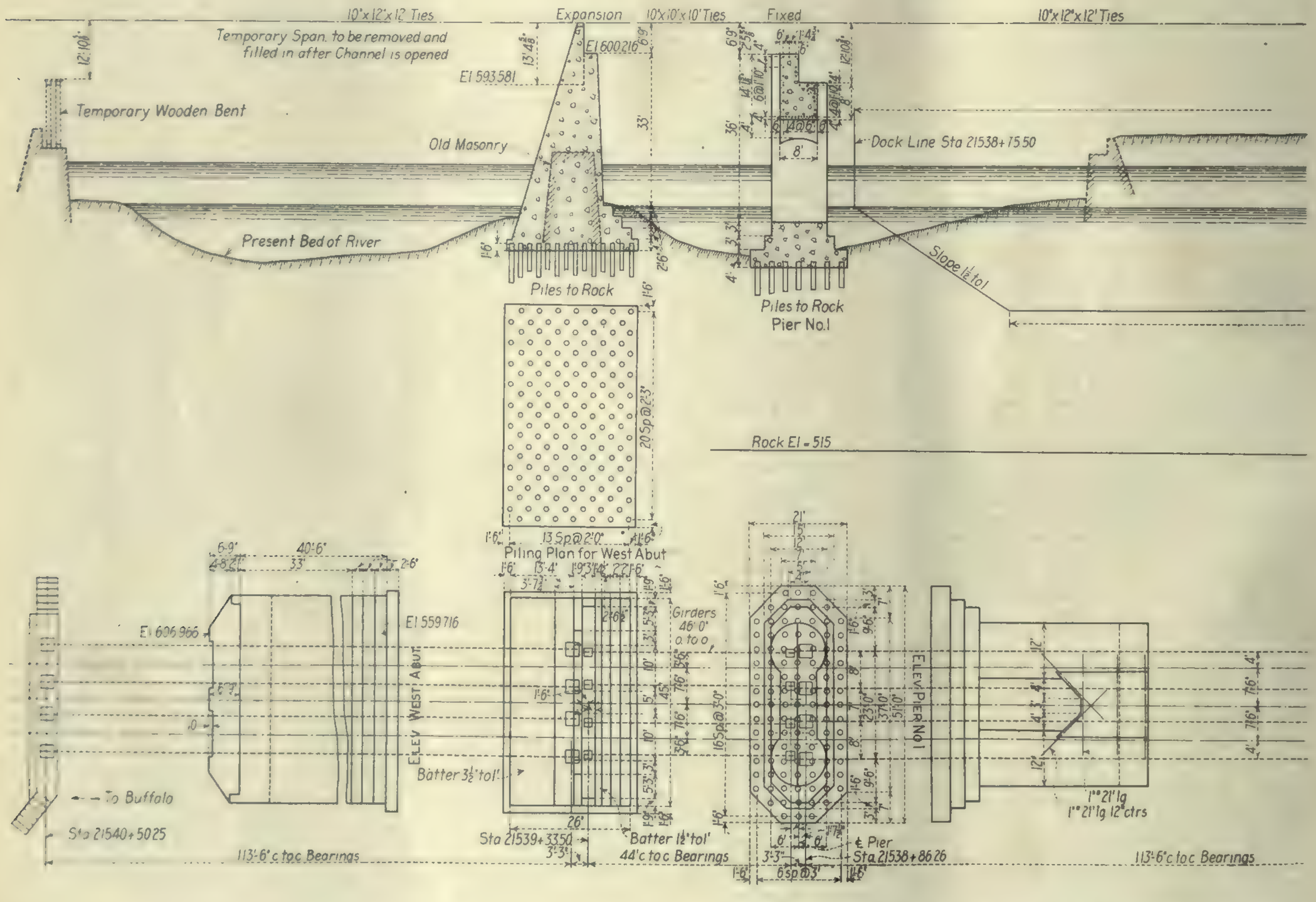


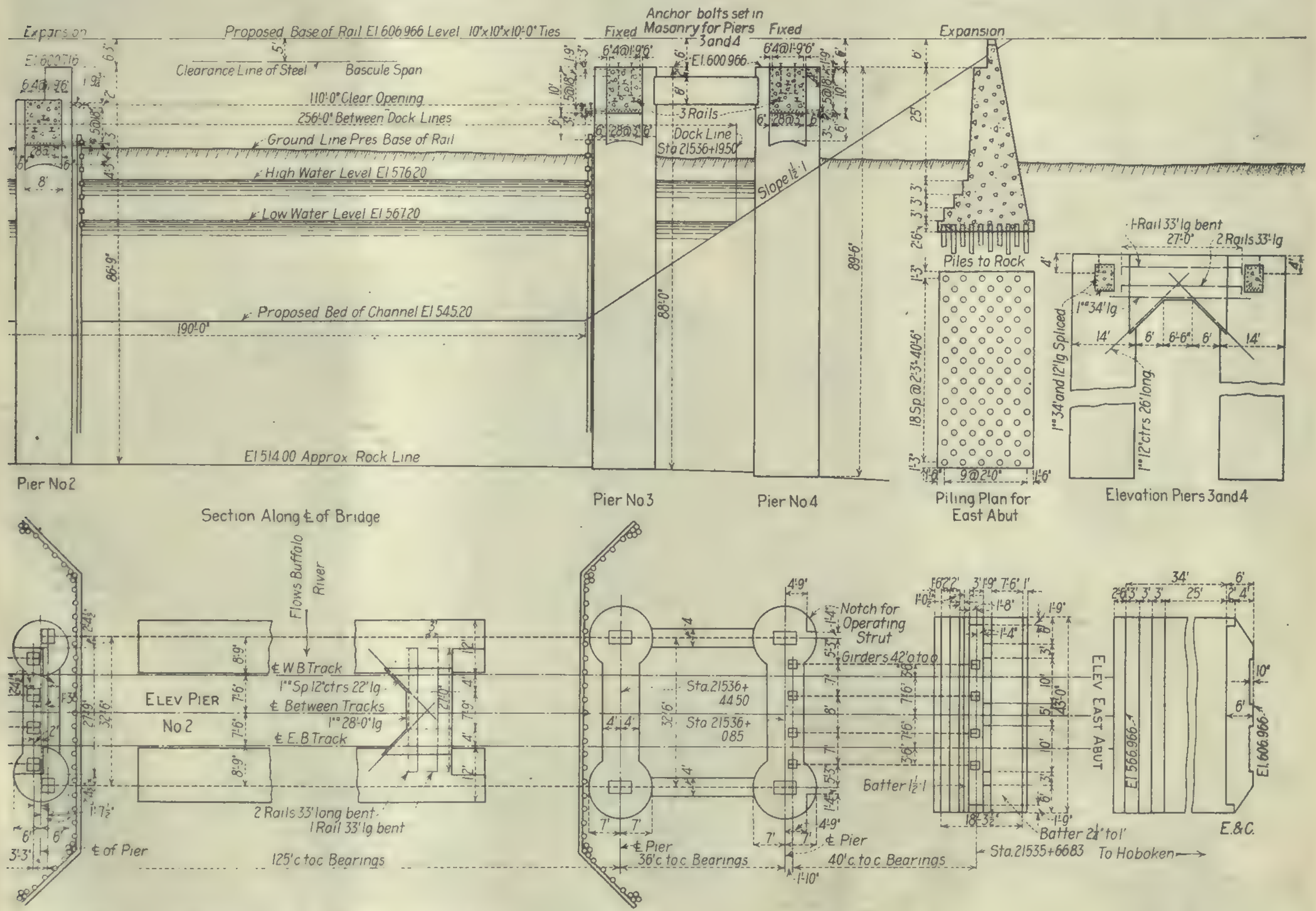
Fig. 1. Layout and Details of Substructure of Buffalo River Bridge

CHARACTER OF SUBSOIL.

To determine the character of the subsoil at the bridge site five test holes were put down, one on the east side of the river and four on the west side of it. These borings were made by contact, as it was thought that the "dry method" would give better information as to the character of the subsoil strata. Steel pipes were driven, and the material inside of them brought up in its natural condition with earth augers. The subsoil had a pronounced tendency to flow, which rendered the excavation work exceedingly difficult. At the location of the pier shafts bedrock lay at a depth of about 70 ft. below the ground surface. Here the subsoil strata consisted of the following: 6 ft. of filled material, 14 ft. of black clay, 12 ft. of sand and gravel, 28 ft. of clay, and about 10 ft. of sand and clay overlying the limestone bedrock.

PRELIMINARY CONSTRUCTION WORK.

As the new bridge occupies the same alignment as the old structure the old plate girder spans for each track were each moved outward 41 ft. 6 ins., thus allowing sufficient working space for the new bridge. The spreading of the tracks was also continued for a considerable distance to the east and west of the bridge site to permit the construction of the embankment made necessary by the grade crossing elimination. Temporary lines of piling and timber cribbing were placed to confine the embankment so it would not interfere with the operation of the temporary main tracks. Figure 2 is a view of the site taken after the tracks had been spread, but before construction had started.



of Delaware, Lackawanna & Western R. R. at Buffalo, N. Y.

DRIVING PILES AND CONSTRUCTING COFFERDAMS.

As shown in Fig. 1, the west abutment occupies the site of the central pier of the old bridge, and it was therefore necessary to remove the old construction before the piles for the new abutment could be driven. These piles were driven by a floating piledriver, the tops of the piles being driven to a depth of about 8 ft. below the water level by means of a follower. The piles for the west pier were also driven by this piledriver, in this case to a depth of about 12 ft. below the water level.

For the east abutment the piles were driven by a land driver, after the material had been excavated to the required depth by a locomotive crane equipped with an orange-peel bucket. The sides of the excavation were retained by sheet piling, braced as the excavation proceeded. These piles were driven to bedrock, and were cut off at a plane 1 ft. below lower water level.

After the piles were driven cofferdams were constructed for the west abutment and the west pier. These cofferdams were built of "Wakefield" sheet piling, bracing being added as the cofferdams were unwatered. The dimensions of the cofferdams for the west abutment were 55 ft. long by 30 ft. wide, and those for the pier were 55 ft. long by 21 ft. wide.

Figure 3 is a view taken during the unwatering of the west pier. In addition to the cofferdam for the west pier, the view shows the site of the west abutment, together with the piledriver and the derrick used for this part of the work.

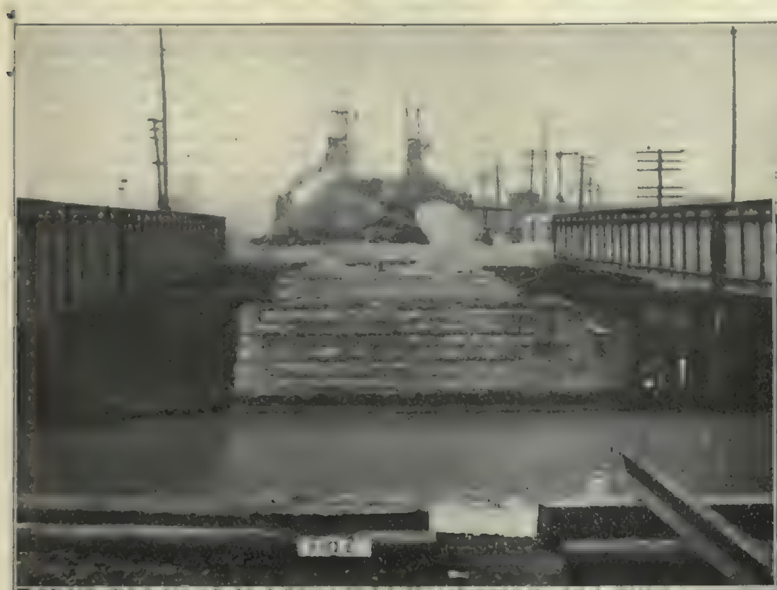
EXCAVATION AND PIER CONSTRUCTION.

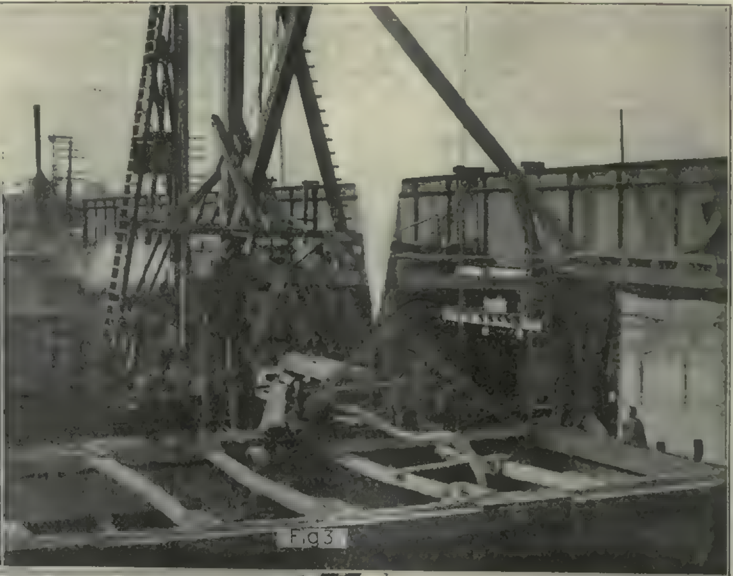
The method used in excavating for the piers was novel and effective, the work being done in the following manner: The location of a pier shaft was first established, and a hole, about 20 ft. square and 4 ft. deep, was dug, the excavation being lined with cribwork consisting of 12x12-in. timbers. After the bottom of the hole had been leveled a steel ring, having a diameter 6 ins. larger than that of the finished pier shaft, was set in place. This ring, which was 20 ins. high and contained an inner shelf 8 ins. wide, formed the cutting edge of the caisson. A wooden form having roughly the shape of a truncated cone was then fitted to the cutting edge. The shape of this inside form (see Fig. 4) was designed to control the sinking of the caisson. Two concentric rows of vertical reinforcing bars, spaced about 12 ins. on centers, were then placed around the cutting edge, and the outside form placed in position. This circular form was built of steel plates, in sections 5 ft. high, each section being reinforced both horizontally and vertically with angles (see Fig. 5). Each section was built in two parts, with flange angles at the abutting edges to provide a bolted connection. After being set in place the outside form was braced against the timber cribwork which lined the excavation. The outside row of reinforcing bars was carried up to the top of the pier, these bars being set about 4 ins. inside of the outer circumference of the pier. The inner row was used to reinforce the cutting chamber only, the bars being bent to terminate at the top of first course of concrete. As shown in Fig. 4, the top of the inner wooden form for the cutting chamber is open, to provide an open well 7 ft. in diameter, through which the material was removed.

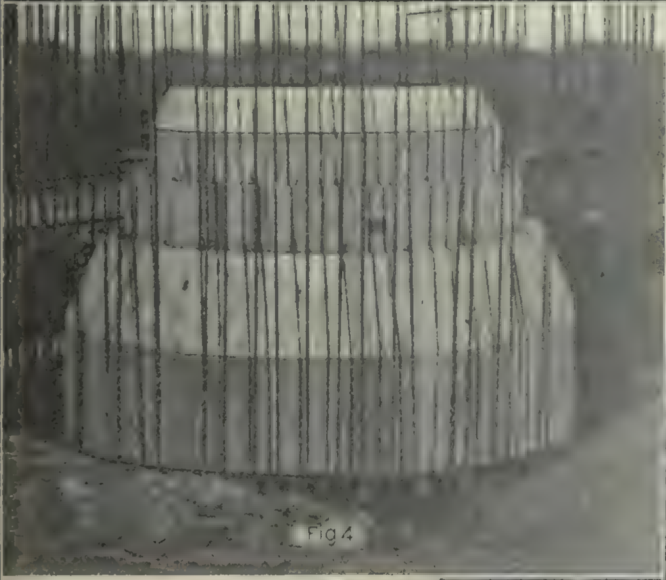
After the lower section, which contained the cutting chamber, had been concreted and the concrete had hardened sufficiently the outer steel form was raised 5 ft. (its height), and braced. A cylindrical concentric inner form, 7 ft. in outside diameter, was then suspended from timbers resting on the upper edge of the outer form. This 5-ft. section was then concreted, forming an annular concrete ring, 14 ft. in outside diameter and 7 ft. in inside diameter. Several sections were built in this manner. The soil in the cutting chamber and under the cutting edge was then removed through the 7-ft. opening by means of a locomotive crane equipped with an orange-peel bucket. This crane operated over a track placed along the center line between each pair of pier shafts, as shown in Figs. 5 and 7. The excavated material was loaded into "Western" dump cars, which operated over an auxiliary track, placed south of the piers, between the south line of the pier shafts, and the south railroad track.

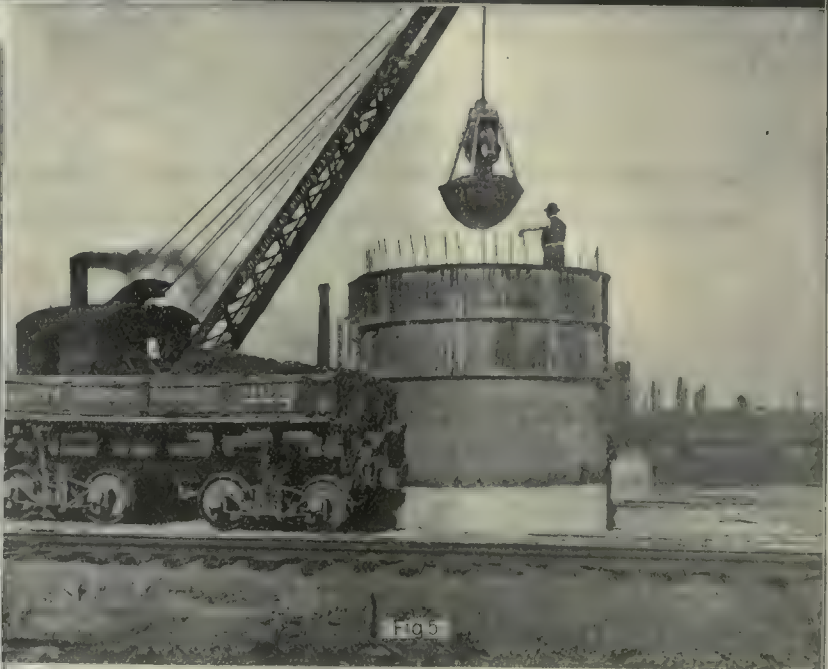
It was planned to secure an average daily settlement of about 10 ft., and a sufficient number of 5-ft. sections were added to provide enough weight to sink the caisson. When bedrock was reached the rock surface was cleaned and the bottom sealed with concrete. The working chamber and the central well were then filled with concrete.

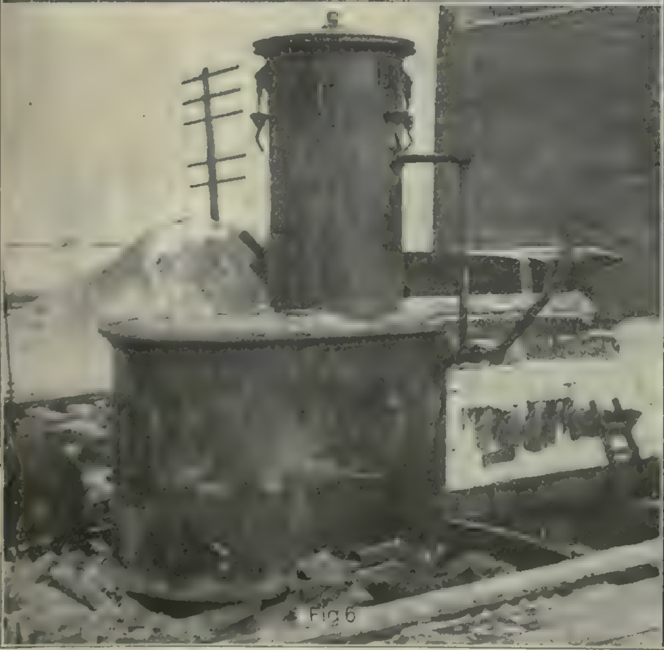
The construction of pier No. 2 and the north shaft of pier No. 4 (for location see











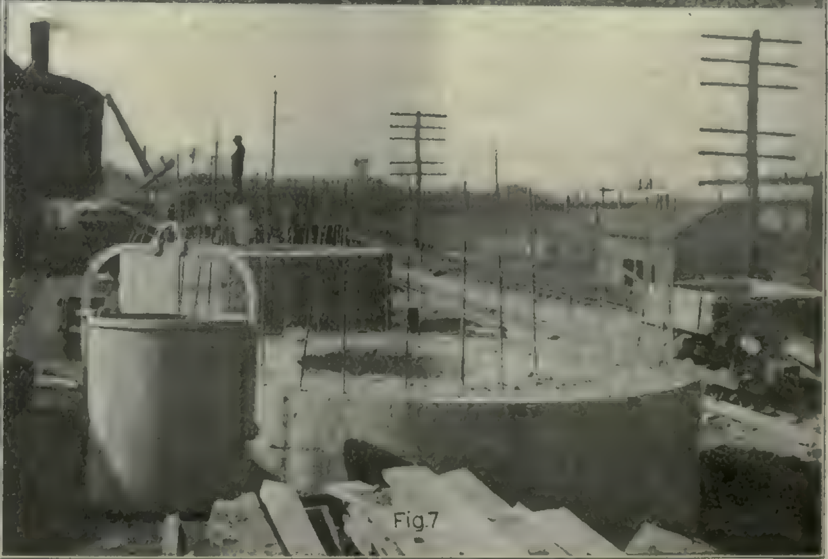


Fig. 2. View of Site of Buffalo River Bridge After Tracks Were Spread to Permit Construction of New Bridge. Fig. 3. View of Cofferdam for Pier No. 1 and Piledriver and Derrick Used. Fig. 4. Inner Form for Cutting Chamber of Caissons for Piers of Lift Span and Reinforcement for Same. Fig. 5. View Illustrating Manner of Excavating Through Open Wells of Piers; View Also Shows Outer Sectional Steel Forms Used. Fig. 6. Air Lock Used in Sinking Cylinders Nos. 4S and 3N. Fig. 7. View Showing Cylinders Nos. 3N and 4N After Reaching Rock; View Also Shows Bucket and Carriage Used in Concreting.

Fig. 1) was completed, as planned, without serious trouble. In sinking the shafts of pier No. 3 and the south shaft of pier No. 4 considerable difficulty was experienced due to the unstable condition of the subsoil. When the caisson for the south shaft of pier No. 3 had been sunk to within about 8 ft. of bedrock it was found that the soft material was flowing in under the cutting edge from a northeasterly direction. As the excavating continued it was noted that the ground surface between the shafts of pier No. 4 was settling unduly, the maximum settlement being about 9 ft. This caused the south shaft of pier No. 4 (which at the time was within about 12 ft. of bedrock) to move in a northwesterly direction. By means of a 35-ton jack and wooden struts placed against the south shaft of pier No. 3, pier No. 4 was righted, and the sinking continued. It was found impossible to sink the north shaft of pier No. 3 below a point about 8 ft. above bedrock. An investigation was made, and it was found that a large boulder under the cutting edge caused the trouble. This boulder was removed by drilling a hole outside of, but close to, the caisson to the boulder and shattering the latter with a heavy charge of dynamite. It was then decided to install air locks (see Fig. 6) on the north shaft of pier No. 3 and on the south shaft of pier No. 4, and to continue the excavation under air pressure, using a pressure of 28 lbs. per square inch. This proved satisfactory, and it was found that none of the shafts were out of line and plumb an appreciable amount after being completed.

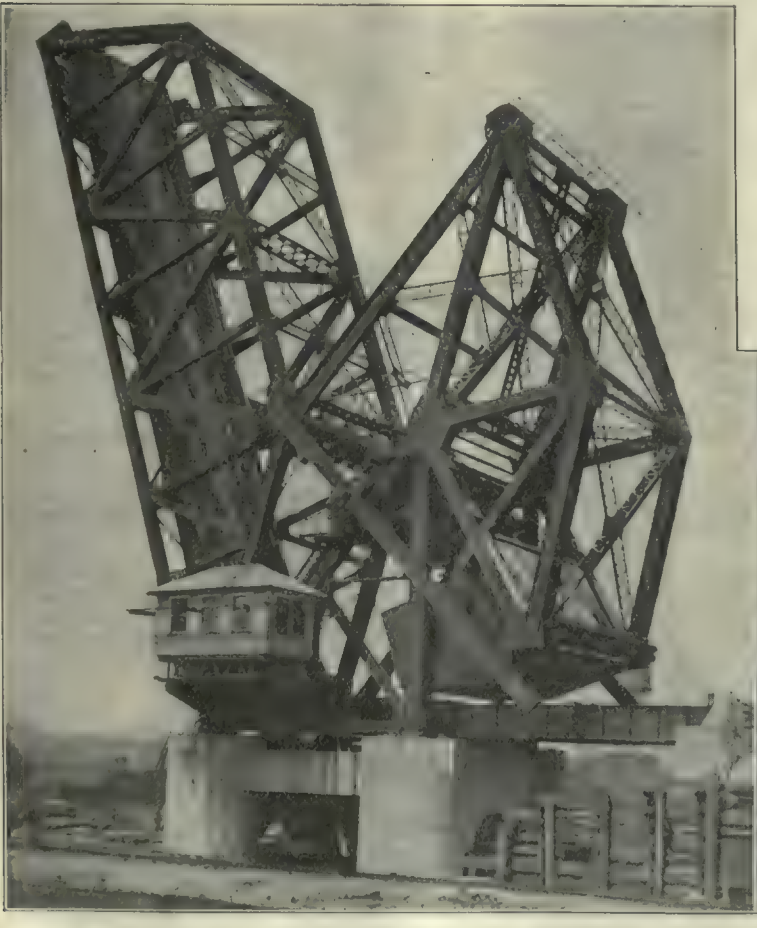


Fig. 8. Lift Span in Open Position.

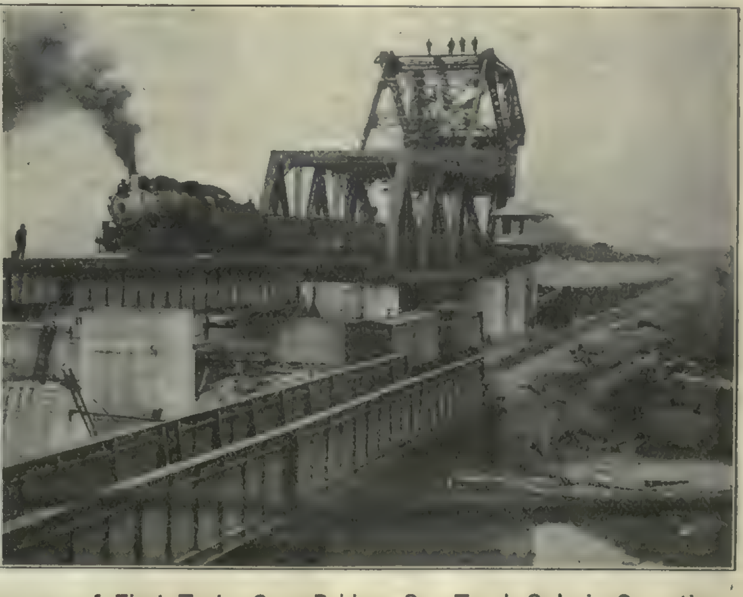


Fig. 9. Lift Span Closed for Passage of First Train Over Bridge; One Track Only in Operation.

CONCRETE PROPORTIONS AND CONCRETING PROCEDURE.

Above the ground level the concrete proportions were 1 part cement, 2 parts sand and 5 parts broken stone; below this level the proportions were 1 part cement and 5 parts Niagara River sand and gravel.

The concrete plant was located at the east end of the bridge, the broken stone and gravel being stored in bins under a pile trestle which had been built at this end to facilitate the construction work. The aggregates were dumped directly into these bins from gondola cars. The storage house for the cement was located adjacent to the storage bins for the aggregates. The cement house was at the level of the low railroad tracks used during the construction of the new bridge, and it was thus possible to unload the cement directly from the cars.

The concrete plant was equipped with a "Smith" mixer, the arrangement of the plant being such as to insure rapid charging and discharging of the mixer. The concrete for the cylindrical piers Nos. 3, 4 and 5 was handled in buckets by the locomotive crane, while that for pier No. 1 and for the west abutment was handled by a derrick. The concrete, in buckets, was transported to the various piers and abutments on small cars operating over a 2-ft. gage track, located between the north row of pier shafts and the north railroad track (see Fig. 7). These cars were moved by an endless cable, the power being furnished by a hoisting engine placed near the mixer.

Figure 7 also shows the condition of the north shafts of piers Nos. 3 and 4 after they had reached bedrock. These piers were later carried to a height of about 19 ft. above the ground surface. The reinforced concrete tie between the two shafts of each pier was cast monolithic with the pier shafts. The longitudinal ties between piers Nos. 3 and 4, however, were cast after the piers were concreted, notches having been left in the pier shafts to receive them.

Figure 8 shows the lift span in an open position, and Fig. 9 shows the approach spans and the lift span closed to permit the passage of the first train over the structure, at which time (June 10, 1915), only one track was in operation. The second track was placed in service June 30, 1915. Figure 9 also shows the position of the south railroad track during the construction of the bridge. At the time this view was taken the channel of the river had not yet been shifted, as will be noted. The work of cutting the new channel under the lift span was completed Oct. 30, 1915.

PERSONNEL.

All work was done under the direction of G. J. Ray, chief engineer, Delaware, Lackawanna & Western R. R., under the immediate supervision of A. E. Deal, bridge engineer, and George E. Boyd, division engineer. The substructure contract was executed by Walter H. Gahagan, Inc., Brooklyn, N. Y., the pile driving being done under a sub-contract by the D. E. Horton Construction Co., Buffalo, N. Y. The Pennsylvania Steel Co., Steelton, Pa., fabricated and erected the bascule bridge superstructure, which was of the Strauss design.

Results of Some Tests to Determine the Distribution of Loads from Concrete Floor Slabs to Steel Joists.

(Staff Abstract.)

The following data give the results of a series of tests made to determine the distribution of loads on reinforced concrete slabs to the supporting I-beam joists.

SCOPE OF TESTS AND TEST DATA.

The space in the laboratory and the capacity of the hoists limited the size of the slabs which could be handled to about 5 ft. x 8 ft., and all slabs, eight in number, were made this size. In one series 0.75 per cent reinforcement was used, two of these slabs having a thickness of 6 ins., one a thickness of 7 ins., and one 8 ins. In the other series 1 per cent reinforcement was used, two of the slabs having a thickness of 6 ins., one a thickness of 7 ins., and one 8 ins., the latter being tested twice, as noted later. With the exception of two slabs all were reinforced with a layer of wire netting of 6-in. mesh, made of No. 9 and No. 11 wire. The main reinforcing rods were parallel to the greatest dimension of the slabs and were placed with their centers 1 in. above the bottom of the slabs. Table I gives complete data on these slabs.

The slabs were bedded in cement mortar spread on the tops of the I-beam joists in order to secure an even bearing on all the beams. The slabs were allowed to stand 24 hrs. after bedding before testing to allow the bedding mortar to harden. There is no doubt that the value of these tests depends in a large degree upon the care used in this bedding. A slab built in place as they are moulded in the field would have a much more uniform bearing on the joists than could possibly be secured by bedding it after it was cast.

The I-beam joists were supported on ¼-in. rods as knife edges on the tops of the cross beams.

The load was applied through a paving brick, 4¼ x 8½ ins., bedded in mortar and placed at the center of the slab over the middle joist. This should give the greatest possible load on the middle joist. The load was applied in increments of 2,000 lbs., until a total load of 20,000 lbs. was reached, by means of a simple beam acting as a lever. An upward pressure was exerted on the lever at one end by means of a screw jack resting on the weighing table of the testing machine, which produced a downward pressure at the other end on the brick. The level was held down between the slab and the testing machine by means of 1¾-in. rods anchored into the floor. All bearing points of the lever were on round rods as knife edges.

During the tests both the elongations of the extreme fiber of the I-beam joists and the deflections at the middle were taken.

TABLE I.—THICKNESS, REINFORCEMENT AND AGE OF 5x8-FT. TEST SLABS.

Reference mark.	Thickness, ins.	Reinforcement, per cent.	Rods, ins. square.	Spacing, ins.	Trans. reinf.	Date made.	Date tested.	Age, days.
A1	6	¾	½	6⅔	6-in. wire netting	12/ 7/11	4/19/13	497
A2	6	¾	½	6⅔	6-in. wire netting	12/18/11	4/25/13	491
B1	7	¾	½	5 7/16	6-in. wire netting	11/25/11	4/ 9/13	498
C1	8	¾	½	4¾	6-in. wire netting	12/11/11	4/22/13	495
D1	6	1	⅝	7¾	None	5/21/12	4/18/13	327
D2	6	1	⅝	7¾	None	10/ 9/12	4/16/13	187
E1	7	1	⅝	6 11/16	6-in. wire netting	5/22/12	4/17/13	325
F1	8	1	⅝	5 7/16	6-in. wire netting	11/20/12	7/20/14	607
F1	8	1	⅝	5 7/16	6-in. wire netting	11/20/12	4/12/13	142

A 20-in. Berry strain gage was used to measure the elongation of the lower fiber of each beam at the middle. By a calibration of the strain gage one division was found to represent 0.00019 in.

RESULTS OF TESTS.

The results of the tests of the eight slabs are given in Tables II to X, inclusive. By plotting the results it was shown that the distribution was practically the same for all loads.

DISCUSSION OF RESULTS OF TESTS.

The first test of slab *F*1 (thickness 8 ins., reinforcement 1 per cent), recorded in Table IX, shows a higher percentage of the load going to the middle beam than is given by either of the 7-in. slabs or the 8-in. slab with ¾ per cent reinforcement. This was thought not to be consistent and to be due possibly to unequal bedding of the beams, therefore the slab was bedded and tested again 15 months later. The results of the second test of slab *F*1 are given in Table X.

TABLE II.—RESULTS OF TEST OF SLAB A1. THICKNESS OF SLAB, 6 INS; REINFORCEMENT, ¾ PER CENT

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0077	.0162	.0095	2	4½	2
4,000	.0147	.0312	.0175	4	9½	6
6,000	.0232	.0467	.0255	6	12½	8
8,000	.0297	.0622	.0340	8	16½	9
10,000	.0382	.0782	.0405	10	20½	11
12,000	.0452	.0952	.0475	11	25½	12
14,000	.0517	.1087	.0540	13	29½	14
16,000	.0587	.1247	.0620	16	33½	15
18,000	.0647	.1397	.0675	17	36½	16
20,000	.0712	.1577	.0755	17	41½	19

TABLE III.—RESULTS OF TEST OF SLAB A2. THICKNESS OF SLAB, 6 INS.; REINFORCEMENT, ¾ PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0095	.0140	.0092	1	4½	2½
4,000	.0180	.0300	.0177	4	9½	4½
6,000	.0255	.0455	.0257	5	13½	5½
8,000	.0330	.0615	.0322	7	18½	6½
10,000	.0395	.0785	.0402	10	23½	9½
12,000	.0470	.0945	.0472	11	26½	11½
14,000	.0530	.1080	.0532	13	30½	12½
16,000	.0610	.1230	.0602	16	33½	14½
18,000	.0675	.1385	.0682	16	37½	18½
20,000	.0735	.1545	.0732	18	40½	19½

TABLE IV.—RESULTS OF TEST OF SLAB B1. THICKNESS OF SLAB, 7 INS.; REINFORCEMENT, ¾ PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0060	.0087	.0042	1½	1½	1½
4,000	.0130	.0192	.0137	3½	3½	5½
6,000	.0215	.0317	.0222	4½	6½	6½
8,000	.0290	.0447	.0297	7½	9½	8½
10,000	.0375	.0552	.0372	9½	12½	9½
12,000	.0455	.0687	.0457	11½	16½	11½
14,000	.0525	.0797	.0547	12½	18½	12½
16,000	.0630	.0927	.0627	15½	21½	14½
18,000	.0685	.1037	.0702	17½	24½	17½
20,000	.0780	.1192	.0787	19½	28½	18½

TABLE V.—RESULTS OF TEST OF SLAB C1. THICKNESS OF SLAB, 8 INS.; REINFORCEMENT, ¾ PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0095	.0122	.0085	1½	1	3
4,000	.0150	.0187	.0160	4½	4	5
6,000	.0245	.0282	.0275	5½	7	6
8,000	.0320	.0377	.0305	7½	7	7
10,000	.0405	.0497	.0405	9½	10	10
12,000	.0475	.0572	.0470	12½	12	11
14,000	.0540	.0682	.0535	13½	15	12
16,000	.0625	.0792	.0620	13½	16	15
18,000	.0715	.0922	.0720	16½	19	17
20,000	.0755	.1007	.0785	19½	23	18

TABLE VI.—RESULTS OF TEST OF SLAB D1. THICKNESS OF SLAB, 6 INS.; REINFORCEMENT, 1 PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0682	.0140	.0090	1	3½	3
4,000	.0192	.0300	.0170	4	7½	4
6,000	.0257	.0445	.0250	7	11½	6
8,000	.0347	.0580	.0345	7	16½	7
10,000	.0382	.0720	.0405	9	19½	9
12,000	.0487	.0875	.0500	12	23½	13
14,000	.0527	.1020	.0560	14	24½	16
16,000	.0607	.1155	.0620	14	29½	17
18,000	.0682	.1290	.0710	18	34½	19
20,000	.0682	.1290	.0710	18	34½	19
20,000	.0757	.1435	.0780	18	37½	20

TABLE VII.—RESULTS OF TEST OF SLAB D2. THICKNESS OF SLAB, 6 INS.; REINFORCEMENT, 1 PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0085	.0147	.0077	1	2½	2
4,000	.0160	.0307	.0152	2	7½	3
6,000	.0230	.0482	.0227	5	13½	4
8,000	.0315	.0647	.0302	7	18½	7
10,000	.0390	.0807	.0377	9	21½	8
12,000	.0465	.0967	.0447	10	26½	10
14,000	.0535	.1132	.0522	12	30½	11
16,000	.0600	.1292	.0592	14	35½	15
18,000	.0665	.1457	.0662	16	38½	17
20,000	.0725	.1597	.0742	16	43½	17

TABLE VIII.—RESULTS OF TEST OF SLAB E1. THICKNESS OF SLAB, 7 INS.; REINFORCEMENT, 1 PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0100	.0090	.0092	2	1½	2
4,000	.0170	.0200	.0162	4	4½	4
6,000	.0255	.0320	.0247	6	7½	6
8,000	.0325	.0435	.0327	9	10½	8
10,000	.0405	.0575	.0412	11	13½	10
12,000	.0475	.0690	.0482	12	17½	12
14,000	.0550	.0845	.0567	14	20½	13
16,000	.0620	.0990	.0637	16	24½	15
18,000	.0700	.1145	.0722	18	28½	18
20,000	.0785	.1315	.0802	19	33½	18

TABLE IX. — FIRST TEST OF SLAB F1. THICKNESS OF SLAB, 8 INS.; REINFORCEMENT, 1 PER CENT.

	Deflections, in ins.			Elongations of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	.0087	.0130	.0090	1	2½	1½
4,000	.0187	.0255	.0175	2	5½	3½
6,000	.0252	.0365	.0275	4	8½	5½
8,000	.0347	.0490	.0355	8	11½	7½
10,000	.0437	.0605	.0440	11	16½	10½
12,000	.0532	.0720	.0530	13	18½	11½
14,000	.0622	.0840	.0605	14	21½	13½
16,000	.0687	.0960	.0705	15	23½	15½
18,000	.0762	.1075	.0765	18	29½	17½

20,000—Yoke of testing machine broke.

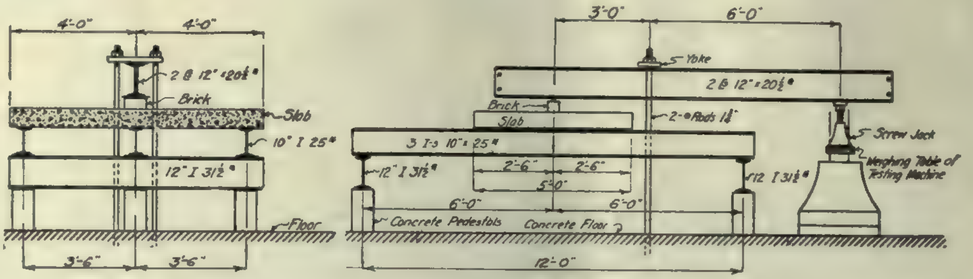


Fig. 1. Diagrams Showing Manner of Conducting Test to Determine Distribution of Loads from Reinforced Concrete Slab to the Supporting Steel Joists.

The information desired is not necessarily the amount of load carried by each beam, for this would also necessitate the knowledge of the distribution of the load on the beam, but the equivalent load for which to figure the beam, assuming the distribution to be known. We shall assume that the distribution of the load to the beam is uniform for the length of bearing the slab, and calculate the load which will give the same extreme fiber stress in the beam. This will be the equivalent uniform load.

From the strain gage readings during cali-

TABLE X.—SECOND TEST OF SLAB F1. THICKNESS OF SLAB, 8 INS.; REINFORCEMENT, 1 PER CENT.

	Deflections, in ins.			Elongation of lower fiber in divisions per 20 ins.		
Load.	A	B	C	A	B	C
2,000	Deflections not taken			2	2	2
4,000				4	4	3
6,000				[illegible]	7	4
8,000				8	10	6
10,000				10	15	9
12,000				12	17	10
14,000				16	20	12
16,000				18	22	15
18,000				19	25	16
20,000				21	28	17

TABLE XI.—EQUIVALENT UNIFORM LOADS ON JOISTS FOR A CONCENTRATED LOAD OF 20,000 LBS.

			Equivalent uniform loads							Percentages		
			Beam A.		Beam B.		Beam C.					
Slab.	Thickness, ins.	Reinforcing, per cent.	Div.	Load, lbs.	Div.	Load, lbs.	Div.	Load, lbs.	Sum, in lbs.	A.	B.	C.
FROM ELONGATIONS OF LOWER FIBER												
A1.....	6	¾	18.9	4,480	41.8	9,990	20.4	4,800	19.270	22.4	50.0	24.0
A2.....	6	¾	18.4	4,360	43.3	10,350	19.1	4,490	19.200	21.8	51.7	22.5
B1.....	7	¾	18.7	4,430	26.0	6,220	19.3	4,540	15,190	22.2	31.1	22.7
C1.....	8	¾	18.9	4,480	20.8	4,970	18.9	4,440	13,890	22.4	24.9	22.2
D1.....	6	1	18.9	4,480	37.8	9,030	20.8	4,890	18,400	22.4	45.2	24.5
D2.....	6	1	16.7	3,960	43.3	10,350	17.1	4,020	18,330	19.8	51.8	20.1
E1.....	7	1	20.2	4,790	29.5	7,050	19.3	4,540	16,380	24.0	35.3	22.7
F1.....	8	1	19.1	4,530	30.5	7,290	19.2	4,510	16,400	22.7	36.4	22.6
F1.....	8	1	21.1	5,000	27.3	6,520	17.1	4,020	15,540	25.0	32.6	20.1
FROM DEFLECTIONS												
A1.....	6	¾	.0736	4,560	.1565	9,780	.0788	4,850	19,190	22.8	48.9	24.3
A2.....	6	¾	.0777	4,820	.1541	9,630	.0776	4,770	19,220	24.1	48.2	23.9
B1.....	7	¾	.0754	4,680	.1134	7,090	.0762	4,690	16,460	23.4	35.4	23.5
C1.....	8	¾	.0790	4,900	.0989	6,180	.0793	4,880	15,960	24.5	30.9	24.4
D1.....	6	1	.0785	4,860	.1447	9,040	.0805	4,950	18,850	24.3	45.2	24.8
D2.....	6	1	.0758	4,700	.1606	10,040	.0745	4,580	19,320	23.5	50.2	22.9
E1.....	7	1	.0797	4,940	.1201	7,510	.0810	4,980	17,430	24.7	37.6	24.9
F1.....	8	1	.0870	5,390	.1209	7,560	.0875	5,380	18,330	27.0	37.8	26.9

bration, one division of the gage corresponds to the following loads on the three beams:

	Concentrated at center, lbs.	Uniformly distributed over middle 5 ft., lbs.
Beam A	203	237
Beam B	209	239
Beam C	201	235

The results obtained from the strain gage readings given above may be roughly checked by the deflections. This check is only approximate, because the distribution of the load may not be uniform. Due to unequal bedding of the slab, the load might approach two concentrations 5 ft. apart. From the deflections, 0.001 in. corresponds to the following loads on the three beams:

	Concentrated at center, lbs.	Uniformly distributed over middle 5 ft., lbs.
Beam A	57.0	62.0
Beam B	56.2	62.5
Beam C	56.3	61.5

As was shown by constructing graphs, the curves between load and deformation and load and deflection both very closely approximate straight lines, and therefore the equivalent loads will be fixed percentages of the total load for each test, and these percentages will not vary with the amount of the load.

Table XI gives the equivalent uniform load figured for the 20,000-lb. load, for each beam, and also the percentage which this is of the 20,000 lbs.

It is worthy of note that the column in Table XI giving the sums of the equivalent uniform loads going to each joist shows in all cases a total less than 20,000 lbs.; in other words less than 100 per cent of the load is accounted for by the assumption of uniform distribution along the joists.

Although, as heretofore mentioned, the deflections were observed primarily as a check they may be employed to show the manner of distribution of the load along the beam; that is, with deformation at center given we may compute the weight of a concentrated load required to produce it, and also its corresponding deflection. We may do likewise assuming the load uniformly distributed over the length of bearing of the slab, and lastly, assume it transmitted to the beam at the extreme end of the superposed slab. By comparing observed deflections with the computed deflections for each of the cases we may reasonably assume that the load was borne by the I-beam in the manner indicated by the deflection.

Table XII shows the loads and deflections computed from the given fiber stress. The last column of loads is found by interpolating between computed loads in proportion to the deflections. It will be seen that this table shows some range in the manner of distribution due presumably to imperfection in imbedding the slab onto the beam, and although the range covers the two extreme modes of distribution, it averages very nearly uniform.

CONCLUSIONS.

From these tests it will be noted that the percentage of reinforcement has little or no effect on the load distribution so long as the safe loads are not exceeded. This indeed would appear to be a logical conclusion because the unit stress in the concrete does not change greatly with varying percentages of steel and the deflection would depend upon the unit stress in the concrete and on the thickness of the slab.

The following conclusions regarding the distribution of concentrated loads on a reinforced concrete slab to the steel floor joists seem to be warranted by these tests:

1. The percentage of reinforcement has little or no effect upon the load distribution to the joists so long as safe loads on the slab are not exceeded.
2. The amount of load distributed by the slab to other joists than the one immediately under the load increases with the thickness of the slab.
3. The outside joists should be designed for the same total live load as the intermediate joists.
4. The axle load of a truck may be considered as distributed uniformly over 12 ft. in width of roadway.
5. If the slab has ample grip on the upper flange of the I-beam and is continuous over the floorbeams, and the joists are riveted to the web of the floorbeams, the live load stress in the joist may be but one-half as great as for a similar load on the bare I-beam supported at its ends.
6. Under these favorable conditions the axle load in a panel of not more than 20 ft. may be assumed as uniformly distributed over two-thirds of the length of the joists considered as simple I-beams support at the ends. Without these conditions the load may be assumed as uniformly distributed over a length of at least 5 ft.

TABLE XII.—COMPUTED LOADS CORRESPONDING TO OBSERVED FIBER STRESSES AND DEFLECTIONS IN I-BEAMS FOR CONCENTRATED LOAD OF 20,000 LBS.

Slab.			Concentrated			5 ft. uniform			2 concentrated					
		Division.	Fiber stress, lbs.	Load, lbs.	Deflection, in.	Fiber stress, lbs.	Load, lbs.	Deflection, in.	Fiber stress, lbs.	Load, lbs.	Deflection, in.	Observed deflection, in.	Corresponding load, lbs.	Per cent of total.
A1	Beam A	18.9	5,630	3,820	.067	5,230	4,480	.073	5,230	6,085	.084	.074	4,630	...
	Beam B	41.8	12,550	8,510	.151	11,650	9,990	.164	11,650	13,530	.187	.157	9,190	49.0
	Beam C	20.4	6,000	4,070	.073	5,590	4,800	.078	5,590	6,480	.089	.079	4,950	....
Total		....	......	16,400	....	......	19,270	....	......	26,095	....	....	18,770	....
A2	Beam A	18.4	5,485	3,720	.065	5,100	4,360	.071	5,100	5,930	.081	.078	5,460	....
	Beam B	43.3	13,000	8,800	.157	12,080	10,350	.170	12,080	14,020	.193	.154	8,800	45.4
	Beam C	19.1	5,630	3,820	.068	5,230	4,490	.074	5,230	6,080	.084	.078	5,130	....
Total		....	......	16,340	....	......	19,200	....	......	26,030	....	....	19,390	....
B1	Beam A	18.7	5,570	3,770	.066	5,180	4,430	.072	5,180	6,030	.082	.075	4,610	....
	Beam B	26.0	7,790	5,275	.094	7,250	6,220	.102	7,250	8,420	.116	.113	7,950	45.7
	Beam C	19.3	5,690	3,850	.069	5,290	4,540	.074	5,290	6,150	.085	.076	4,830	....
Total		....	......	12,895	....	......	15,190	....	......	20,600	...	....	17,390	....
C1	Beam A	18.9	5,630	3,820	.067	5,260	4,480	.073	5,260	6,085	.084	.079	5,360	....
	Beam B	20.8	6,240	4,240	.075	5,250	4,970	.081	5,250	6,740	.092	.099	6,740	38.5
	Beam C	18.9	5,570	3,780	067	5,180	4,440	.073	5,180	6,020	.083	.079	5,390	....
Total		....	......	11,840	....	......	13,890	....	......	18,845	....	....	17,490	....
D1	Beam A	18.9	5,640	3,830	.067	5,240	4,480	.073	5,240	6,090	.083	.079	5,450	....
	Beam B	37.8	11,340	7,690	.137	10,540	9,030	.148	10,540	12,250	.169	.145	8,660	45.2
	Beam C	20.8	6,130	4,160	.074	5,700	4,890	.080	5,700	6,630	.091	.081	5,050	....
Total		....	......	15,680	....	......	18,400	....	......	24,970	....	....	19,160	....
D2	Beam A	16.7	4,980	3,380	.059	4,630	3,960	.064	4,630	5,370	.073	.076	5,370	....
	Beam B	43.3	13,000	8,820	.157	12,100	10,350	.170	12,100	14,050	.194	.161	9,290	46.2
	Beam C	17.1	5,030	3,410	.061	4,690	4,020	.066	4,690	5,450	.075	.075	5,450	....
Total		....	......	15,610	....	......	18,330	....	......	24,870	....	....	20,110	....
E1	Beam A	20.2	6,020	4,090	.072	5,600	4,790	.078	5,600	6,500	.088	.080	5,130	....
	Beam B	29.5	8,820	5,990	.106	8,220	7,050	.116	8,220	9,550	.132	.120	7,680	41.8
	Beam C	19.3	5,690	3,850	.069	5,290	4,540	.074	5,290	6,150	.085	.081	5,570	....
Total		....	......	13,930	....	......	16,380	....	......	22,200	....	....	18,380	....
F1	Beam A	19.1	5,690	3,850	.068	5,290	4,530	.073	5,290	6,150	.084	.087	6,150	....
	Beam B	30.5	9,140	6,200	.110	8,500	7,290	.120	8,500	9,870	.136	.121	7,450	37.8
	Beam C	19.2	5,660	3,840	.068	5,260	4,510	.074	5,260	6,110	.084	.088	6,110	....
Total		....	......	13,890	....	......	16,330	....	......	22,130	....	....	19,710	....

ROADS AND STREETS

The Practical Testing of Asphalt and Road Oil.

(Staff Abstract.)

No matter whether a pavement is laid with sheet asphalt, with some form of asphalt concrete, or is simply an oiled road, asphalt is the road maker. It may be brittle-hard, it may be soft, or it may be a heavy oil—yet always it is essentially asphalt.

To define this asphalt is superfluous—at least to define that which (though not a true asphaltum) is widely so employed on the Pacific Coast, for that this material is the residuum from the distillation of California crude oil, is universally known. But to describe it, in terms of use and properties, rather than source, gives a definition not so commonly understood. Asphalt, as used in paving, is really a glue, a semi-liquid glue—nothing more, nothing less. Its very vital function is to bind together the particles of road mineral, large or minute, with a flexible, yet sure grip, to hold them, cushioned, but without displacement, for indefinite years. And when we consider that this cement, this road-glue, is never, at air temperatures, a solid, in the broader sense, but will, even in the hardest state used, slowly flow—when these apparently deleterious properties are considered, the need for determining the conditions under which this semi-soft cement, when combined with the various ingredients of the road, will be flexible, yet not shifting; commercial to prepare, yet lasting, is evident, and is recognized where sad experience has shown the grief that carelessly prepared and carelessly combined asphalt may cause. A rather well-defined standard, then, has been evolved for asphaltic paving. To maintain this is the realm of the asphalt testing laboratory, municipal or commercial, of today.

The technique, the scope, the purpose, and the trend of asphalt testing are known to many technical men supervising paving throughout the country, but to the general public, and particularly to city officials, property owners, and even to many paving contractors, the essence of asphalt testing has never been expounded, briefly and simply. This, then, is the intent of this paper.

A profuse array of tests has been proposed for asphalt. To consider them all, even in review, would be confusion; to attempt to employ them all, impractical and needless. Some parallel the functions of others, and, of the many proposed, only a few can claim a regular place in practical routine testing. The City of Los Angeles, not unlike other municipalities, has, after years of experience and research, developed specifications which include the essentials of asphalt testing for California conditions.

First, to consider whether the asphalt is *prepared* right, to determine whether it is fit for admixture with the road minerals.

A test is made upon the prepared asphalt, or asphaltic cement, as it is called, for degree of softness, dependent upon the extent of distillation of the oil, and consequently upon the degree to which the light oils were driven off from the crude. This is called the penetration test. The point of a specified size, kind and make of needle is brought to and just scratching the surface of the asphaltic cement sample, which has been brought to a definite temperature (77°F) under water. The needle, held in a frame, weighing 100 grams for all, is released for five seconds. This needle-weight-time-temperature requirement constitutes the District of Columbia standard. The needle and frame sink, penetrating the asphaltic cement at a distance varying with the softness. The depth of penetration is gaged by a micrometer rod and dial, reading to 0.01 cm., and the number of "points", or one-hundredths of a centimeter, is given as the penetration of the sample. The machine for handling this is called a penetrometer.

The City of Los Angeles uses a water bath controlled by a simple electric thermostatic device, and times penetration by an Eastman timer, regulated against a stop-watch.

The chemical composition and condition of asphaltic-cement is scarcely less important than its penetration, for asphalt easily within the limits of consistency set, may yet be worthless for paving. Most commonly this comes from abuse in distillation, or in the kettles at the paving plant, where overheating has "cracked" or decomposed some of the hydrocarbons of the asphalt. This carbene condition, as it is termed, gives, instead of a resilient, ductile, binding cement, a harsh, brittle one, making a pavement that cracks more and more as time goes on. The prevention of carbenes is simple, for cracking will only occur at unnecessarily high temperatures; 600° F. is the limit permissible. Detection of carbenes is accomplished by treating a sample with a solvent which will dissolve the asphalt proper and leave a residue proportional to the extent of the carbene condition. Bromine in carbon bisulphid attacks "cracked" asphaltic cement, and by filtering through a Gooch crucible and weighing, carbenes are readily determined. However, uniformly consistent results can only be obtained with some experience in chemical work, for the process involves standard solutions, careful measuring, vacuum filtration, and weighing with analytical accuracy. The City of Los Angeles checks each paving plant daily for carbenes, and has reaped evident benefits in good streets from the precaution.

But constant watch for excessive carbenes (a few one-hundredths of one per cent is to be expected) is not all. Pure carbon bisulphid will dissolve practically all the asphalt proper, and the residue will be mineral or foreign matter—not over 0.2% is allowable.

Now, hydrocarbons of different classes make up the complex and variable material known as asphalt. It is often desirable to know the proportions of the constituents. Naphtha and sulphuric acid are two solvents which so separate different classes. An occasional test suffices, though a new source should be carefully checked.

Water and sediment present are readily separated from road oils by the centrifuge.

The consistency, and the proportion-composition of an asphalt may be above reproach, and yet it may contain light oils, which volatilize at the temperature of use, and leave a harder residue than desired. Such a condition may either be from the peculiarities of the crude oil used in preparation, or may be from fluxing in some very soft asphaltic cement or oil, to attempt to reclaim some over-hard asphalt.

In any case the detection is simple. In an open container, a sample is heated, driving off the volatile constituents, and the loss in per cent is determined from the residue. This volatility test is applied to all grades of asphalt. The viscous road oil, which may be expected to contain as high as 25% of *moderately* light oils, later to be gradually volatilized in the sun when mixed with the road material, is subjected to a lower temperature and a lesser heating time than the asphaltic residue used in mechanically mixed pavements where temperature (325° F.) and time (five hours) parallel that which the asphaltic cement would meet in use, when mixed with hot sand or rock. The asphalt remaining after volatilization is further tested for penetration, which then should be not less than one-half of the original figure, according to Los Angeles specifications. In the case of road oils, after testing to detect the possible presence of *light* oils, the *heavier ones present,* which are expected gradually to volatilize on the road, may be driven off at higher (425° F.) temperatures, thus leaving only the asphalt proper, the penetration of which may then be taken.

The second group of tests are those made after the asphalt is combined with the mineral road materials. The tests on the uncombined asphalt were to insure its proper *preparation;* tests follow to see that it is *used* right. With road oils all testing has been done that need be done, but the tests of asphaltic cements continue and are important.

We now view asphalt testing in its broader sense, and include not only the asphalt proper, but the mineral aggregate as well, for each inter-relates to the other.

The mixture at the plant is first. Of primary importance is the proportion of all ingredients in the paving mixture. In the most common case, for example, that of sheet asphalt surface, we analyze for the per cent of asphalt, and separate the mineral aggregate, sand and stone dust, into fractions graded in size from coarse to fine. The method, in brief, is to dissolve out from a (heated sample, best and safest by a mixture of carbon bisulphid and carbon tetrachlorid, all the bitumen (asphalt), leaving the clean sand and dust; this is put through standard sieves in mesh from 10 to the inch, to 200 to the inch. Each fraction is weighed separately and the total gives, by difference, the per cent of asphalt. Here, in practical quantity work, labor saving devices play an important part. Thus, in Los Angeles, the number of bituminous mixtures examined in one day has reached fifty-five, and to grade this number by hand agitation of the sieves, would, with two men, be impossible, but to put them through nested, mechanically-shaken sieves is a matter of several hours only. So, too, for extracting the asphalt, the old gravity filtration method has been displaced by quicker mechanical means. But none of these are more accurate than the slower hand processes. To insure good pavement, mechanical analysis, as briefed above, is an essential, and to perform it properly, the best sieves, comparable to a set certified by the National Bureau of Standards, is recommended.

In a general way, the amount of asphaltic cement in a mixture is readily placed between comparatively close limits. A little too much shows "soppy"; a deficiency feels and "works" dry. For any mineral aggregate there is a proper proportion. The mineral aggregates have been, to a degree, standardized; that is, the most suitable proportions for any type of pavement have been derived by years of experience. But to discuss their compounding is beyond the realm of this paper.

At the paving plant, as at the refinery, the thermometer is an essential. Guarding against overheating is the crux, the underheating is no less serious. Asphaltic cement, sand and rock, before and during mixing are kept at 250° F. to 375° F., according to circumstances.

Now, the asphalt mixture, *on the street.* Here is the ultimate condition, here is the consummation of all the care or carelessness in preparation, mixing and laying. A sample cut from the street may be subjected to vital tests. The percentage of asphalt and the proportions of the mineral aggregate are determined by mechanical analysis, and serve as the last word as to the composition of the pavement.

The nicety of proportioning, equivalent to the degree to which the asphaltic cement and fine dust of the mixture, forming a stiff cement, are forced intimately into even microscopic interstices, and against every mineral surface by the rolling is here shown. For, the less the voids, the closer the graded mineral mass fits together, cemented into a near-monolith by asphaltic cement, the denser will be the pavement, i. e., the heavier. Here, then, comes the vital test of specific gravity, which, considered with the mechanical analysis of the same sample, will diagnose the greater part of the symptoms of that pavement, as good, bad or mediocre. Here, in the street sample, is finality as to whether the asphaltic cement was abused. If so suspected, it may be extracted, recovered, and the fault uncovered.

Some conditions do not necessitate test. Illuminating gas and heavy oils in contact with pavement are ruinous. On the contrary, the test of time has shown that properly laid, low-void pavement laughs at water-soaking.

Purposely, no detail of the processes of testing has been given. For one reason, such would be voluminous. For another, it is hoped that a discussion of the reasons for a useful test, together with a brief of its process, will give a clearer concept than a mass of data—times, temperatures, per cents, etc. The City of Los Angeles, in its printed specifications has as much of this lore as is a proven verity, and the results of its experience and testing are open to California municipalities.

The tests herein outlined suffice to detect mistreatment of good asphalt or the presence of undesirable ingredients. The discussion has given little weight to road oils, separately, for they are closely related, being, as mentioned before, merely the same asphalt with the added presence of some volatile oils, purposely not removed when prepared, nature being entrusted to do the rest on the road.

Everywhere the trend of asphalt testing is toward prevention of faults, rather than detection. Thus, instead of sporadic observations of temperature of the asphalt in the melting kettle, and of the hot, dried sand or rock, ready to mix, a recording pyrometer will show *any* elevation beyond safe limits.

In the laboratory efforts are being made to derive ideal street conditions by preparation, mixing and compression of various experimental combinations, on a small scale. The City of Los Angeles has a miniature mixer, 12-inch length of box, with adjustable mixer teeth or paddles, so that at any phase of mixing may be varied at will. Sufficient mixture may be prepared at a batch to make a tamped test block suitable for present and contemplated mechanical tests, as well as regular analysis.

Research, practical research, will further advance the degree to which efficient asphalt pavement may be laid. But for the control of paving, the tests of totady are available and ample. There is no mystery to them. But they require skilled, careful, interested workers, capable of testing, in conjunction with asphaltic cement, the stone dust, rock, and sand, for specific gravity, voids, etc.

By employing the test methods outlined above, a street may be constructed without fault or flaw, may be built with the assurance that it will perform its functions for years. A decade ago, asphalt paving might be right, it might be wrong—the rule of thumb, the guess of inexperience and abuse from ignorance—these never made over-many right. Today careful, consistent asphalt testing and control is producing good streets.

Reprint of a paper before the Pan-American Road Congress by T. A. Fitch, Asphalt Tester, Los Angeles, Cal.

Costs of Monolithic Brick Road Construction.

To THE EDITORS: I notice in an editorial discussing monolithic brick construction which appeared in ENGINEERING AND CONTRACTING of Oct. 27, this statement: "How little we really know of the new construction is evidenced by the contradictory cost data cited by different writers."

I believe that an examination of the cost data will be found not to be contradictory, but practically the same for each of the four writers whom you mention in that editorial. In my article, which appeared on Oct. 6, I made the statement that under similar conditions this new type of construction would be from 10 to 12 cts. cheaper per square yard than the old sand cushion. The type of work which I was describing was a 4-in. brick laid on a 4-in. green mortar base, with a film 3/16 in. thick of dry mortar mixed 1 part cement to 5 parts of sand.

In Mr. D. Moomaw's article, which appeared in the Engineering Record, he was talking of an entirely different type of construction. He was using a concrete base and instead of the regulation sand cushion he was using the dry mortar cushion which was mixed 1 part cement to 3 parts of sand. This mortar cushion was specified to be 1 in. thick after rolling, which would mean that it would be at least 1¼ ins. thick before rolling. When the cement which it takes to make this cushion is figured and the extra work of mixing this amount of material, I think that his figures on the extra cost of this type over the sand cushion are very reasonable. The type of construction which Mr. Moomaw was discussing must cost more than the old sand cushion type, in that he makes no saving at all and adds considerable expense, both in labor and material, in preparing his dry mortar cushion.

In regard to Mr. Compton's statement that he found no appreciable difference in the cost between the old sand cushion method and the dry mortar cushion, I cannot speak with authority, but I believe that Mr. Compton, in the work at Baltimore, reduced the thickness of his concrete base, so that after the work was constructed with the dry mortar cushion that the total thickness of the concrete base and the dry mortar cushion (which really becomes a part of the concrete base) was the same that he had originally used for his concrete base. If I am right in this assumption I can see that there would be very little difference in the cost of the two types.

In Mr. Perkins' article, he has been talking all the way through of the benefits of using a 1-in. dry mortar cushion, mixed 1 part cement to 5 parts of sand, and I presume that his statement that this type of work costs 5 or 6 cts. more per square yard than the 2-in. sand cushion would not be far from correct.

The greatest discrepancy, however, was between Mr. Moomaw's statement and my own, and as we were describing two entirely different types of work, there is really no contradiction between the two statements. It is very possible that the figures which I cited may not be the exact difference in cost, but we have done enough work so that I feel reasonably safe in quoting them at this time, and when we have gone over the cost of the 7,000 yds. of work which we are just finishing, I feel satisfied that the saving will be not less than that named in my article of Oct. 6.

Very truly yours,
RODNEY L. BELL.
Division Engineer, State Highway Department.
Paris, Ill., Nov. 3, 1915.

Cost of Paving with Asphaltic Concrete on Old Macadam.

(Contributed.)

The work consisted of paving Lake Shore Drive in Chicago. A 2-in. wearing surface of asphaltic concrete was laid on an old macadam base. This road was 46½ ft. wide and 12,125 sq. yds. were paved. The work was done under the direction of the engineers of the Lincoln Park Commission, Chicago. The costs follow:

BASE: COST PER SQUARE YARD.

Labor:	
Spiking roadbed, cost per sq. yd.	$0.002
Shaping roadbed, cost per sq. yd.	.019
Spreading stone, cost per sq. yd.	.038
Sprinkling, cost per sq. yd.	.002
Rolling, cost per sq. yd.	.012
Total cost of labor per sq. yd.	$0.073
Material:	
Stone, cost per sq. yd.	$0.093
Screenings, cost per sq. yd.	.022
Coal, cost per sq. yd.	.003
Miscellaneous supplies, cost per sq. yd.	.001
Total cost of material per sq. yd.	$0.119
Teams:	
Hauling	$0.013
Overhead Charges:	
Plant charge, cost per sq. yd.	$0.012
Engineering services, cost per sq. yd.	.005
Superintendence, cost per sq. yd.	.003
Total cost overhead charges, per sq. yd.	$0.020
Total cost of base, per sq. yd.:	
Labor	$0.073
Material	.119
Teams	.013
Overhead charges	.020
Total cost per sq. yd.	$0.225

WEARING SURFACE: COST PER SQUARE YARD.

Labor:	
Mixing, cost per sq. yd.	$0.059
Spreading, cost per sq. yd.	.030
Raking, cost per sq. yd.	.013
Tamping, cost per sq. yd.	.011
Rolling, cost per sq. yd.	.009
Cost of labor, per sq. yd.	$0.122
Material:	
Stone, cost per sq. yd.	$0.034
Stone dust, cost per sq. yd.	.026
Asphalt, cost per sq. yd.	.124
Sand (torpedo), cost per sq. yd.	.054
Sand (bank), cost per sq. yd.	.019
Coal, cost per sq. yd.	.019
Miscellaneous supplies, cost per sq. yd.	.001
Cost of material per sq. yd.	$0.277
Overhead Charges:	
Plant charge, cost per sq. yd.	$0.031
Engineering service, cost per sq. yd.	.008
Superintendence, cost per sq. yd.	.005
Total cost of overhead charges per sq. yd.	$0.044
Total cost of wearing surface per sq. yd.:	
Labor	$0.122
Material	.277
Overhead charges	.044
	$0.443

SQUEEGEE COAT: COST PER SQUARE YARD.

Labor:	
Pouring asphalt, cost per sq. yd.	$0.005
Placing granite screenings, cost per sq. yd.	.004
Rolling, cost per sq. yd.	.003
Total cost of labor per sq. yd.	$0.012
Material:	
Asphalt, cost per sq. yd.	$0.042
Granite screenings, cost per sq. yd.	.020
Coal, cost per sq. yd.	.002
Total cost of material per sq. yd.	$0.064
Overhead Charges:	
Plant charge, cost per sq. yd.	$0.008
Engineering service, cost per sq. yd.	.001
Superintendence, cost per sq. yd.	.001
Total cost of overhead charges, per sq. yd.	$0.010
Total cost of Squeegee Coat, per sq. yd.:	
Labor	$0.012
Material	.064
Overhead charges	.010
	$0.086

SUMMARY.

Total yardage of pavement	12,125 sq. yds.
Average width of road	46.5 ft.
Total cost of base	$2,833.05
Cost per sq. yd.	0.225
Total cost of wearing surface	5,373.03
Cost per sq. yd.	0.443
Total cost of squeegee coat	1,045.63
Cost per sq. yd.	0.086
Total cost of pavement	9,146.71
Total cost per sq. yd.	0.754

The Value of a Traffic Census in Determining the Type of Road to Be Constructed.

The value of a traffic census is not the accurate record of the number of vehicles passing over a road in any particular day or week. The amount and character of traffic varies so widely with changing conditions, that even when we take a census on a broad scale we find it confusing to interpret satisfactorily the results. We cannot but recognize the fact that the traffic on no one day can safely be said to represent the maximum average or minimum amount to be expected throughout the week, the month, the season, or, least of all, the year.

If we set about to take a census on the main line of travel in a territorial district, such as a county or state, and extend the count over a sufficient length of time to represent accurately actual conditions of travel, we are staggered by the enormity of the task, and even though the means for making such a comprehensive count were available it seems doubtful if the results would justify the cost and the effort.

In view of the fact that the amount and character of traffic differ on different days of the week, differ in wet and dry weather, differ in each of the seasons, differ with changes due to improvement, or to road surfaces wearing out, or to new conditions of development, in a word differ from innumerable causes, it would seem that the cost of taking a traffic census on any great comprehensive scheme could not be justified. Matters are still further complicated by the fact that the character of the traffic is as important as the amount, and while both vary widely, they do not vary together or in accordance with any rule.

There are, however, some very good reasons for taking a traffic census, and some very reliable and useful results to be obtained therefrom. On any one particular road, for instance, it is desirable to know the traffic it carries in order to observe the behavior of the road type under known conditions, and thus compare its value with that of other types and to determine for future consideration its limitations, with a view to enabling us to design more economically. This sort of census is not expensive considering the great value of the results and should be taken by all authorities having much road work in contemplation. It must be remembered, however, that the value of such a census depends upon a complete knowledge of all the construction details of the particular road type as slight changes in workmanship, quality of material, grades, general drainage conditions, etc., will often be more significant than appreciable changes in the traffic.

Sufficient information is already available to make an approximate estimate of the traffic any of the commonly used types of road surfaces will bear. This is particularly true of the less expensive types, like gravel and waterbound macadam. If, then, in the future, the data already recorded is supplemented by a consistent, systematic and careful study of the effects of traffic on each type of improvement, much valuable information will be obtained, and as time passes we will be able to trace with reasonable accuracy the limitations of each type, thus enabling us to say with some assurance just what the economic type of improvement under a given set of conditions will actually be.

By far the most important value of a traffic census in determining the economic type of road, lies in its application to a large system of road improvement, such as a township, county, or a state system of roads. It is inconceivable that in any big system of roads the traffic will ever be the same on each road of the system. It is admitted that the traffic on a few of these roads will probably be so nearly the same that for practical purposes it may be considered identical, but some of the roads in the system will surely never carry more than a half, a quarter, a fifth, or a tenth the burden of the main roads, and if we have designed all the same, we must necessarily have wasted a great deal of money.

It follows, then, from the foregoing that the greatest value of a traffic census is in its ability to show the relative amounts of traffic, both as to character and number of vehicles that may be expected upon the various roads under consideration and this is accomplished with reasonable accuracy through one or two counts made simultaneously at stations properly selected because even though varying conditions may change the traffic between wide limits, still for any one particular time or set of conditions the traffic may be considered as relatively representative of the proportionate share of the total traffic which each road in the system will ultimately bear, the only exception being those roads which are permanently improved and which are at the time of the count carrying a much greater traffic than they will carry later after all of the roads of the system are improved. Due allowance can be made for this fact, however, in construing the results.

It is clear that if the main roads are carrying 2,000 or 3,000 vehicles a day and other roads 1,000, still others 100, that we must proportion the type of road to the burden that will ultimately come upon it, in order that we may arrive at true economy in design.

The cost of service in road construction is directly comparable to the cost of service in any public utility improvement and can, to a certain extent, be reduced to a unit basis. The most important factors entering into the cost of service are first cost, interest on investment and maintenance of cost. The low first cost roads are able to sustain some limited amount of traffic and if we overburden them, the maintenance cost makes the total cost excessive. On the other hand, if a road will be called upon to carry only a small amount of traffic, a high first cost improvement cannot be justified because it is capable of carrying so much more traffic that the total cost per unit of travel over the road in question is exorbitantly high and all requirements may be met with a lighter and less expensive first cost improvement.

To sum up the whole matter, it is necessary in economic design of a system of roads to consider the load burden which each road will be called upon to bear and this cannot be even approximated without some sort of estimate, and it would seem that the only way of making an estimate would be to actually count the number of vehicles which use the roads in the various parts of the system. This method will at least give some basis for design and it is a decided step in the right direction. Too frequently we base our estimates of traffic on broad general assumptions, such, for instance, as main roads shall be of such and such a type, forgetting that different parts of the main roads may carry very materially greater loads than others; or we say that we have investigated local conditions and find out from the old residents that such a road is the main traveled road and therefore should have a certain durable type of construction, overlooking entirely the fact that a main traveled road in some parts of the state may carry only one hundredth part of the load that a main traveled road in another part of the state is called upon to bear.

In any event, the traffic census must be used with caution and in conjunction with all other available data, but when intelligently construed it enables us at least to consider roads relatively and make due allowance in design and while we may from time to time be misled in certain special cases, still on the whole the errors thus made will not be of much consequence as compared with the inefficient methods of some of the small local authorities, or as compared with the common practice of adopting one type of road to meet ten different grades or conditions of traffic.

Paper read before the Northwestern Road Congress by Wm. W. Marr, Chief State Highway Engineer, Springfield, Ill.

SEWERAGE AND SANITATION

A Summary of the Experience Gained in the Treatment of the Wastes from the Scouring of Wool.

Contributed by Harry R. Crohurst, Sanitary Engineer, U. S. Public Health Service, and Arthur D. Weston, Sanitary Engineer, Massachusetts State Department of Health.

The production of woolen goods from the raw wool involves the processes of sorting the wool fibre as it arrives at the mill and the cleaning or scouring of the fibre to remove the impurities always contained in it, so that it can be spun or woven into the finished product. These processes vary considerably because of the great variety of the goods produced and the differences in the raw materials used. In the production of the goods the following preparatory steps are usually carried out: Sorting, dusting, picking, carbonizing, scouring.

After the removal of the impurities and the production of a clean fiber it is then spun into yarn or woven into cloth. This process involves the following steps: Oiling, picking, combing, spinning, weaving.

The finishing process consists of a second scouring to remove foreign substances added to assist in the spinning and weaving, and the fulling or dyeing to produce the finished product.

Wastes are produced from the processes of scouring and finishing. The waste from scouring is a dirty brown liquor high in suspended matter, containing a large amount of wool fat and considerable potassium salts in solution. The wastes from finishing consist of the scouring solutions used for the cleaning of the goods previous to fulling and dyeing, the scouring solutions and rinse waters after fulling, and the spent dyes and rinse waters from the coloring operations. It is the purpose of this paper to deal principally with the treatment of the liquors produced in the process of scouring the raw wool. In a later paper the authors will take up the treatment of the wastes from the finishing processes.

In order that the engineer may have a better understanding of the character of the wastes produced, it may not be out of place to give here a brief outline of the structure of the wool fiber, the various classes of wool, the impurities encountered at the mills and the processes used in finishing the raw fiber.

The term wool is sometimes broadly applied to the covering of many animals, but is usually applied to the covering of sheep which is the most important of the fibers used in the textile industries. The wool fiber has its root in a gland in the middle layer of the skin and is produced by a secretion of lymph-like liquid. This gland also secretes an oil which softens and lubricates the fiber. Other glands secrete the wool fat which forms a protective coating on the fiber and prevents matting. The length and diameter of the wool varies not only in the different species of sheep but also in the individual animal. The length varies from 1 to 8 ins. and the diameter from .0018 to .0040 ins. Wool fiber is divided into two grades—"Tops" and "Noils." Tops contain the long staple fibers which are combed and spun into worsted yarns and then woven into dress goods, etc., but are not fulled to any extent in the finishing. The noils contain the short staple fibers which are carded and spun into woolen yarn to be used in goods which are fulled in the finishing.

Wool used in this country comes from nearly all parts of the world. The quality depends upon the breed of the animal, climatic conditions, the nature of the pasturage and the physical condition of the sheep.

COMPOSITION OF WOOL.

The composition of wool fiber proper is very similar to that of hair, horn, feathers and other epidermal tissues. Omitting the dirt, dried sweat and grease and considering the pure fiber, it is made up of combinations of carbon, hydrogen, oxygen, sulphur and nitrogen. While it has no definite chemical formula, an average of its composition may be approximated as follows:

	Per cent.
Carbon	50
Hydrogen	7
Oxygen	26-22
Nitrogen	15-17
Sulphur	2- 4

IMPURITIES OF WOOL.

The wool fiber as it is received at the mill contains a large percentage of impurities. To show the amount of pure fiber obtained from the raw Merino wool, which is considered to be of rather high quality, "Chevreul" gives the following analysis:

	Per cent.
Earthy matter deposited by washing in water	26.06
Suint and yolk soluble in cold distilled water	32.74
Neutral fats soluble in ether	8.57
Earthy matter adhering to fat	1.40
Wool fiber	31.23
Total	100.00

The above per cent of pure fiber is based on wool dried at 100° C. Air dried wool containing 14 per cent moisture would yield about 27 to 28 per cent pure fiber. The impurities consist of yolk, suint and earthy matter. The yolk and suint are usually classed together. The suint is that portion of the impurities which can be removed with water and consists of the dried perspiration deposited on the fiber. This is made up chiefly of potassium salts, oleic acid and other fatty acids. Potassium in the form of carbonates, sulphates and chlorides is also present. It will be seen that the removal of these impurities which are soluble in water forms a solution valuable for the recovery of potash salts.

Stabler & Pratt in Water Supply Paper No. 235 give the following average of the soluble salts recovered from the water used in the steeping of wool previous to scouring:

SALINE COMPOSITION OF POTASH RECOVERED FROM WOOL STEEP LIQUOR.

Per Cent of Crude Potash.

	Per cent.
Potassium carbonate, K_2CO_3	74.6
Potassium sulphate, K_2SO_4	3.2
Potassium chloride, KCe	9.5
Potassium silicate, K_2SiO_3	8.2
Sodium carbonate, Na_2CO_3	3.7

The yolk or wool fat is composed of ethereal salts of cholesterol and isocholesterol and salts of fatty acids (oleic, stearic and palmitic). This wool fat is insoluble in water but can be dissolved by volatile solvents as carbon bisulphide, naphtha, benzine, etc., or as an emulsion by the aid of alkaline detergents. Here again the solution from the removal of the grease offers a chance for the recovery of a valuable product.

The Massachusetts State Department of Health in their experiments upon the effect of wool scouring wastes upon the Merrimack River give some figures upon the amount of recoverable material contained in the waste. Table I is made up from these data.

The earthy matter consists of sand, dirt, etc., adhering to the wool mechanically. The amount depends upon the soil from which the wool is produced and varies from 3 or 4 per cent to 30 or 35 per cent of the weight of the wool. There are also present in the fiber, dung, burrs, grass, straw, etc. The following estimate by a New England scourer shows the average makeup of raw wool received at the mill: Soil 20%, dung 5%, moisture 12%, grease 23%, clean fiber 40%, total 100%.

Following is the makeup of German wool: Mineral matter 6.3%, suint or yolk 44.3%, moisture 11.4%, clean fiber 38.0%, total 100.0%.

The raw wool received at the mill will contain anywhere from 30 to 80 per cent of impurities which must be removed before the fiber can be spun and woven into the finished product. The removal of these impurities is carried out in the process of wool scouring.

TABLE I.—AMOUNT OF RECOVERABLE MATERIAL CONTAINED IN WOOL SCOURING WASTES.

Mill.	Bowl.	Quantity of waste, gals. per day.	Per cent of total waste from bowls 1 and 2.	Lbs. per day, fat.	Per cent of total fats found in bowls 1 and 2.	Lbs. per day, potash.	Per cent of total potash found in bowls 1 and 2.	Bowls 1 and 2. Lbs. in each 1,000 gals. Fats.	Bowls 1 and 2. Lbs. in each 1,000 gals. Potash.
Lower Pacific	1 and 2	24,845	..	5,471	..	1,633	..	...	..
	All 4	72,015	35	5,797	94	1,751	93	220	66
Washington	1 and 2	44,675	..	5,705	..	3,498	..	...	..
	All 4	130,591	34	5,941*	96	3,570*	98	130	78
Kunhardt	1 and 2	1,566	..	189	..	45	..	...	..
	All 4	22,569	7	251†	75	50†	90	120	29
Lewis	1 and 2	51,888	..	7,158	..	3,485	..	...	..
	All 4	58,909	88	7,406	97	3,555	98	138	67
Ayer	1 and 2	32,108	..	4,494	..	2,502	..	...	..
	All 4	35,877	89	4,528	99	2,510	99	140	78
Wood	1 and 2	55,651	..	5,863	..	3,179	..	...	..
	All 4	119,364	47	6,430	91	3,313	96	105	57

*Does not include 56,000 gals. per day discharged from 4th bowl.
†Does not include 10,500 gals. per day discharged from 4th bowl.

SORTING.

The wool as it arrives at the mill is spread upon a sorting table and graded according to the requirements of the material to be made. The sorting tables are provided with a screen top and a heating system (used generally in the cold weather when the grease solidifies making the fiber stiff and difficult to sort). Solid material easily removable passes through the screens and the larger foreign matter is cut from the wool. The wool is sorted according to the length and fineness of the fiber which is dependent on the part of the sheep from which it comes.

DUSTING, PICKING AND CARBONIZING.

The sorted wools containing dust and fine material are generally run through a dusting machine. By the aid of a fan this machine removes fine dirt, straw, etc., the larger particles of foreign matter dropping out through the bottom. Where the wool contains large burrs in considerable numbers it may be run through a burr picker or where the burrs are small the wool may be carbonized by soaking it in dilute sulphuric acid. This disintegrates the vegetable matter of the burr and on drying and passing through rolls is ground to dust and removed in the dusting machine. After carbonizing the wool must receive a neutralizing bath and it is then ready to be scoured.

As already stated, the wool at this point contains all the wool grease and potassium salts which are recoverable. Where an attempt is made to recover any of these products it can be done at this stage. Steeping the wool in warm water will remove the soluble potassium salts which can be recovered by evaporation and incineration of the steep water. If volatile solvents are used in scouring this will remove the wool grease which can be recovered. Where no preliminary steps are made for the recovery of products the wool is run directly to the scouring machines and the resulting waste water, containing all the wool grease and potash, may be treated as described later for the recovery of the products.

SCOURING.

The ridding of the wool of grease and dirt is carried out in wool scouring machines and the process is called scouring. The methods now in use are the primitive single bowl process and the modern method consisting of scouring in a machine with several bowls. The old method consisted in lowering the wool in a cage into the scouring liquor and stirring or "poling" it to insure the liquor reaching all parts of the fiber. After remaining in the liquor until the grease and dirt were removed the fiber was withdrawn, drained and then put into a rinse box and washed in clean water. The modern method, which is carried out in the mechanical wool washer, is more rapid and economical. The machine is divided into four—sometimes three—compartments called bowls which contain the scouring liquor and the rinse water which are kept heated to about 100° F. The modern type of four-bowl machine is sometimes known as the "Parallel Rake Wool Washing Machine." The machines are made in various sizes. The bowls are either 16, 27, 32 or 37 ft. long and 2, 3 or 4 ft. wide. A mill scouring about 15,000 lbs. of grease wool a day, which has a shrinkage of 60 per cent, would use a four-bowl machine 4 ft. in width, the length of bowls being, No. 1, 37 ft.; No. 2, 27 ft., and Nos. 3 and 4, 21 ft. The first two bowls would be used for scouring and the last two for rinsing.

Scouring Agents.—Alkali and soap are the agents commonly used and the amounts of each vary in different mills and with the quality of the wool being scoured. As an example of the solutions used the following formula for the soap solution and amounts used is given by a wool scourer. The wool assumed to be in the machine has a shrinkage of about 60 per cent. The amount scoured is 12,000 lbs. per day in a four-bowl machine.

ALKALI SOLUTION (SOAP).

Dissolve 25 lbs. of caustic potash in 100 gals. of water.
Add water to make up to 300 gals.
Add 100 lbs. of red oil, which will produce a jelly-like mass.

SOAP SUDS.

1 lb. of soap to every 2 gals. of water.
If each bowl has a capacity of 800 gals. the following amounts of solutions should be added:
Bowl 1. 80 lbs. soda ash, 36 gals. suds and add water to make up to 800 gals.
Bowl 2. 40 lbs. of soda ash, 18 gals. suds and add water to make up to 800 gals.
Bowl 3. No soda ash, 12 gals. of suds and add water to make up to 800 gals.
Bowl 4. Running water.

In the operation of such a machine the suds are renewed every hour and the soda ash in the middle of the morning, at noon and the middle of the afternoon. When the liquid in the first bowl becomes muddy it is discharged and the liquor from bowls 3 and 2 is pumped forward to bowls 2 and 1, after which the strength is made up and new liquor is added to the third bowl.

The outline for solutions used in a three-bowl machine is as follows:

ALKALI SOLUTION (SOAP).

400 lbs. caustic potash dissolved in 100 gals. of water.
Add water to make up to 400 gals.
Add 100 gals. of red oil, forming a jelly.

SOAP SUDS (SCOURING LIQUOR).

Boil 125 lbs. of soap, 200 lbs. of pearl ash and 250 gals. of water until all are dissolved.
Using three 16-ft. bowls for very greasy wool, use 12 pails of scouring liquor in the first bowl, 10 pails in the second bowl and clear water in the third bowl.

Stabler & Pratt have estimated that for each 1,000 gals. of water 40 to 50 lbs. of soft soap and 5 to 10 lbs. of potash were generally used to scour from 1,000 to 2,000 lbs. of wool to produce 600 to 900 lbs. of wool fiber. The raw wool is fed continuously into one end of the scouring machine and by a series of moving rakes is carried forward through the first compartment until it reaches a squeeze roll where the liquid it has taken up in passing through this compartment is squeezed out of it. It then passes into the second compartment and through the machine in a similar manner. The water from the first compartment receives the greatest amount of dirt and when too concentrated to be of further use is discharged. The water from the second and third compartment is then pumped forward into the first and second compartments, respectively, more reagents being added to make up the strength of solutions, and fresh solution added to the third compartment. The last compartment may in some cases be supplied with running water which washes the scoured wool after passing through the solutions in the first three compartments. The waste from the machine is, therefore, a very concentrated, dirty brown liquor containing large amounts of suspended matter, grease and the reagents used in scouring. The wastes from these bowls may be separated, that from the fourth passing directly into some stream and the concentrated liquor from the first stored for the recovery of valuable products as described later; or as is the common practice both are discharged into a nearby stream and if the flow is small the effects are noticeable considerable distances below the point of discharge. Analyses of the liquor in each of the bowls of the scouring machines are given later in a table.

Shrinkage.—During the process of scouring, the wool shrinks on an average of about 60 per cent. Table II shows some of the grades of wool handled in this country and the shrinkage during scouring.

TABLE II. — SHRINKAGE OF VARIOUS WOOLS DURING SCOURING.

Grade of wool.	Shrinkage. Per cent.
Washed fleeces:	
Ohio and Pennsylvania	50-52
Texas	58-65
Georgia	34-42
Lake	40
Grease California	55-65
Eastern Oregon	61-62
Valley Oregon	50
Graded territory:	
Arizona	55-66
Colorado	62-64
Dakota	58
Idaho	62-70
Montana	60-63
Nevada	65-70
Utah	62-66
Wyoming	65-72
New Mexico	65-66
Australia:	
Choice Sydney	56-57
Choice Geelong	51-52
Average Sydney	50
Average Queensland	52
Choice New Zealand	25-30
South America:	
Montevideo	48-50
Buenos Aires	48-50

OILING AND PICKING.

After scouring and washing the fiber is dried in a centrifuge, or by passing hot air through it, or by both methods. Scouring leaves the wool harsh and brittle and before being finished the fiber is softened by oiling. At this point any mixing of the different grades of wool or other fibers which is necessary for the various kinds of materials produced is carried out. The mixed fibers are run through a "mixing picker" to obtain the necessary blend and may be oiled at the same time. The oil is added to replace the wool grease which has been removed during scouring and lubricates the fibers, prevents waste in combing and spinning and protects the fiber in handling. Olive oil, lard oil, oleine, red oil and certain mineral oils are used in this process, which can be done by hand or in machines. The oil is applied as an emulsion.

COMBING, SPINNING AND WEAVING.

Carding is the first of several processes which collectively are known as combing. It consists of separating the fibers, arranging them in a continuous sliver, all parts of which are equal in weight, thickness and quality and contain fibers of every length. After the combing process the wool which has taken up some dirt in the operations may be given another washing and subsequent oiling before being spun. This is called "back-washing" and is usually carried on in a two-bowl machine. There is a small amount of dirt, and pure olive oil soap is used in washing, the dirt being removed by squeeze rolls. The water used in back-washing is small in quantity compared with that used in the wool washing. Probably the quantity is less than one-tenth of the quantity used in the wool scouring operation. Because of the small quantity and the small amount of dirt and grease contained in it, this water used in back-washing has very little effect on the character of the heavier liquor if the two are combined. After dyeing the wool is oiled again and is ready for spinning. The remaining operations consist of preparing the warp, in which there are several steps, and the weaving into the finished goods.

FINISHING.

After the goods come from the looms the remaining processes through which the different grades and classes of goods pass are called finishing. These operations consist of fulling, washing, dyeing, etc. The wastes from these processes will be discussed in a later article by the authors.

QUANTITY OF WOOL SCOURING LIQUOR.

In Table III, made up from the data of the Massachusetts State Department of Health in their examination of the Merrimack River, will be found the quantity of wool scouring liquor based on 100 lbs. of wool scoured. While these figures may give some indication of the average quantity of waste per pound of wool scoured, it is always well to bear in mind that there are many grades of raw wool, all varying in the per cent of impurities that they contain and that the amount and character of the waste depends on the grade of raw fiber in the machine.

In the four-bowl machines the average quantity of water used per 100 lbs. of wool scoured amounts to approximately 147 gals., or roughly 1½ gals. per pound of wool scoured. The figures for the three-bowl machines show that about 86 gals. of water are used per 100 lbs. of wool scoured, or slightly less than a gallon per pound of wool scoured. The method of operating these machines, as already described, varies considerably. In all mills the concentrated waste is discharged from the first bowl, the water from the second and third bowls being advanced to the first and second bowls so that the discharge occurs at intervals from the first bowl and contains all the impurities in a concentrated solution. Usually the last bowl contains only wash water which is constantly passing through the machine and running to waste. Sometimes the last two bowls are operated in this manner in which case only about 46 per cent of the total water used, or about 68 gals. per 100 lbs. of wool scoured, would consist of the heavy offensive wool liquor.

TABLE III.—QUANTITY OF WOOL SCOURING LIQUOR PER 100 LBS OF WOOL SCOURED.

Mill.	Bowl.	Waste, gals. per day.	Quantity of wool scoured per day in lbs.	Waste per 100 lbs. wool scoured.
Pacific	1	17,080	......	44
	2	7,765	38,692	20
	3 & 4	47,170	......	122
Total		72,015	......	186
Washington	1	31,427	......	37
	2	13,348	84,463	16
	3 & 4	85,916	......	102
Total		130,691	......	155
Lewis	1	34,923	......	51
	2	16,965	68,359	25
	3	7,021	......	10
Total		58,909	......	86
Ayer	1	21,646	......	56
	2	10,462	38,460	27
	3 & 4	3,769	......	10
Total		35,877	......	93
Wood	1	30,427	......	40
	2	25,224	77,099	33
	3 & 4	63,713	......	82
Total		119,364	......	155

The analyses of the wastes from the various bowls of the machine show that bowls 3 and 4 contain only a small percentage of the impurities found in the first two bowls. The analyses show, however, that the liquor from the last two bowls is usually stronger than domestic sewage. About 95 per cent of the recoverable material is contained in the liquor of the first two bowls, or, as the liquor of bowl 2 is pumped into bowl 1 before being discharged, 95 per cent of the recoverable material is in the discharge from the first bowl.

QUALITY OF WOOL SCOURING WASTES.

In Tables IV-VIII is given the composition of various wool scouring liquors from several different sources.

Tables IV and V are made up from many samples collected by the Massachusetts State Department of Health in their study of the pollution of the Merrimack River at Lawrence. These tables show the character of the waste from each bowl of the scouring machines, the average of all the bowls and show the character of the wastes from several mills in the State.

Table VI gives the analyses of samples of wool scouring liquor from various sources and is taken from Stabler & Pratt's analyses in Water Supply Paper No. 235.

Table VII gives the analyses of wool scouring liquors by Wilson & Calvert in "Trade Waste Waters" from English Mills.

As the discharge from most mills never consists wholly of the concentrated wool scouring wastes, but usually contains the wash waters from the operations of bleaching and dyeing which produce a diluted wool scouring liquor, Table VIII giving analyses is presented to show the difference between the concentrated wool scouring liquor and the composite wastes from the several operations.

A comparison of the analyses in Table VIII with the analyses of the undiluted heavy wool scouring liquors shows the composite wastes

TABLE IV.—AVERAGE ANALYSES OF WOOL SCOURING WASTES FROM THE MILLS AT LAWRENCE, MASS.

Parts Per Million.

Source.	No. of samples in average.	Residue on evaporation. Total residue. Total.	Residue on evaporation. Total residue. Suspended.	Residue on evaporation. Loss on ignition. Total.	Residue on evaporation. Loss on ignition. Suspended.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Kjeldahl nitrogen. Total.	Kjeldahl nitrogen. In solution.	Oxygen consumed.	Hardness.	Fats.
Lower Pacific Mill.													
First bowl	16	92,490	51,510	69,680	45,150	151	409	161	1,153	607	5,311	9,640	46,300
Second bowl	9	23,840	13,700	17,800	11,070	39	134	63	385	192	1,728	2,590	10,010
Third bowl	7	5,700	2,900	4,130	2,280	9	44	26	108	49	574	790	2,960
Fourth bowl	10	940	470	680	400	3	16	11	27	811	107	170	290
Average of third and fourth	2	2,620	1,280	1,870	1,000	12	28	17	65	25	215	410	750
Average of four bowls	6	39,030	23,040	26,720	16,730	75	210	118	493	257	1,662	3,980	15,690
Washington Mills.													
First bowl	13	107,670	65,670	55,530	33,100	413	435	162	1,408	680	6,581	10,690	27,730
Second bowl	9	17,020	9,880	12,290	7,920	69	108	51	309	161	1,390	2,010	6,960
Third bowl	9	3,810	1,810	2,530	1,520	13	22	11	79	32	342	520	1,960
Fourth bowl	5	1,650	860	1,170	720	5	36	21	45	16	184	230	620
Average of four bowls	7	35,510	17,980	23,250	13,900	224	226	92	536	299	2,780	4,800	12,060
Geo. E. Kunhardt Mill.													
First bowl	12	78,420	43,840	48,250	30,840	161	480	211	1,190	663	5,515	10,130	24,330
Second bowl	9	17,460	9,720	10,990	7,030	51	115	57	296	146	1,040	5,860	6,120
Third bowl	5	1,190	380	810	340	80	11	5	25	16	162	630	400
Fourth bowl	5	110	......	60	......	1	0.5	0.2	2	1	10	80	30
Average of third and fourth	1	1,050	940	500	460	8	10	9	19	2	49	50	60
Average of four bowls	4	30,710	15,120	15,610	7,920	103	200	103	631	295	2,760	4,980	12,030
E. Frank Lewis Mill.													
First bowl	13	79,440	41,180	42,120	23,760	185	489	212	1,062	624	4,603	14,730	20,100
Second bowl	10	41,340	17,900	20,280	11,070	94	224	96	463	262	2,010	12,780	10,160
Third bowl	11	16,190	6,590	7,490	4,140	21	73	36	191	93	940	6,440	3,520
Average of three bowls	7	51,110	26,030	26,380	15,550	130	232	96	630	302	2,818	12,140	11,400
Ayer Mill.													
First bowl	9	74,050	29,210	48,830	23,610	371	467	125	1,326	888	7,010	11,140	15,880
Second bowl	9	13,820	7,940	10,270	6,410	33	109	43	296	186	1,170	1,700	5,000
Third bowl	6	4,870	2,350	3,630	1,990	9	49	21	131	64	370	660	1,440
Fourth bowl	6	2,360	1,050	1,740	950	4	26	14	61	28	234	400	880
Average of third and fourth	3	3,210	1,700	2,380	1,420	7	29	15	71	37	397	370	850
Average of four bowls	6	28,730	12,570	19,680	10,360	146	191	67	541	389	2,080	4,420	7,340
Wood Worsted Mill.													
First bowl	14	73,710	42,670	39,780	23,120	399	470	183	1,015	491	4,940	8,860	19,010
Second bowl	8	20,730	13,980	13,540	9,060	34	104	49	379	157	1,500	2,000	6,220
Third bowl	5	3,510	1,800	2,550	1,570	5	24	13	69	36	347	640	1,560
Fourth bowl	9	1,010	480	720	420	3	10	7	27	11	96	200	390
Average of third and fourth	3	3,120	1,920	1,990	1,360	9	29	18	66	28	353	330	1,070
Average of four bowls	5	23,530	11,720	14,850	8,260	115	144	45	413	239	1,481	3,370	7,720

TABLE V.—ANALYSES OF WOOL SCOURING LIQUORS FROM MILLS IN MASSACHUSETTS.
Parts Per Million.

Total residue.		Loss on ignition.		Free	Kjeldahl nitrogen.		Oxygen	
Total.	Dissolved.	Total.	Dissolved.	ammonia.	Total.	In solution.	Consumed.	Fats.
95,542	40,382	73,310	24,460	109	1,326	655	5,747	51,350
69,070	36,570	40,190	16,800	32	1,273	672	3,136	20,090
217,903	47,593	78,613	24,013	157	2,299	869	9,383	41,500
39,147	21,780	24,520	11,834	296	647	348	2,950	16,560
95,000	36,900	43,700	14,020	560	.....	.....	.....	......
43,020	35,950	11,580	4,910	68	.....	.....	.....	......
109,980	81,860	......	......	2,400	.....	.....	.....	......
55,950	18,780	33,490	17,020	66	.....	.....	6,650	15,956
19,384	5,699	8,968	5,918	20	.....	.....	1,550*	......
73,860	43,040	45,020	21,220	720	.....	.....	6,300	......

*Filtered.

are many times weaker. It might not be out of place to mention in passing, that the first four analyses in Table VIII represent wastes which were experimented upon at the Lawrence Experiment Station to determine the applicability of sewage treatment methods to woolen mill wastes. These wastes were in no way comparable with the heavy undiluted wool scouring liquors. The possibility of treating the wool scouring liquors by sewage methods when diluted with the other mill wastes will be discussed in the author's paper on the treatment of wastes from the finishing processes.

TABLE VI.—ANALYSES OF SAMPLES OF WOOL SCOURING LIQUOR FROM VARIOUS SOURCES.

No.	Specific gravity.	Turbidity.	Scum, per cent by volume.	Sediment, per cent by volume.	Solids. Total.	Solids. Volatile.	Solids. Fixed.	Alkalinity.	Fats.	Oxygen consumed.	Free amm.	Organic nitrogen.
				Milligrams per Liter.								
1	1.023	22,000	..	15	45,090	24,670	20,420	8,000	14,600	5,680	300	663
2	1.027	120,000	8	8	116,400	85,000	31,400	8,000	59,000	11,500	300	1,550
3	1.019	55,000	*	20	68,060	50,710	17,350	3,100	38,200	5,700	164	795
4	.....	....	20	14	70,800	46,600	24,200	3,800	31,620	5,200	180	941
5	.....	....	..	..	41,700	29,800	11,900	3,420	20,200	......	...	.....

1. Lymansville Co., Lymansville, R. I., Nov. 13, 1906.
2. Lorraine Manufacturing Co., Pawtucket, R. I. Average 3 samples March 13, 1907.
3. Lorraine Manufacturing Co., Pawtucket, R. I. Average for week ending Mar. 29, 1907.
4. Lorraine Manufacturing Co., Pawtucket, R. I. Average for week ending May 23, 1907.
5. Field Head Mills, Bradford, England. Crude suds, May, 1900.

*Slight.

PURIFICATION PROCESSES.

From the foregoing tables of analyses of the wool scouring liquors it will be seen that they are a concentrated, brownish liquor, containing large quantities of organic matter in solution and suspension, soap and alkali used in the process of scouring and a large amount of grease derived from the wool. The waste contains two products—potash and grease—which have considerable commercial value if recovered. Purification processes may consist of those methods used in sewage purification, losing the valuable products contained in the liquor, processes involving partial recovery of valuable products combined with sewage treatment methods, or complete recovery methods. A discussion of these methods for the treatment of the various classes of waste follows.

TABLE VII.—ANALYSES OF WOOL SCOURING LIQUORS FROM ENGLISH MILLS.
Parts per Million.

Source.	Total solids.	Nitrogen. Ammoniacal.	Nitrogen. Organic (Kjeldahl).	Fats.	Alkalinity.	Potash as K_2CO_3.
Mixed wools	23,883	162	338	8,346	5,433	4,177
Greasy Colonial, home bred, skin wools	24,666	91	238	10,189	5,404	3,089
Greasy Colonial Merino wool	33,879	196	394	17,995	4,077	.....
Average of several analyses	22,392	115	226	12,378	.....	.....
Back-washing water	8,427	19	87	5,176	415	.....

PURIFICATION BY SEWAGE METHODS.

Experiments on the purification of wool scouring liquor have for a number of years been in progress at the Lawrence Experiment Station of the Massachusetts State Department of Health under the direction of Mr. H. W. Clark, Chemist of the Department. The results of these experiments have been published from time to time in the annual reports of the Department and the following information on the application of sewage methods to the purification of wool scouring liquors is taken from these reports.

Sedimentation.—Plain sedimentation results in the separation of the coarser material, such as sand and mineral matter, washed from the wool in scouring. Only 30 per cent—generally less—of the suspended organic matter can be settled in a reasonable time.

Chemical Precipitation.—All the common precipitants such as lime, ferric sulphate, ferric sulphate and lime, iron alum, alumina sulphate, ferrous sulphate, ferric chloride, calcium chloride, etc., were tried. In all experiments excessive amounts of the precipitants were required to cause any coagulation whatever. Lime up to 30,000 lbs. per 1,000,000 gals. and the same amount of ferric sulphate had little effect, while 50,000 lbs. of sulphate of alumina caused no precipitation beyond coagulation alone. Calcium chloride was the most efficient but 10,000 to 20,000 lbs. per 1,000,000 gals. were required to produce a filtrate nearly odorless. As wool scouring liquor is about 100 to 300 times as strong as domestic sewage, it would be expected that large amounts of precipitant would be required. The fatty matter of the liquor is in a form of emulsion and lighter than water, and the coagulation of this material causes it to rise carrying the coagulating material up with it.

Straining Through Coke.—Considerable clarification can be obtained by treating the waste on beds of coke or cinders. Where the wastes are mixed with domestic sewage, the treatment in settling tanks and on coke strainers, followed by sand filtration, is recommended.

TABLE VIII.—ANALYSES OF MIXED WOOLEN MILL WASTES.

Residue on evaporation.			Ammonia.				
				Albuminoid.			
Total.	Loss on ignition.	Fixed.	Free.	Total.	In solution.	In suspension.	Oxygen consumed.
1,187	476	711	1	9	.	..	199
1,500	600	900	6	8	3	5	81
2,704	1,215	1,489	4	22	..	..	181
1,623	624	999	1	6	..	..	114
2,744	1,140	1,604	15	27	20	7	230

Sand Filtration.—All experiments tried by treating the wool liquor directly on sand beds resulted in the beds clogging and the effluent having the same characteristics as the applied liquor. When clarified by chemicals the liquor filtered readily, but the effluent was similar to the raw waste. When applied to a filter which was treating domestic sewage and when nitrification was active this was quickly checked by the waste. Combined waste and sewage in the proportion of 1 part waste and 17 parts sewage allowed to rot for 48 hours before filtration gave better results. The results of filtration experiments by the Massachusetts State Departemnt of Health are given in Table IX, p. 374.

From these experiments it seems probable that the treatment of the more concentrated liquors from the scouring of raw wool by sewage methods cannot be recommended as the beds clog rapidly and nitrification will not take place.

Inasmuch as the concentrated waste contains recoverable grease which is the cause of failure of sewage methods, and as the recovery of this grease can at least be made to pay some part of the cost of purification, the best method seems to be the separation of the concentrated liquor, the recovery of both potash and grease or the grease alone, and the purification of the dilute liquors together with the remaining liquors after the recovery process by sewage purification methods.

PURIFICATION BY RECOVERY.

Steeping.—Steeping before scouring is almost unknown in this country, but is practised in France and Belgium, and to a lesser extent in Germany, Russia and England. It is merely a preliminary step in the scouring process and consists of passing warm water continuously through the wool loosening the impurities and making the later scouring process much easier. The steep water extracts about 40 per cent of the impurities and becomes highly concentrated with potash. This liquor is then evaporated, incinerated and the crude potassium carbonate recovered. The wool is then scoured by the usual method, but the process is much easier as the remaining impurities are softened and can be removed with much less soap and in a shorter time. The soap and alkali added and the grease from the wool contained in this scouring liquor, and their purification involves the same methods that would be used if the steeping process had not been employed.

Volatile Solvents.—At some mills scouring with volatile solvents has been tried but the method is not in general use. In this method the wool is put in suitable containers, is treated with the solvent by continued circulation through it, and finally removed by some inert gas as carbon dioxide. The wool treated in this way can be completely cleansed with warm water. The solvent is distilled and re-used and the wool fat recovered. Such a plant is in operation at the Arlington Mills, Lawrence, Mass. The merits of this process consist in a saving of the wool fiber and a saving in soap in the subsequent washing process. The water used in cleansing after extraction with the solvent is very similar to the steep water in the first process. It contains a greater percentage of wool impurities and is somewhat less valuable for the recovery of potash.

The solvents proposed have been petroleum-naphtha, carbon-disulphide and carbon-tetrachloride, but because of the uncertainty of the control of these compounds and the expense from loss, together with the danger from fire, the process has not come into general use.

Cracking Process.—The general outline of the cracking process of grease recovery from wool scouring liquor is as follows: The waste from the first bowls of the scouring machine is run to a preliminary settling tank where the sand and mud are retained and the liquor cooled. From these tanks the liquor passes to the treatment tank. When a tank is filled, its contents are agitated, usually by compressed air delivered through a system of piping in the bottom of the tank. At the same time sulphuric acid is added until the "cracking" of the liquid takes place which is a separation of the fats. At this time also, loam may be added to assist in the settling process which follows later. This mixture is then agitated for a number of hours and allowed to settle for a similar period. During settling a portion of the fat rises to the surface and a portion settles. The clarified acid liquor is drawn off from between these two layers and is treated by filtration with or without neutralization. The sludge remaining in the tanks contains the fatty matter and is run onto sludge drying beds usually covered with a layer of sawdust. The grease solidifies and is absorbed by the sawdust and the excess moisture drains away or is treated with the acid liquor. The sludge can then be shoveled into bags and pressed in heated presses where the grease and oil are released, after which it is further purified by treatment with acid and water and is then barreled. The cake remaining in the press contains about 50 per cent water and considerable dirt. This sludge is deposited on land or in some cases used as a fertilizer, although its value as such has not been definitely proven.

TABLE IX.—RESULTS OF EXPERIMENTS OF TREATING WOOL SCOURING WASTES UPON VARIOUS FILTERS.

Parts per Million.

Sample.	Depth of sand, inches.	Size of sand, m.m.	Rate of application, gals. per acre per day.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen consumed.
Scouring liquor	..	...	....	173.0	431.0	0.00	0.000	2,320.0
Effluent filter 61	60	.25	17,000	278.0	83.0	2.80	0.000	900.0
Filtration of the effluent from filter 61—								
Filter VI	60	.25	50,000	195.8	79.0	2.26	.012	766.0
Filter VII	60	*	50,000	211.7	83.9	2.20	.260	761.0
Filter VIII treating scouring liquor after clarification with calcium chloride	60	.25	100,000	111.9	65.4	1.51	.953	536.3
Applied waste-wool scouring liquor containing wash and rinse water	..	...	....	19.5	5.5	...	.....	30.5
Effluent from filter filtering above waste plus 1/5 volume of sewage	54	.23	400,000	4.4	0.3	10.00	.....	4.0
Strong scouring liquor plus 17 parts sewage	..	...	....	41.0	21.5	....	.....	196.2
Effluent of filter treating above	54	.23	55,600	23.7	10.2	5.70	.550	125.0
Effluent of filter treating above mixture after standing 48 hours	54	.23	55,600	.69	1.13	37.50	.075	16.6

*Coke breeze.

Stabler & Pratt in Water Supply Paper No. 235 give an analyses of wastes and the results of purification by this process at the plant of the Lorraine Manufacturing Company, Pawtucket, Rhode Island, as shown in Table X. A comparison of these analyses with the analyses of the liquor from the first bowls of some of the Lawrence Mills shows it to be a very strong wool scouring liquor.

The preliminary sedimentation of the liquor at this plant was omitted and a large proportion of mineral matter in suspension was carried through the treatment process.

TABLE X.—WOOL SCOURING LIQUOR AND EFFLUENT FROM THE TREATMENT TANKS AT LORRAINE MILLS.

Milligrams Per Liter.

Date.	Turbidity.	Sediment.	Oxygen consumed.	Free amm.	Organic nitrogen.	Alkalinity.	Fats.	Total solids.	Loss on ignition.	Fixed solids.	Shrinkage of wool.
WOOL SCOURING LIQUOR.											
Mar. 13	120,000	8%	11,500	300	1,550	8,000	59,000	116,400	85,000	31,400	High
Mar. 22-29	55,000	20%	5,700	164	795	3,100	38,200	68,060	50,710	17,350	42%
May 17-23	......	14%	5,200	180	941	3,800	31,620	70,800	46,600	24,200	48%
TREATMENT TANK EFFLUENT.											
Mar. 13	1,500	1.2%	1,800	330	200	1,600*	1,360	19,600	6,900	12,700	High
Mar. 23-29	8,000	Heavy	2,160	230	258	2,200*	4,420	21,010	9,960	11,050	42%
May 17-23	......	3.5%	2,800	289	346	3,000*	7,000	27,670	13,310	14,360	48%

*Acid.

Stabler & Pratt give estimates of relative volumes at different steps based on 1,000 gals. of scouring liquor at the Lorraine Mills, as shown in Table XI.

The purification accomplished at this plant, based on the following determinations, was as follows: Total solids, 67%; volatile solids, 77%; fixed solids, 46%; fats, 85%.

Turner-Akeroyd Process.—This process is a slight modification of the cracking process, patented in England by Messrs. Turner and Akeroyd, and is employed in the recovery of grease from dilute solutions. The liquor is diluted to such specific gravity that the fats on treatment with acid settle to the bottom leaving a clear supernatant liquor. Such a plant was installed by the firm of Turner & Akeroyd, and operated by them during the years 1906 to 1911 at the Pontoosac Mill in Pittsfield, Mass., to demonstrate the methods of the process. A brief description of this plant follows:

TABLE XI.—ESTIMATES OF RELATIVE VOLUMES AT DIFFERENT STEPS BASED ON 1,000 GALS. OF SCOURING LIQUOR.

Source.	Total amount of material. Gals.	Total amount of material. Lbs.	Water Gals.	Water Lbs.	Composition Total solids. Lbs.	Composition Volatile solids. Lbs.	Composition Fixed solids. Lbs.	Composition Fats. Lbs.
Scouring liquor	1,000	8,520	948	7,941	579	406	173	291
Acid used	5.2	77	1.5	13	...	...	...	...
Liquid from acid tanks	620	5,290	619	5,164	126	60	66	30
Filter effluent	225	2,174	254	2,122	52	25	27	12
Material pressed	.....	1,093	80	668	425	321	104	249
Liquor from cisterns	167	1,405	167	1,391	14	10	4	3
Liquor from purification of grease	7	60	7	60	Trace	...	...	Trace
Grease recovered	.....	183	.....	Trace	183	183	Trace	183
Press cake	.....	255	3	27	228	128	101	63
Total liquid effluent	1,049	8,929	1,047	8,737	192	95	97	45

The Pontoosac Mill is located on the Housatonic River about two miles above Pittsfield, Mass. The output consists of woolen cloth. The waste treated consists of the worst part of the scouring liquors, the wash waters and dye waters being diverted to the river. An analysis of the waste treated is as follows:

Total residue:	
Total	5,224
Suspended	2,048
Loss on ignition:	
Total	3,564
Suspended	1,584
Free ammonia	3.0
Albuminoid ammonia:	
Total	33.0
Suspended	25.8
Oxygen consumed:	
Unfiltered	700
Filtered	515

The purification plant consists of two settling tanks, three sludge beds, a filter and a sludge press, together with the necessary pumps for lifting the liquor, an air compressor and the necessary piping for operating. The settling tanks are each 20 ft. in diameter and 10 ft. deep having a capacity of 20,000 gals. They are provided with inlet troughs, a system of air piping in the bottom for agitation and outlets for the sludge and supernatant liquor. The three sludge beds are each approximately 1/160 of an acre in area and consist of 3 to 4 ins. of fine cinders underdrained by broken stones and tile underdrains which discharge into the river. The filter for the supernatant liquor has an area of 1/36 of an acre and consists of 4 ins. of cinders underdrained by broken stone and tile drains also discharging into the river. The hydraulic sludge press has a capacity of 35 to 40 cu. ft. and is provided with steam pipes for treating the sludge in the press.

The operation of this plant is as follows: When a treatment tank is full the compressed air is turned on and a thorough mixing takes place. At this time also about one-third of a barrel of loam is added and from 12 to 15 gals. of sulphuric acid. Mixing then takes place for from 4 to 5 hours and the contents are allowed to settle over night. The supernatant liquor is then drawn off and applied to the filter bed. About 3 to 4 ins. of sawdust are added to the surface of one of the sludge beds and the sludge is applied to the surface. After drying and draining for a day or so the sludge becomes thick and oily and can be removed with a shovel and placed in burlap bags ready for pressing. Any accumulation of grease on the surface of the liquid filter is also treated with this dried sludge. The bags are treated with steam in the press which liberates the grease and oil which is further purified, barrelled and sold. The dry cake in the presses is used for filling or sold as fertilizer.

Table XII shows the results of a test on the operation of this plant.

The purification, based on the raw liquor and the effluent of the filter, was as follows: Total solids, 60%; volatile solids, 83%; albuminoid ammonia, 91%; oxygen consumed, 94%.

Stabler & Pratt give the following analyses of the raw liquor and filter effluent obtained by them from this plant.

	Milligrams per liter. Scouring liquor.	Milligrams per liter. Filter effluent.
Total solids	4,740	2,460
Volatile solids	3,200	100
Fixed solids	1,540	2,360
Free ammonia	2.6	5.6
Organic nitrogen	47.6	6.1
Oxygen consumed	410	64
Fats	2,148	38

The percentage purification based on their analyses was as follows: Total solids, 48%; volatile solids, 97%; oxygen consumed, 84%; fats, 98%.

This plant was operated by the firm of Turner and Akeroyd, and after demonstrating that a profit could be made on the recovery of the grease its operation was discontinued. The owners of the mill believed that, while a profit could be made over operating expenses, the profit over operating expenses plus interest on the cost of the plant would be little or none.

The estimated yearly cost of operating such a plant is given as follows:

Labor, 52 weeks at $12	$ 624
Acid	260
	$ 884
Value of oil recovered, say, 3,600 bbls. at $0.28	$1,008
Profit	$ 124

Figuring the interest and depreciation on the cost of the works, it will be seen that no profit can be made from the recovery of grease from this class of waste. On the other hand, if the waste was to be treated by sewage methods alone there would be absolutely no return upon the capital expended. When the liquor treated by the cracking process is the heavy concentrated liquor from scouring raw wool the profit from the recovery of grease ought to go far towards paying for the cost of the plant and operating expenses.

TABLE XII.—RESULTS OF A TEST ON THE TURNER-AKEROYD PROCESS PLANT AT PONTOOSAC MILL, PITTSFIELD, MASS.

	Parts per million									
	Total residue.		Loss on ignition.			Albuminoid ammonia.		Oxygen consumed.		
Source.	Total.	Suspended.	Total.	Sus-p'ded.	Free amm.	Total.	Sus-p'ded.	Unfiltered.	Filtered.	Acidity.
Wool scouring liquor	5,224	2,018	3,564	1,584	3.0	33.0	25.8	700	515	.....
Same after addition of acid and 6 hrs. mixing	3,980	2,738	2,560	2,028	3.8	16.0	13.8	240	34	1,025
Supernatant after standing over night	2,312	73	924	64	2.6	3.8	1.6	65	35	.....
Effluent from filter	2,112	38	596	26	2.6	3.0	0.9	39	34	615
Sludge applied to sludge bed	22,016	21,722	19,448	18,956	6.0	15.4	14.7	1,350	46	.....
Effluent of sludge bed	2,482	38	612	32	2.9	2.9	0.2	53	51	690

Grease Recovery Plant at Hudson Worsted Co.—A plant for the recovery of grease from the scouring of wool has been in operation at the Hudson Worsted Co.'s plant in Hudson, Mass., since 1909. This plant was constructed under the direction of Mr. Robert Spurr Weston, Civil Engineer, Boston, Mass., and has since been operated under his supervision. We are indebted to Mr. Weston for the following notes on this plant.

The works were installed to improve the condition of the river into which the raw waste was formerly discharged and for the purpose of recovering the grease. The cracking process is used and the acid waters are treated by filtration.

The daily wastes, amounting to about 24,000 gals., are collected in a sump from which they are pumped to a cooling trough and then to a settling tank having a capacity of about 15,000 gals. The settled wastes are then pumped to the treatment tanks, of which there are three, each having 20,000 gals. capacity, covered to prevent nuisance from odors. All fumes are carried away from the tanks by exhaust fans and discharged into the stack over the boiler. The treatment tanks are provided with air agitators which thoroughly mix the contents. Acid is added until cracking occurs and the contents, after thorough mixing, are allowed to settle twelve hours. The supernatant liquor is then drawn off through a floating arm, passed through the settling tank to remove any more fats it may contain and then filtered. The filter beds are four in number, have an area of .023 of an acre, are constructed of cinders 2 ft. deep and are well underdrained.

The sludge from the treatment tanks is treated on eleven filter beds each having an area of 147 sq. ft. About a week's drying puts it in such condition that it can be removed, placed in burlap bags and treated in the presses. Five steam-jacketed hydraulic presses are provided. The grease extracted is pumped to separating tanks and further clarified and barrelled. The sludge remaining after pressing is said to have good fertilizing value and is sold.

The cost of the works was about $15,000. The cost of operating and returns from the grease extracted are not available but it is said that when the grease is sold for 2.5 cts. per pound the plant is run at a loss and when sold for 3.5 cts. at a profit.

So far as is known there are no analyses available of the raw liquor and the effluent of the filters.

Smith-Leach Process.—This method of treatment was in operation in England at the Field Head Mills, Bradford, for several years. It is probably the highest developed recovery process that has been put in operation. Its principle is concentration, separation and subsequent recovery of the potash and wool grease.

The liquor to be treated flows to a preliminary settling tank, which removes the coarser suspended matter, sand and dirt; and then to a Yaryan quadruple-effect evaporator where it is reduced to 1/10 to 1/15 its original volume. The concentrated liquor is then heated nearly to the boiling point and passed through a centrifugal machine which separates it into three portions: an outer layer of sand and dirt, which is removed from the machine by hand, a central layer consisting of soapy liquid which contains potash, and an inner layer of wool grease.

The wool grease is purified by heating with water and then separation takes place, and the potash liquor is further concentrated by evaporation and incinerated until the crude potassium carbonate remains. There is then produced from the raw liquor, distilled water, grease, crude potassium carbonate, mud and sand.

Table XIII from Stabler & Pratt's paper shows the composition and quantity of waste, based on 1,000 gals. of raw liquor, for each step in the Smith-Leach process as conducted at the Field Head Mills:

The above authors give the following balance sheet, as the result of a week's test at the Field Head Plant, made by Chief Inspector H. McLean Wilson of the West Riding Rivers Board:

Cost of plant		$21,900.00
Amount of wool scoured, lbs.		65,256.00
Amount of scouring liquor, gals.		66,000.00
Value of products:		
3,300 lbs. wool fat	$	146.00
2,830 lbs. crude potash		93.98
53,100 gals. distilled water		6.69
Soap saved by using above water, 1/7 total used		10.22
	$	256.89
Cost of operation:		
Coal, 19 tons, 41,780 lbs.	$	50.54
Labor, 3 men		16.60
Interest and depreciation, 10%		42.10
	$	109.24
Profit	$	147.65

Profit per year, $7,677.80 = 35%.

TABLE XIII.—COMPOSITION AND QUANTITY OF WASTE, BASED ON 1,000 GALS. OF RAW LIQUOR, FOR EACH STEP IN THE SMITH-LEACH PROCESS.

	Total amount of material.		Water		Composition				
					Total solids.	Grease.	Organic impurities.	Soluble mineral matter.	Insoluble mineral matter.
Source.	Gals.	Lbs.	Gals.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Crude suds	1,000	8,452	970	8,100	352	174	78	73	27
Concentrated suds	103	959	73	607	352	174	76	63	39
Condensed water	897	7,493	897	7,493	0.5	0.4	0	0.1	0
From concentrated suds:									
Grease	30	125	0.6	5	120	118	0.6	...	1
Potash liquor	73	832	72	601	231	56	55	64	56
Earthy matter	0	2	0	0.5	1.5	0.2	0	0	1.3
	103	959	73	606	352	174	56	64	58
From evaporating potash liquor:									
Crude potash	.....	94	0	0	94	...	2	64	28
Loss	.....	738	72	601	137	56	53	0	28
	.....	832	72	601	231	56	55	64	56

During this test the plant was operating at about half its capacity, making the fixed charges relatively high, and during about half the week scoured wool was being washed. The low cost of coal and labor which could not be duplicated here makes the return greater than could be expected from similar plants operating in this country.

Battage Process.—The success of this process depends upon some form of agitator or beater either of compressed air, superheated steam or a mechanical device which will cause a froth or foam to form upon the surface of the liquor. This liquor will contain the fatty material. The foam is removed from the surface by skimming and the grease recovered by treatment with acid and pressing. This recovery process is used successfully in France.

While a portion of the grease is recovered, the process can hardly be called one of purification as the remaining liquor is a very concentrated, dirty waste and unfit to be discharged into any stream without some additional form of recovery or purification.

Stabler & Pratt give Table XIV, which shows the degree of purification and the profit from the different methods of treating wool scouring liquor.

TABLE XIV.—DEGREE OF PURIFICATION AND THE PROFIT FROM DIFFERENT METHODS OF TREATING WOOL SCOURING LIQUOR.

	Per cent purification.			
	Total solids.	Volatile solids.	Fats.	Per cent profit on capital invested.
Cracking process	65	75	83	0
Turner-Akeroyd process:				
Filtration inclusive	48	97	98	0
Filtration exclusive	...	...	92	0
Smith-Leach process	100	100	100	59

SUMMARY AND CONCLUSIONS.

The application of sewage treatment methods to the purification of heavy wool scouring liquor results in failure. Sewage treatment methods for purifying the composite liquors of woolen mills, where washing and dyeing of the finished cloth are practised and where the heavy scouring liquor is very much diluted, may be applicable; but the process is simply the destruction of a liquor containing valuable products which might by other methods of treatment be made to yield some return on the cost of purification works and their operation.

The common methods of recovery in combination with sewage methods are the so-called cracking process and the Turner-Akeroyd modification. From these methods grease alone is recovered from the waste and considerable revenue can be obtained. The remaining liquid is then treated by filtration and the resulting effluent is well purified. It is doubtful if any profit can be made after paying the fixed charges and operation of the plant. The recovered grease will, however, more than pay the cost of operating the recovery portion of the plant.

By the Smith-Leach process the wool scouring liquor can be entirely destroyed, the resulting products being grease, potash, distilled water, sand and mud. No liquid remains to be treated by sewage methods. From such data as are available, this method of disposal will yield a fair return upon the cost of the plant and cost of operation, and there remains no liquid of a polluting nature to cause nuisance.

WATER WORKS

Some Design and Construction Features of Chicago's First Utilities Gallery.

(Staff Article.)

In connection with the extensive alterations, including changes in street grades, near the site of the proposed new Union Passenger Station there is being constructed a reinforced concrete utilities gallery. This is the first gallery of the kind to be built in a Chicago street and one of the first in the streets of American cities. Similar structures are not uncommon on the grounds of private properties. For example, there are numerous utility galleries connecting the various buildings on the grounds of American colleges and universities. These are referred to locally as "tunnels" and are built by cut and cover methods. The street gallery construction is not uncommon in European cities, as described at some length in an article published in this section of Nov. 3, 1915.

The Chicago gallery is three blocks long. It extends along Canal St. from Washington to Monroe Sts., two blocks, thence along Monroe St. to Clinton St. Some details of the design at the intersection of Canal and Madison Sts. are shown in Fig. 1. Figure 1 also shows a typical section of the conduit between Washington and Madison Sts., detailing the reinforcement. Figure 1 also shows, at the lower left hand corner, the design adopted for supporting the 12-in. water pipe and shows the method of making a hydrant connection to that water main.

For the present only a water main will extend down the gallery on Monroe St., but in the portion of the gallery along Canal St. several utility lines will be accommodated. The arrangement of these utilities at the Madison St. crossing are shown in the several sections on Fig. 1. It will be noted that the lines of the Chicago Edison Co., the Chicago Sanitary District electric wires, the Chicago Telephone Co. ducts, the wires of the Western Union Telegraph Co., the Fire Alarm and Police wires, and two pneumatic mail tubes are accommodated in addition to the 12-in. water pipe.

A view of the form work for the gallery is shown in the foreground of Fig. 2. The street grade is to be raised at this point. The roof of the gallery will form a part of the new sidewalk at this point. All along this street, Canal St., the gallery will be under the sidewalk. This cut also shows a general view of the concrete tower and chutes. The contractor, the W. J. Newman Co., of Chi-

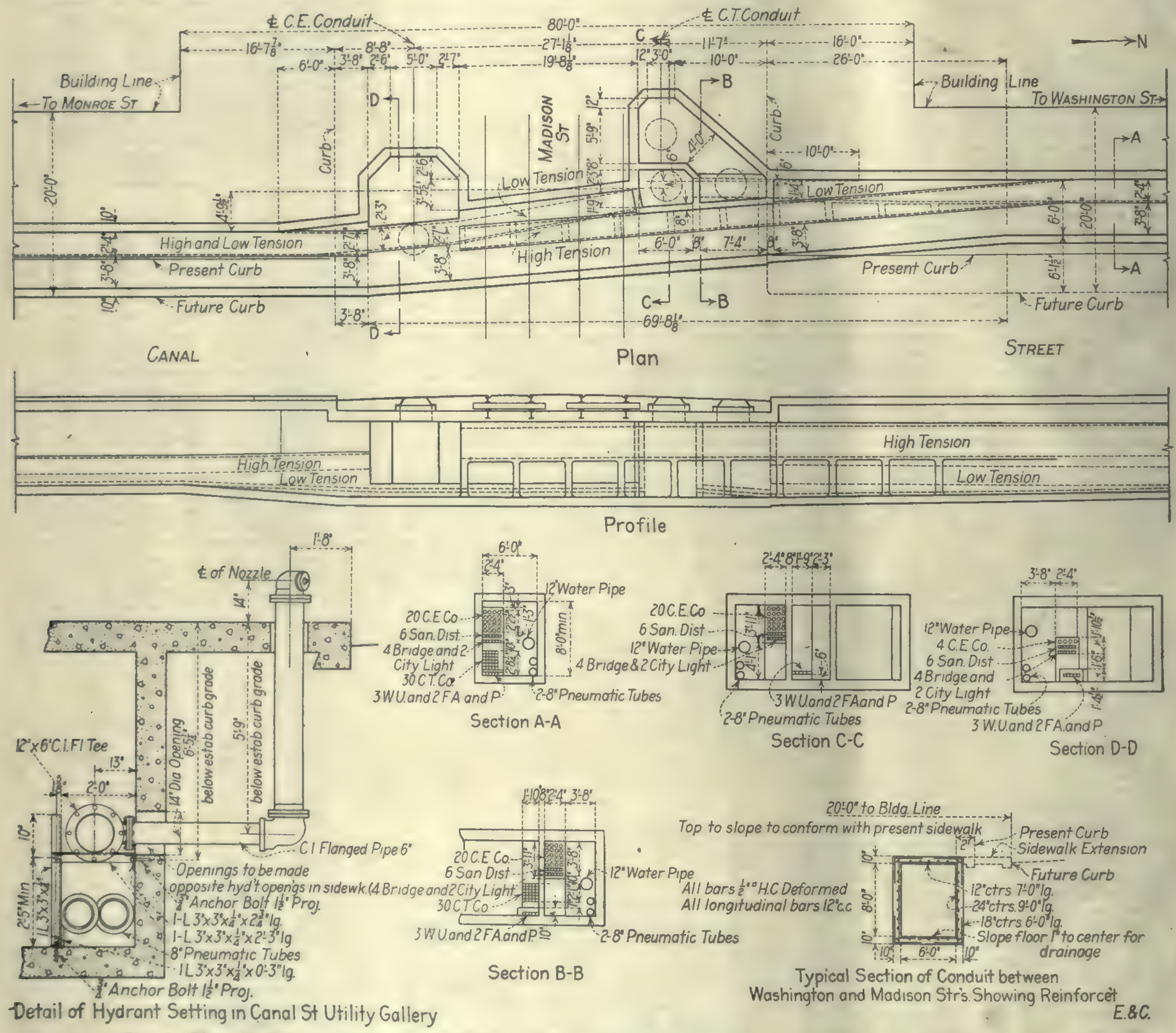


Fig. 1. Plan, Profile and Sections of Utilities Gallery Under Construction at Madison and Canal Sts., Chicago.

(Typical section, showing reinforcement, between Washington and Madison Sts., at lower right corner. Hydrant connection to water main at lower left hand corner.)

cago, also has the contract to construct a 9x12-ft. reinforced concrete sewer, down the center of Canal St., and a heavy concrete retaining wall along the same street opposite the utility gallery. These latter jobs only are of sufficient magnitude to warrant the installation of the plant used but since the gallery is being concreted with this plant the contractor's equipment is described in this article.

Madison St., where it crosses the utilities gallery, is a very busy thoroughfare, with two street car tracks and a heavy vehicle traffic. The Northwestern Railway passenger station is at this point, so the number of pedestrians using this crossing daily is very great. All this traffic is maintained during construction. The excavation is planked over to provide a sidewalk and the gallery is built in tunnel under the street car tracks which remain undisturbed. These are supported by means of suitable timbering in the tunnel. All sewer connections encountered are lowered to pass into the sewer in Canal St.

Between the North and South curb lines of Madison St. the excavation is paid for at the cost of digging and loading plus 10 per cent. Outside of this portion of the work done by the city the excavation is paid for at the rate of $1.45 a cubic yard. This excavation includes the removal of a strip of pavement, a portion of the present concrete sidewalk and the curb, all earth and other materials encountered. The necessary backfilling and the relaying of the granite paving blocks are included in this cost for excavating. The city work extends only to the South line of Madison St.; the other two blocks of the gallery are Chicago Union Station Co. work.

It was found necessary to cut out part of the concrete wall extending around the subsidewalk space occupied by the Chicago and Northwestern Railway and this was paid for at the rate of 25 cts. per cubic foot.

The contractor is paid $15.43 per cubic yard of concrete placed for constructing the gallery. This figure includes forms, reinforcing steel, setting manhole castings, etc. The concrete mixture is 1:2:4, machine mixed. Sewer connections changed are paid for a cost plus 10 per cent.

The present sidewalk is removed, in part, with care so that the present West blocks of the walk are left undisturbed. The roof slab of the gallery will form the new East block of the sidewalk. The top of this slab has a 1-in. finishing coat poured monolithic with the rest of the slab.

CONSTRUCTION PLANT.

Views of the concrete handling plant are shown in Figs. 2 and 3. The general layout of the tower and chutes is shown in Fig. 2. Attention is called to the trestle work built up over Madison St., to the left of the street car shown in Fig. 2. This structure was erected to provide an anchorage for the rope lines supporting the chute at that point.

The hoisting tower shown is of Lakewood Engineering Co. manufacture and is 160 ft. in height. It is built up of 10x12 ft. sections 12 ft. high. The half-round concrete chutes are of 12 gage iron. The plant is located at the edge of the Pennsylvania Railroad yards, and all the concreting materials are brought to the plant in carload lots. A stiff-leg derrick, operated by a 30 hp. Monighan hoisting engine and equipped with a 1 cu. yd. clam-shell bucket, unloads the crushed stone and sand from the cars, and carries these materials to the storage bins at the tower. From these bins the materials gravitate to a measuring hopper and thence to the ¾-cu. yd. Chicago concrete mixer. These materials, when received in excess of the demand, are piled beside the track. Bulk cement is used. It comes in box cars and is shovelled into wheelbarrows and wheeled to the cement shed shown at the base and to the left of the tower. The wheeling is done on the level and the distance wheeled does not exceed 25 ft. The cement gravities to a boot where it is picked up by a bucket elevator and conveyed to an auxiliary storage bin above the measuring hopper previously mentioned.

All the steam used is obtained from a 40 hp. horizontal boiler. This steam is piped to the engine operating the derrick and to the one operating the concrete mixer. The hoist used in the tower is of Thomas Elevator Co. manufacture and is operated by electric power. This hoist is equipped with car-pulling thimbles which are used to shift the material cars on the adjacent tracks.

ACKNOWLEDGMENT.

The gallery was designed in the City Engineer's office. It is being built by the W. J. Newman Co. Mr. J. P. Carroll is the contractor's superintendent. We are indebted to Mr. H. S. Baker, Assistant City Engineer, and to his assistant, Mr. C. C. Saner, for the information here given.

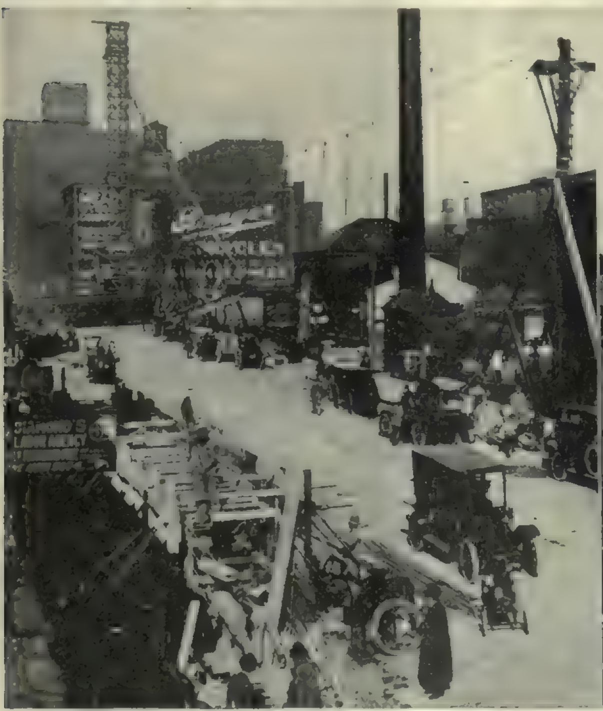


Fig. 2. View of Form Work for Utilities Gallery and Concrete Hoisting and Conveying Plant in Background.

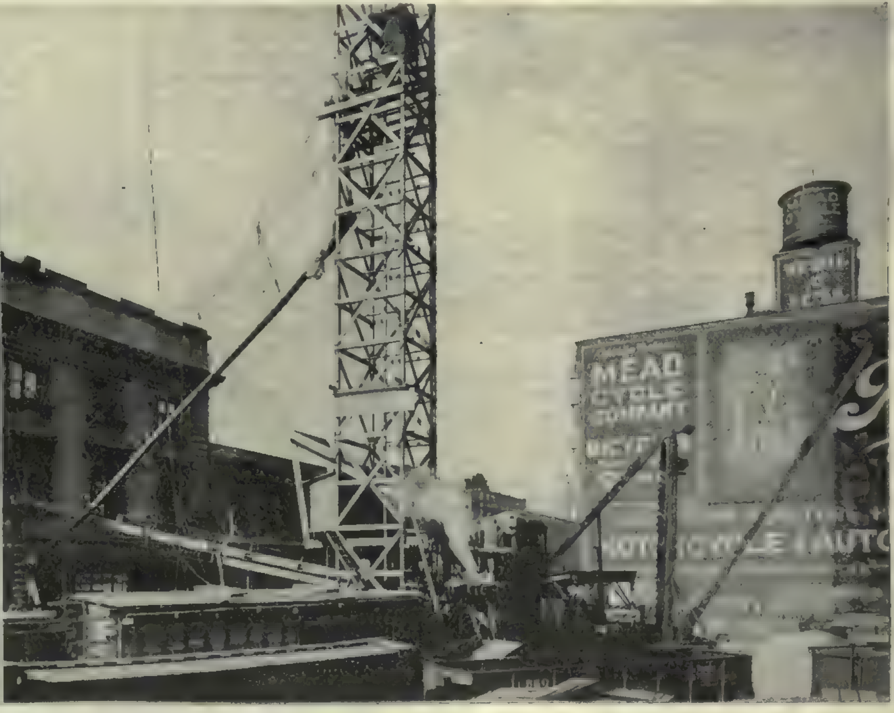


Fig. 3. Close View of Concentrating Plant for Construction of Parallel Utilities Gallery, Sewer and Retaining Wall.

Some Construction Features of the Greater Winnipeg Water Works.

(Staff Abstract.)

The Greater Winnipeg Water District is now building works for securing by gravity about 100,000,000 U. S. gals. of water per day from the Lake of the Woods, which lies about 100 miles east of and about 300 ft. higher than Winnipeg. The District is a corporation including the cities and town of Winnipeg, St. Boniface and Transcona, the rural municipality of St. Vital and portions of the rural municipalities of Fort Garry, Assiniboia and Kildonan, all of which adjoin the city of Winnipeg. The aqueduct is a horseshoe, concrete conduit having the following slopes and sizes:

Slope of aqueduct.	Dimensions of section.
0.11	10′ 9″ x 9′ 0″
0.279	10′ 9″ x 9′ 0″
0.300	8′ 9″ x 7′ 4⅝″
0.332	8′ 3¾″ x 7′ 0″
0.480	7′ 11½″ x 6′ 8½″
0.600	7′ 7½″ x 6′ 5¼″
0.684	7′ 5½″ x 6′ 3½″
0.744	7′ 4″ x 6′ 2¼″
1.290	6′ 7″ x 5′ 6⅛″
1.537	6′ 4¾″ x 5′ 4¾″

LOCATION.

The location of the aqueduct line required a great deal of patient, hard work. For the greater part of the distance the country is practically flat, the rise toward the east averaging 3 ft. to the mile, the steepest slopes being not over about 8 or 9 ft. to the mile. The whole country drops gently toward the northwest but the fall is so slight that rain water has great difficulty in getting away, and consequently has formed large areas of swamps, marshes and muskegs. The subsoil throughout practically the entire distance is a sandy clay practically impervious to water. It is this condition of imperviousness combined with the flatness of the country which has caused the remarkably large areas of swampy land. In the course of ages these swamps have become grown up with grasses and mosses; bushes and trees which thrive in wet places, have grown up generation upon generation, and gradually built up, upon the impervious sub-soil, water-soaked, compressible, spongy masses of roots and moss in a more or less advanced state of decomposition. In some places these masses or beds of moss and primitive peat reach great depths, some, a few miles to the north of the location of the aqueduct line, being known to be at least 70 ft. in depth. The deepest muskeg so far encountered along the line of the aqueduct is about 15 ft. At mile 85, where the muskeg is quite deep, the bottom of the trench is being prepared for the aqueduct by placing therein a gravel bottom and driving piles along the sides, to carry the aqueduct, which will be reinforced with steel along this section for several hundred feet, on account of a soft, yielding sub-surface stratum.

It can readily be appreciated that running lines through a country such as above described is a tedious operation. The country is practically unsettled excepting along the Brokenhead and Whitemouth Rivers, the only two streams worthy the name which cross the aqueduct line between Winnipeg and the Lake, and supplies had to be packed in on the backs of porters from the nearest railway, some 15 miles to the north, or brought up to the line of the survey in canoes on the Whitemouth River, or Brokenhead River or through the Lake of the Woods from the Kenora, which is some 40 miles from the point where the aqueduct line reaches the Lake.

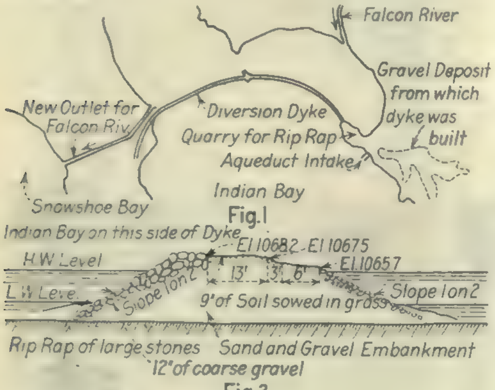


Fig. 1. Plans of Falcon River Diversion Works, Winnipeg Aqueduct Construction. Fig. 2. Cross Section of Dyke Across Indian Bay Shown in Plan in Fig. 1, Winnipeg Aqueduct Construction.

The preliminary surveys showed that a feasible line could be had between the two termini and the first work, to which the engineers of the District addressed themselves was to determine whether such feasible line could not be materially improved. Two features of this line commended themselves for special consideration; one was to determine whether the summit cut where the aqueduct passed into the watershed of the Lake of the Woods from the watershed of the Whitemouth River could be reduced in depth, and the other was whether by increasing the length of the line and securing a grade more nearly approaching the average slope between the two termini the total cost of the aqueduct could be materially reduced.

The country is so flat and so thickly covered with timber and underbrush that it was impossible to judge by eye of differences of elevation for any distance, and for this reason lines of levels had to be run to the north or south, and sometimes to both the north and south, of the preliminary lines, sometimes as much as 8 or 10 miles, in order to be able to place contours upon maps with sufficient accuracy to determine approximately the desired location. By pursuing this method and by then running more accurate levels over the line located approximately from the contour map, adjustments and modifications were made until finally a line was secured which passed through the critical points on the profile and gave the fewest changes of grade throughout the whole line. It is interesting to note that although the finally located line is longer by several miles than the preliminary line, careful estimates of cost show that it is cheaper by nearly a million dollars, the saving being largely in concrete.

CONSTRUCTION RAILROAD.

Prior to entering upon the construction of the aqueduct proper it was necessary for the District to do a good deal of preliminary construction work. As can be seen from the description of the country no means of access were available for the delivery of the materials along the line of the aqueduct, the nearest railway being about 15 miles to the north, and there being practically no highways over which materials could be hauled. The first work done, therefore, was to let the contracts for the clearing of the right-of-way for the construction of a railroad from Winnipeg through to the Lake of the Woods and start the erection of a telephone line. The contracts for all this preliminary work were let in the winter of 1913-14 and the railroad was laid through to the Lake by December of that year. Coincident with the construction of the railway a large amount of ditching and surface drainage was done by the District to free the ground of water in the vicinity of the aqueduct line as much as possible. Some of the off-take ditches were several miles in length. The railroad is standard gage, with 60-lb. steel rails on a heavily ballasted roadbed, the ballast being hauled from two or three gravel pits along the line opened up by the Northern Construction Co., the contractors for the building of the railroad. The cost of the road was about $1,200,000. Trains were in operation in the spring of 1915. There are 102 miles of track built including sidings, and the equipment consists of four 52-ton Mogul locomotives, forty 20-yd. air dump cars, 20 flat cars, 10 box cars, three cabooses and two coaches. Railway water tanks, sidings, miscellaneous railway buildings and engineer's quarters were established and contracts for the aqueduct proper were let during the year 1914.

FALCON RIVER DIVERSION.

The water is to be taken from the westerly end of Indian Bay, a branch of Shoal Lake, which is itself a portion of the main Lake of the Woods. Indian Bay is a comparatively shallow bay. Its length is about 6 miles and its width from 1 to 3 miles, and its depth is from 24 to 26 ft. over the whole area, excepting in the immediate vicinity of the shores, which shoal up more or less rapidly. Falcon River discharges into the westerly end of Indian Bay, the very dark brown drainage from the swamps lying to the northwest. In order to prevent the discoloration of the lake water by the discharge of the Falcon River into it, a dyke was built across the end of the lake and a canal cut through between the end of Indian Bay and Snowshoe Bay, which lies just to the south, and the discolored Falcon River water diverted from Indian Bay into Snowshoe Bay.

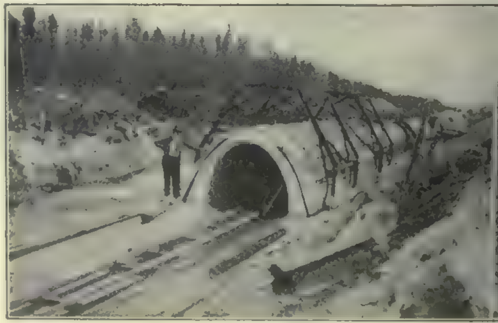


Fig. 3. View of Outside Traveler for Moving Outside Forms, Winipeg Aqueduct Construction.

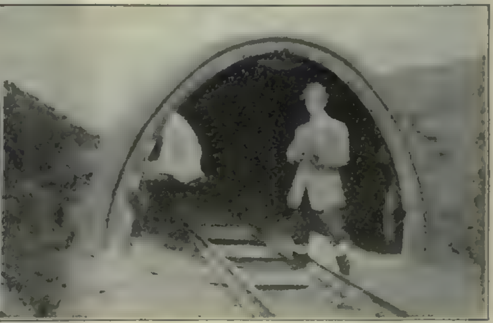


Fig. 4. View of Inside Forms in Place, Winnipeg Aqueduct Construction.

The construction of this dyke was begun in 1914 and finished in the early part of 1915. It is built of sand and gravel and riprapped on the side toward the lake with a bed of heavy stones obtained from a quarry right at the end of the dyke. The plan of the diversion works and a cross section of the dyke are given in Figs. 1 and 2. The dyke was formed by dumping the sand and gravel overboard from a bridge connecting the shore end with a scow held in position by spuds. The scow was gradually pushed out and the bridge dragged with it as the building proceeded. The cross section of the dyke as given represents the natural slopes to which the materials have settled under the water and the lines to which they were trimmed above the water level. The top of the dyke was covered with top soil and seeded with Brome grass. Following the construction of this dyke there has been a progressive reduction in the color of the water of Indian Bay.

AQUEDUCT CONTRACTS.

The work was divided into five sections and each section awarded as a separate contract; the first section which is called Contract No. 30 is 20.064 miles in length running from Deacon at mile 12.473 to mile 32.537. Contract No. 31 is 17.765 miles in length running from the end of Contract No. 30 to mile 50.302. The next contract, No. 32, is 18.201 miles in length, running from mile 50.302 to mile 68.503. The fourth contract, No. 33, is 16.089 miles in length running from mile 68.503 to mile 84.592, and the last contract, No. 34, is 12.919 miles in length running from mile 84.592 to mile 97.511. The estimated quantities of work on each contract, with the names of the contractors and the prices bid, are given in Table I.

The contracts have not yet been awarded for the steel pipe line from Deacon to the Red River nor for the tunnel under the Red River nor the 4-ft. cast iron pipe line leading to the Winnipeg reservoir. The contract has been awarded, however, for core borings at the Winnipeg River crossing preparatory to making plans for this tunnel work. The plans have not yet been drawn for the 250,000,000-gal. reservoir at Deacon nor for the intake at Indian Bay, as these can be deferred until next year.

Progress Required.—Construction work is now progressing on all the contracts, and by the end of this working season possibly 10 per cent of the entire aqueduct may be completed and backfilled. The schedule of progress required by the specifications calls for the completion of 6 per cent of the work by Aug. 1, 1915; 18 per cent by Dec. 1, 1915; 31 per cent by Aug. 1, 1916; 50 per cent by Dec. 1, 1916; 65 per cent by Aug. 1, 1917; 85 per cent by Dec. 1, 1917; and 100 per cent by Sept. 1, 1918. In case the contractors fail to maintain the rate of progress stated in this schedule there is due and payable by the contractor to the District as liquidated damages $200 per day for each working day during which the work remains less fully completed than required at the specified dates, with the exception that prior to Sept. 1, 1918, no damages are charged by the District between November 15th in any year and May 1st next following. In case the contractors' rate of progress improves so the amount of work accomplished at any of the stated dates shall equal the amount required to be done at such dates rebates will be allowed in compensation therefor.

CONSTRUCTION PLANT AND METHODS.

Excavation Plants.—The construction methods employed by the different contractors are quite interesting. The contractor for Contract No. 30, which is the prairie section, the greater part of which is through cleared and cultivated land, is excavating part of his trench with a walking dredge and part with teams and scrapers. The walking dredge is a barn-like structure carried on four pads, one at each corner with an intermediate pad at each side arranged so that by means of chains and winches the weight can be shifted from the four corner pads to the two intermediate pads, and the whole structure pushed forward by chains working on the legs resting on these pads. The machine straddles the trench and digs forward, throwing the excavated material to one side on a waste bank. The contractor for Contract No. 31 is using small Thew shovels for excavating the trench, putting all his waste along the north side of the trench; and the contractor for contracts Nos. 32, 33 and 34 is using drag line machines for excavation and dumping his excavated materials along the south side of the trench to form an embankment upon which to place the track for the conveyance of concrete and other materials to the work. These drag line machines stand at the end of the trench and work backwards, the bucket being dragged toward the machine and then swung out to the side to form the dump as stated. The machine is carried upon pads of heavy timber built in rectangular form about 8 ft. wide and some 16 ft. long, their area being calculated so as to bring the unit pressures upon the bottom of the pads to very small amounts; the machines are working successfully upon muskegs so soft as to be hardly able to bear the weight of a man. The machine moves itself forward by first picking up the pad nearest the end of the excavation and swinging it around behind itself in line with the trench, skids being then laid down upon the extension of the pads, upon which the machine pulls itself back by anchoring the drag line bucket in the ground behind, and dragging itself along on the skids on rollers made of 6-in. pipe. The rollers are then blocked and the machine proceeds with the digging of the trench. Moves are made very quickly, the machine doing its own grubbing for the placing of the pads. On account of the considerable cost of coal all these machines are provided with superheaters and every device for getting the greatest economy out of the fuel.

Concrete Plants.—The contractors for contracts Nos. 30 and 31 have very similar arrangements for handling the concrete. These consist of a track along the south side of the trench upon which the concrete mixer moves upon a car, the mixer being turned by a steam engine. Each contractor is required by the specifications to provide a platform along the District's railway, 300 ft. long, upon which the District is to dump the gravel and sand. Under the terms of the contract the District agrees to deliver the cement, sand and gravel to the contractor at a stated price per cubic yard. In order to get these materials to the mixers the contractors for contracts Nos. 30 and 31 have each provided a large stiff-leg derrick mounted upon trucks, on a broad gage track, with bottom dump buckets holding 16 cu. ft. The sand and gravel is shoveled from the platforms into the buckets and then swung around by the boom of the stiff-leg derrick and transported to the mixer; or else the concrete car is run back to a point opposite the stiff-leg. A good deal of difficulty has been experienced with these plants, owing to the very heavy weights which cause the truck wheels to break, thus delaying the whole work until new wheels are secured and the necessary repairs made. Ordinary cast iron wheels do not give satisfactory service and experiments with different grades of chilled cast iron, semi-steel and other materials have not yet secured a wheel that will stand the work; the trucks will probably have to be replaced by others with more wheels.

The contractor for Contracts Nos. 32, 33 and 34 has his concrete mixer located upon an elevated cribbing near the center of the length of his gravel platform, and an elevated trestle curves from the mixer both ways to meet the track laid on top of the dump along the south side of the excavation. A short track also runs the whole length of the gravel platforms and the gravel is shoveled into small dump cars which are pushed to the mixer site and elevated to the mixer in a boot worked by a chain from an engine which turns the mixer. The concrete is dumped from the mixer into small dump cars made especially for the work and hauled to the work by gasoline dinkeys on a narrow gage track and shot down into the work through spouts. The maximum distance to which the concrete is transported from the mixer is about one-half mile; no difficulties have appeared in this long transportation, there being no segregation of the materials in the cars, and no difficulty in dumping the concrete even at the extreme ends of the work.

Forms.—All the contractors are using Blaw collapsible steel forms for the construction of the arch. The inverts are laid in alternate blocks 15 ft. long with copper expansion strips, having a V-shaped groove lengthwise of the center, at the end of each invert joint, steel forms being provided and set accurately to line and grade for the finishing of the inverts. After a set of blocks has been laid and when the concrete is sufficiently hard the headers are taken off and the intermediate sections then poured to make a continuous invert. The arches are built in 45-ft. lengths with copper expansion joints at each end, the whole length of arch being formed in one continuous operation. The interior forms are moved on travelers on a 2-ft. gage track laid on sized blocks upon the invert floor and accurately lined up, the forms being carried on jacks integral with the travelers and lined up by means of turn-buckles on rods hinged to the traveler frame. After a section of interior forms has been put in place the carrier is run out and the forms bolted up tightly, their surfaces being made flush and uniform. The exterior forms are made in 5-ft. sections bolted together to form the full 45-ft. length and are handled in different ways by the different contractors; some take them apart and move them by hand; some pick up each outside half as a unit and swing it forward; and some have a special carrier made which straddles the whole construction in the trench and runs on an auxiliary track (directly outside the arch) which picks up the whole outside form for the full length of 45 ft. and transports it as a unit, to the next section. Figure 3 shows one of these travelers with the exterior form lifted clear of the arch. Beyond are seen several alternate sections of completed arch. The arches are concreted in alternate lengths, the gap being filled by moving the forms back or forward as the case may be. Considerable difficulty has been had in holding the forms in line and surface during concreting owing to some structural imperfections and defects, but these are gradually being overcome and a system worked out by which the delays, now necessary to line up the surfaces and adjust the braces, will be greatly reduced.

For the screeding of the concrete in the inverts the most satisfactory device yet used on the work has been a 3½ by 3½-in. angle iron 16 ft. long with handles arranged so that two men can pull at each end. Lighter screeds are not satisfactory because they will not push down the stones in the concrete sufficiently to enable the finishers afterward to obtain a smooth surface. Considerable experience has been required in the handling of the screeds to get a good invert. If the concrete stones come to the surface the floating and troweling produces a wavy face no matter how much care may be taken by the men, but the heavy screed, moved slowly and in a way to press down rather than dig up the surface, produces a very good result by going over the face only two or three times; and the trowelers can then get on a plank across the trench and trowel the surface to a very good finish.

To guard against leakage where the arch comes down upon the sides of the invert a strip of soft pine wood ⅝-in. thick by 1¾ ins. high is sunk into the concrete about half its depth throughout the whole length of each side of each pad; and where two invert blocks join a little pine plug is driven in tightly between the ends of abutting wood strips. Leakage between the invert joints themselves is prevented by the copper expansion strip al-

TABLE I.—APPROXIMATE QUANTITIES AND UNIT CONTRACT PRICES ON WINNIPEG AQUEDUCT.

	Approximate quantities						Unit prices				
	Contract number						Contract number				
							J. H. Trembley & Co.	Thomas Kelly & Sons.	Winnipeg Aque. Const. Co.		
Description.	30.	31.	32.	33.	34.	Measure.	30.	31.	32.	33.	34.
1. Top soil excavation	121,000	20,000	15,000	13,000	2,000	Cu. yds.	$0.32	$0.50	$0.30	$0.30	$0.30
2. Earth excavation	190,000	....	....	....	....	Cu. yds.	.29	.....	.....	.....	.....
3. Earth excavation	....	280,000	....	....	....	Cu. yds.	.....	.60	.....	.....	.....
4. Earth excavation	....	....	358,000	....	....	Cu. yds.	.....	.....	.55	.....	.....
5. Earth excavation	....	....	....	371,000	....	Cu. yds.	.....	.....	*1.50	.55	*1.50
6. Earth excavation	....	....	....	....	789,000	Cu. yds.	.....	.....	.....	*1.50	.55
6A. Rock excavation	300	6,000	9,000	4,000	1,000	Cu. yds.	2.50	4.00	3.00	3.00	3.00
7. Refill and embankment	490,000	....	....	....	....	Cu. yds.	.20	.....	.....	.....	.....
8. Refill and embankment	....	429,000	....	....	....	Cu. yds.	.....	.40	.....	.....	.....
9. Refill and embankment	....	....	390,000	....	....	Cu. yds.	.....	.....	.25	.....	.....
10. Refill and embankment	....	....	....	314,000	....	Cu. yds.	.....	.....	.....	.25	.....
11. Refill and embankment	....	....	....	....	288,000	Cu. yds.	.....	.....	.....	.....	.25
12. Foundation embankment	24,000	113,000	98,000	13,000	36,000	Cu. yds.	.75	1.50	1.50	1.50	1.50
13. Sodding and seeding	161	95	97	107	87	Acres.	15.00	200.00	100.00	100.00	100.00
14. Timber and lumber furnished and ordered left in place	1,300	2,700	1,600	1,700	2,400	M ft. B. M.	37.00	37.00	45.00	45.00	45.00
15. Piling furnished and in place	....	40,000	600	3,000	3,200	Lin. ft.	.....	.50	.60	.60	.60
16. Sheet piling furnished and ordered left in place	....	1,250	130	360	1,035	M ft. B. M.	.....	50.00	50.00	50.00	50.00
17. Concrete in aqueduct	73,500	72,200	65,700	65,600	72,000	Cu. yds.	6.50	6.25	9.90	9.90	9.90
18. Concrete in culverts, walls, etc.	700	2,200	725	960	500	Cu. yds.	7.50	8.25	12.00	12.00	12.00
19. Reinforcing steel furnished in place	3,320,000	1,460,000	200,000	227,000	137,600	Lbs.	.034	.045	.05	.05	.05
20. Cast iron and steel furnished and in place	45,000	6,000	8,000	6,000	6,000	Lbs.	.07	.09	.10	.10	.10
21. Cast iron pipes and specials furnished and in place	6,000	4,500	7,000	5,000	7,000	Lbs.	.055	.05	.15	.15	.15
22. Cast iron gates and valves furnished and in place	180,000	1,000	1,200	2,000	1,000	Lbs.	.30	.12	.20	.20	.20
23. Testing portions of aqueduct	100	100	100	100	70	Portion	300.00	200.00	300.00	300.00	300.00
24. Testing extra lengths	1,000	1,000	1,000	1,000	700	Lin. ft.	1.50	1.00	3.00	3.00	3.00

*Siphon excavation.

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ready mentioned. This strip is about 6 ins. wide and rolled with a groove about ⅜-in. high through the center, the edges of the groove being crimped close together to prevent entrance of mortar when the concrete is placed. The copper strip is bolted tightly through the bulkhead at the end of the invert section leaving about 3 ins. to project into the concrete. The same detail is employed in the ends of the arches at the end of each 45-ft. length, the copper being bolted tightly into the bulkhead form at the ends of the arch. Figure 4 shows both the copper strip at the expansion joint and the wood strip in the edges of the invert pad to stop leakage. Mr. W. G. Chace, Chief Engineer of the work, is shown standing in front of the arch. The interior forms, in place, are shown, the exterior forms and bulkhead having been removed.

It has been found quite difficult to educate the men placing the concrete in the arch forms properly to spade the material so as to prevent the formation of air holes on the interior face of the concrete. Most of the labor employed is foreign and few of the men can speak English, and, as is usually the case, they will persist in spading too violently and without interest in the work. Better results are being secured, however, as the work progresses and some of the last arches poured do not show any imperfections or air holes.

FOUNDATIONS.

Throughout the greater part of the work so far done an excellent bottom has been obtained in the trenches although in a few places springs have had to be stopped and considerable pumping resorted to in order to keep the water down. In some places the natural bottom has been too soft at the elevation of the invert to carry the work and in such places the soft material has all been removed and an artificial bottom prepared by flooding the trench with water to a depth of a foot or two, dumping sand or gravel into the trench and casting it so that it settles into the water, the water level being kept always higher than the top of the fill. These foundation fills in cuts are carried up a few inches higher than the required elevation and the water is then pumped or drained out of the trench so that it passes down through the gravel instead of flowing off over the surface. By this means it has been possible to prepare a bottom so tight and hard that the invert can be laid on it almost as soon as the water is drained out, without fear of further settlement. The sand and gravel placed this way pack so tightly that it is necessary to use picks and mattocks to do the trimming for the reception of the invert.

The material used for these foundation fills in cuts is, with the exception of a limited amount of pit-run material, the excess sand from the District's gravel plant, a material which would have to be wasted if not used in this manner, because the gravel pit contains more sand than is required to make an economical concrete aggregate.

DISTRICT FURNISHES CEMENT, SAND AND GRAVEL.

Under the contracts awarded for the construction of the works the District supplies its contractors with the cement, sand and gravel necessary for the construction of the works. The sand and gravel is delivered to the contractor on his platforms for 75 cts. per cubic yard, and the cement is delivered to the contractor at the cost to the District, which cost includes the cost of the cement, cost of inspection, handling, hauling and delivering of the cement to the contractor with a rebate for the sacks returned. The contractor's prices for concrete include the cost of the gravel and sand, but do not include the cost of the cement, the cement being charged to the contractor as it is delivered to him and credited as it is used in the work.

Under the adopted policy of supplying the contractors with sand and gravel the District has been obliged to open a large gravel pit and install excavating machinery, tracks, dinkey locomotives, dump cars and a plant for grading the materials. The materials excavated from the pit are brought to this plant on an elevated track in 6-yd. dump cars and dumped through a grizzly which leads to the foot of an elevator. The materials passing through the grizzly are carried by a belt and bucket elevator to a rotary screen in the top of the screen house which separates the material into three sizes. The screen is in three sections, one having ½-in. holes, the next having 1-in. holes and the last 2½-in. holes. Since the material, as excavated from the gravel pit, contains a small percentage of moisture, it was found impracticable to screen it through fine screens owing to the clogging of the meshes. After screening, the materials pass from the storage bins under the screen through chutes leading to a belt conveyor, upon which th different sizes of material are spouted from the bins in the correct proportions to form a concrete aggregate. From the belt the material discharges into the boot of a second elevator which raises it to the top of the screen house and dumps it upon other belt conveyors which drop it into storage bins from which the 20-yd. air dump cars are loaded. An inspector stands at the end of the lower belt conveyor and samples the materials carried by the belt, from time to time, and changes the proportions of fine, intermediate and coarse materials as required. The over-size, which passes through the rotary screen, goes back to a jaw crusher, which breaks up the stones, and they in turn are thrown back through the boot under the grizzly and carried up again to the rotary screen. A gyratory crusher has also been installed at the foot of the grizzly for breaking up large stones which will not pass through the 3-in. spaces between bars of the grizzly. The storage bins have not as yet been a success, the difficulty being that as the material drops from the belt into the bins the sand falls straight down and the stones, jumping further, run down the outside; this produces a very extensive segregation of the materials. Devices are now being installed, however, to prevent this so that the storage capacity of these bins may be utilized. Up to the present time the only extra storage that has been available at the plant has been in the 20-yd. air dump cars. The material is spouted directly to these cars from the belt without appreciable segregation. The plan proposed for preventing the segregation of the materials in the storage bins is to have a vertical telescopic chute in sections, hung at the end of each belt so that the materials will fall down through this chute; and as the chute fills up the lower sections will be raised progressively to allow the materials to spread as the bin fills up. It is a device used extensively in collieries to prevent the breaking up of the coal when loading into storage bins, and it is believed it will work successfully to prevent the segregation of the materials as loaded into the storage bins. No difficulty will be experienced in loading materials from the storage bins to the cars.

ESTIMATED COST.

The original estimates of cost of the complete work as made and as given in the report of the Consulting Engineers in 1913, was $13,045,600. On the basis of contracts already let there is reason to believe that the cost of the completed work will be about $1,000,000 less than this, including the cost of the construction railroad, the disposition of which, after the completion of the aqueduct, has not yet been determined.

PERSONNEL.

The engineering work of the Greater Winnipeg Water District is under the direction of the writer as Consulting Engineer and W. G. Chace, Chief Engineer. M. V. Sauer is Assistant Chief Engineer in charge of all designs, and next in authority under Mr. Chace. The division engineers in charge of construction on the different contracts are: C. J. Bruce, Contract No. 30; R. T. Sailman, Contract No. 31; Geo. F. Richan, Contract No. 32; W. R. Davis, Contract No. 33, and A. C. D. Blanchard, Contract No. 34. Mr. D. L. McLean is assistant to the Chief Engineer and has had charge of all the studies of sands, concrete aggregates and cement testing, as well as of the permeability tests. Mr. R. W. Haven is also assistant to the Chief Engineer at headquarters. All these engineers have been on the work since the engineering corps was first organized, and participated in the surveys for the location of the aqueduct, the location and construction of the District's railway, the erection of the telephone line and the final location of the aqueduct.

ACKNOWLEDGMENT.

From a paper by Mr. James H. Fuertes, Consulting Engineer, New York City, before the Western Society of Engineers.

Dredging Records on Panama Slides.—The development of high records during the period in which navigation on the Panama canal has been suspended by the latest slide is an interesting example of continued work at high pressure by an organization of ambitious workers, and of the way such an organization of men, spurred by the sense of a common cause, develops greater and greater efficiency. On September 6 the dipper dredge Gamboa made a run of 12,545 cu. yds., which surpassed anything done on the Isthmus before that time in hard material. Later the Gamboa made a record of 15,145 cu. yds., while the Paraiso set a high mark at 14,650. And on October 4 the 15-yd. dipper dredge Paraiso went as high as 17,185 cu. yds. This was an average of 5,728⅓ cu. yds. by each of the three shifts, and at the rate of 716 cu. yds. an hour. The latest record is greater by 4,640 cu. yds. than that of a month ago. It represents an output 37 per cent greater. The difference between the two records is equivalent to a good day's work for one of the 5-yd. dipper dredges. In the month of September the dredging fleet excavated 1,052,586 cu. yds. from the Cut, setting a new high record for its work in that section. In addition, 63,066 cu. yds. were rehandled.

11-19-22.

The Lighter Side of Engineering and Contracting

Here Goes the Smokes.

AFTER much deliberation and considerable mind changing, Skinner Mulvey has decided on the prize winner in the September-October story telling contest. The tobacco goes to S. E. R., Richmond, Va., for his contribution "Good Bait Anyway." This was printed in the Nov. 3 issue. The Skinner is pleased to announce that the story telling contests will be continued. For the best story submitted during November and December he will give a $5 box of cigars or the equivalent value in pipe tobacco. If the winner should be a nonsmoker his reward will be a $5 gold piece. He can present this to his wife or his sweetheart, whichever he chooses. Skinner Mulvey feels under obligations to all who contributed stories and he hopes to hear from them again. He is firmly convinced that "a little wheeze now and then is relished by the wisest men." Won't you, Mr. Reader, help the old gentleman out by sending him your favorite wheezes?

How Expert Accountants Are Made.

SEVERAL years ago when railroad construction was exceedingly active in Arizona there was a notable character known as "Shorty" McBride around the camp who excelled as "champeen" teamster. One evening while the accountants were engaged in rendering their monthly reports, "Shorty," feeling rather jubilant, strolled into the office to jolly the "boys." He inqired of the chief material clerk if he could assist them with their work. The chief retorted by adding, "Why, Shorty, you couldn't keep a set of books in a barber shop." "Shorty," however, insisted he was, also, a "champeen" at figures. "Well," replied the clerk, "see if you can balance this sheet.' He handed "Shorty" the monthly report of cars used in construction work and when 12 o'clock came they still found the new expert digging with all his might to get a grand total of the car numbers listed.—C. A. E., Los Angeles, Cal.

Taking No Chances.

SOME years ago Alex McGavock took a contract for building a railroad through a backwoods section of Minnesota where no railroad had ever ventured before. A few days before the road was to be turned over to the owners the contractor made a trial run over it. In pulling out of a small way station the engineer discovered a small country lad on horseback in the middle of the track. The engineer blew the whistle again and again, but the rider only lashed his horse into a gallop and made no effort to turn off into the farm lands on either side of the right of way. At the end of a mile chase the engine was close to the heels of the laboring horse. The pestered engineer leaned out of the cab window and yelled: "You blamed idiot you, why don't you get off the track?" The frightened youth flung back a desperate retort: "Naw sah! Ef ever you git me out yander on that plowed ground you'll ketch me in a minute."

Father Was Called.

A CONTRACTOR had six grown sons. They wouldn't work for the old man because he held out their wages. However, the old sport was clever at poker and on Sundays managed to win all the boys had left of their week's wages. At length the youngest son tired of this arrangement and left home. A couple of months later the old man died. The absent brother was apprised of this event in these words: "God has called father." He wrote back to inquire: "How did God get into the game and what did He hold when He called?"

The Cockroach Wept.

IN the good old days when there were at least two railway jobs under way at the same time, a hobo drifted into a grading camp and landed a job. It was not long before the cook began missing grub from his storehouse. The newcomer was promptly charged with the dastardly deed and the foreman proceeded to interview him. The man denied the charges vigorously. "Why, boss," said he, "I didn't take no food out o' there. There wasn't no grub there. Why, I jes' looked in the door one day an' I met a cockroach comin' outer it with tears in his eyes."

Speaking Politely.

JOHNNIE Block, the butcher for the Bob Russell outfit, on his Virginia job, had bought some fresh meat on the hoof and was trying to drive it back to camp. Johnnie and the cow came to a cross road. The man wanted to go straight ahead but the cow didn't. A negro was coming down the cross road. "Haid her off; haid her off!" yelled Johnnie. The colored man jumped into the middle of the road and waved his arms. The cow kept calmly on. "Haid her off! Haid her off!" yelled Johnnie. "I'se tryin' to, boss," replied the negro. "Speak to her! Speak to her and she'll stop." "Good mawnin' cow, good mawnin'" said the negro politely.

They Guessed Wrong.

JACK Carland had just received a contract for a new railroad grade in southeastern Ohio. Two of his old and favorite employees went over the grade on Sunday before commencement of work. One of these men was Flynn, a powderman, the other was Murphy, the stable boss. The work was nicely staked out. Murphy put on his glasses and read a stake that was marked C1.7. "Oh yes," he said to Flynn, "Station 17." Flynn stooped over and looked at the stake through his glasses and said "Well, Murphy, you d—d fool. Can't you read a stake? Why that's cut 17 ft." J. F. L., Toledo, O.

Business Was Good.

WHEN Oklahoma and Indian Territories were merged and given statehood the newly created state legislature revised the sizes of several counties—particularly in the western part of Oklahoma Territory. This action eliminated the position of several county boundary lines. Two small towns, only a mile apart in one county, being affected so that they were cast into separate counties, decided to consolidate and move the buildings from one town to the other. The house-moving contractor upon undertaking the job found he would be required to move a graveyard to successfully fulfill his contract. He had finished moving the buildings, when he went to the mayors of the respective burroughs stating, "Fellows, I can't move your graveyard. There's a big sign on the entrance of that cemetery, which says, 'WE ARE HERE TO STAY.'"—C. A. E., Los Angeles, Cal.

Whaddayoumean Humdrum, Herbert?

IT is related that Herbert Spencer threw up a good life-job for the purpose of experimenting with an invention which a fortnight's investigation showed to be utterly impractical. Reviewing this experience 50 years later he said: "Had there not been this seemingly foolish act, I should have passed a humdrum and not very prosperous life as a civil engineer. That which has since been done would never have been done." One fancies that the average engineer will testify to the truth of the "not very prosperous" part of this statement but, humdrum? No, not that, Herbert, not that.

Skinner Mulvey says: I saw a stuffed two-headed calf in a shoe store window the other day. Big crowd blocked the sidewalk. Ain't it great to be celebrated? When you give a sick mule a dose of roach-well salts by blowing 'em down his gullet through a tube, always be careful not to make him cough before the job's ended.

CURRENT NEWS

The Doings of the Week.

There has been no slowing up of activities in business, finance and industry during the past week. On the contrary, distinct gains in many prominent lines were shown. Bank clearings were well above the totals for the corresponding periods in 1914 and 1913. The surplus of idle freight cars was greatly reduced. Demands on the steel trade were greater than ever before in its history. Thus the three generally accepted barometers of trade conditions point clearly to business recovery. The railroads have had a marked increase in traffic during the past few weeks. In the west this has been due to the large crops and in the east to the great industrial activity. As a result, it is predicted that it is only a question of a very short time until the carriers report a new high record gross earnings on a per mile basis. In the construction field activities are at a low ebb as regards new work coming up for bids. Several fair sized jobs, however, have been advertised the past week, and there are good prospects that other important undertakings will be ready for estimates in the near future. Several western irrigation projects and middle west drainage jobs probably will come up for letting shortly. In the building field there is at present unusual activity for this season of the year. In the steel trade the mill outputs are expanding and prices are steadily advancing. The pig iron output in October amounted to 3,125,000 tons as compared with 2,852,000 tons in September. This is the first time the monthly yield has been over the 3,000,000 ton mark. The Pennsylvania Steel Co., with crude steel capacity sold to April, 1916, is reported to have withdrawn quotations. Railroad buying continues at high pressure. The rail orders include 100,000 tons for the Southern Pacific, 60,000 tons for the Chicago & Northwestern Ry. and 25,000 tons for the Boston & Maine. The Pennsylvania R. R. placed orders for 11,000 cars and now is about to close contracts for 9,000 additional. It is reported that the October orders of the U. S. Steel Corporation exceeded shipments by 600,000 tons. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Nov. 3 were as follows:

Finished Iron and Steel.	Nov. 3.	Oct. 27.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.659	1.559
Iron bars, Pittsburgh........	1.50	1.45
Iron bars, Chicago...........	1.45	1.45
Steel bars, Pittsburgh.......	1.50	1.50
Steel bars, New York........	1.669	1.669
Tank plates, Pittsburgh.....	1.50	1.50
Tank plates, New York......	1.769	1.669
Beams, etc., Pittsburgh.....	1.50	1.50
Beams, etc., New York......	1.669	1.669
Skelp, grooved steel, P'gh...	1.45	1.45
Skelp, sheared steel, P'gh...	1.50	1.50
Steel hoops, Pittsburgh......	1.75	1.75
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.15	2.10
Galv. sheets, No. 28, P'gh...	3.60	3.50
Wire nails, Pittsburgh......	1.85	1.85
Cut nails, Pittsburgh........	1.80	1.80
Fence wire, base, P'gh......	1.70	1.70
Barb wire, galv., P'gh......	2.70	2.70

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over 1.50 cts.

Railways.—No developments of particular importance in the railway construction field took place during the past week. The city of San Francisco, Cal., has asked bids for constructing a railway to the Hetch Hetchy dam site. The line will cost about $17,000,000. At Cleveland, O., a large amount of railway construction will be undertaken as a result of the action of the voters at the recent election. One of the developments is already reported to have been placed under contract. The New York Municipal Ry. Corp., New York City, awarded a $2,274,700 contract for furnishing steel for third tracking and other work. The Public Service Commission of New York City is asking bids for installing tracks on the White Plains Road extension of the existing subway. The Linville Ry. Co. of North Carolina awarded contracts for a 14 mile extension; the Richmond, Rappahannock & Northern R. R. of West Point, Va., is understood to be about ready to take bids for its proposed line; the Sapulpa & Oil Field R. R. of Depew, Utah, has started construction on a line from Depew to Drumright; the Dakota & Southwestern Ry. may start work at once on a line from Mitchell to Platte, S. Dak.

Roads and Streets.—No important state highway lettings reached the call for bids stage during the past week. Connecticut is calling for proposals on two small road jobs. The County Commissioners at Fort Myers, Fla., open bids Nov. 15 on a fair sized road contract; the Kanawha County Court, Charleston, W. Va., is asking bids on 5 miles of paved road; Berwyn, Ill., opens proposals Nov. 16 on a $74,000 paving contract. Logansport, Ind., awarded a $100,000 paving contract; Yuma County, Arizona, let a $190,000 road job; Pennsylvania opened bids on three state highway contracts; Beaumont, Tex., awarded contract for 5 miles of street paving.

Bridges.—Several fair sized bridge undertakings came up for advertising for bids last week. The Metropolitan Park Commission, Boston, Mass., opens proposals Nov. 22 for constructing a $150,000 reinforced concrete bridge over the Charles River at N. Beacon St.; Woonsocket, R. I., is asking bids on three reinforced concrete bridges; U. S. Engineer at Louisville, Ky., opens bids Dec. 6 for a swing bridge over the locks of the Louisville & Nashville canal; the State Highway Commissioner of Connecticut is calling for proposals on several small reinforced concrete bridges.

Drainage and Irrigation.—A fair amount of work in the drainage field reached the call for bids stage last week. Several small jobs in Indiana are ready for proposals, and in Minnesota a number of ditch undertakings are being advertised. Drainage District No. 16 of Oseola, Ark., is asking bids on 2,749,925 cu. yds. of ditch work and 620,000 cu. yds. of levee. The East Fork Irrigation District of Hood River, Ore., opens bids Nov. 16 for the construction of its irrigation system.

Water Works.—No particularly large contracts in the water works field appear to have been advertised during the past week. The Board of Public Works of San Francisco, Cal., is preparing to go ahead with its Hetch Hetchy development. Bids are now being asked on the construction railway, and it is understood the $43,000,000 of water bonds will be sold next month. Contracts for clearing and grubbing the Nepaug Reservoir at Hartford, Conn., were let at $25,670 and $21,895.

Sewerage.—Cleveland, Tenn., is asking bids for constructing 16 miles of 8 in. to 20 in. pipe sewers and two sewage treatment plants; Columbus, O., opens proposals Nov. 23 on the Frambes Ave., relief sewer, the work including 5,930 ft., 42 in. to 84 in. sewer; the Metropolitan Sewerage and Water Board, Boston, Mass., is advertising a fair sized sewer siphon job. A $21,370 contract was let for storm and sanitary sewers at the Alton State Hospital, Upper Alton, Ill.; Appleton, Wis., let a $20,000 sewer contract.

Rivers and Harbors.—Orange, Tex., is calling for bids for dredging about 750,000 cu. yds., this being the first step in a harbor development. The Department of Wharves, Docks and Ferries of Philadelphia, Pa., opens proposals Dec. 6 for the construction of the superstructure of the McKean St. pier and its adjacent bulkhead.

Arizona Alien Labor Law.

The alien labor law of Arizona, which seemed likely to be a serious handicap to contractors operating in that state, has been declared unconstitutional by the Supreme Court of the United States. This decision affirms that of a Special Circuit Court. The act was held to be unlawful on the ground that it conflicted with the personal guarantee of liberty accorded aliens by the Federal Constitution. The law, which by the way was enacted by a direct vote of the electors of state, provided that for any employer of more than five persons, at least 80 per cent of his employees must be citizens of the United States. A contractor engaged in building a railroad, say, and employing 1,000 men on the work, therefore would have been required to employ at least 800 citizens. In a busy construction year he undoubtedly would have had some difficulty in complying with the law.

Bond Issues.

The result of last week's elections are encouraging from a construction standpoint. An unusually large number of bond issues for state, county or municipal undertakings were voted on. A great majority of these issues were authorized. At the November elections in 1914 the proposed issuance of securities received a far less kindly reception from the voters. The favorable action of the electors this year on so many bond issues is an optimistic development worthy of note.

Advertise It Now.

The advantages of taking bids in the late fall and winter for work to be done in the following spring is beginning to be recognized. New York state last year adopted the policy of calling for bids during the winter months on a considerable amount of highway construction and as a result obtained excellent competition and prices. One or two western cities make a practice of advertising a portion of their next season's paving in December and January. This year a number of municipalities already have asked proposals on improvements to be carried out in the spring. In most of these instances it is required that the materials shall be delivered during the winter. This is the beginning of the dull period in the construction field. Many contractors have finished their season's contracts and are looking for bidding opportunities. Any work advertised at the present time would receive much closer attention from these men than if it came up when there were plenty of jobs in sight. Most contractors like to have something definite to start on in the spring and consequently will now figure closer to get a contract. Then, too, there is the question of materials. Prices of many constructional materials have been advancing steadily and the chances are that they will continue to advance. Delivery of materials also may be a problem. The steel mills are now working at capacity and are well loaded up with long time bookings. In the finished steel line, for instance, orders have been sent in the past week with the request that they be entered and the buyer notified of the price. Work advertised now should receive excellent competition from contractors and probably lower prices on labor and materials will eb secured than could be obtained next year.

A $340,000 ROAD CONTRACT.

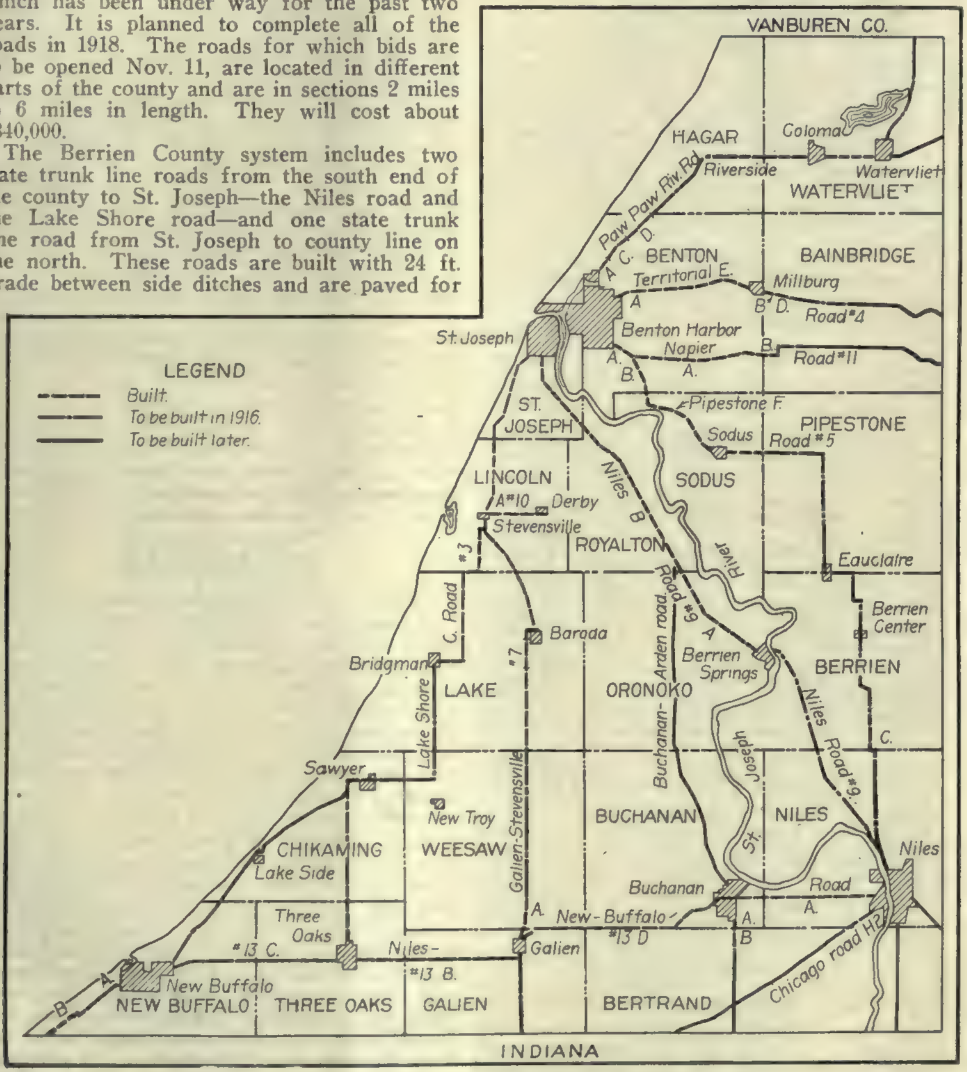
Bids Asked for Constructing 48½ Miles Water Bound Macadam.

Work Is Part of System of Berrien County, Michigan.

The Road Commissioners of Berrien County, Michigan, open bids Nov. 11 for the construction of 48½ miles of water bound macadam, 12 ft. and 16 ft. in width. These roads are a portion of the county highway system and comprise the sections to be constructed in 1916. The accompanying map shows the layout of the system, work on which has been under way for the past two years. It is planned to complete all of the roads in 1918. The roads for which bids are to be opened Nov. 11, are located in different parts of the county and are in sections 2 miles to 6 miles in length. They will cost about $340,000.

The Berrien County system includes two state trunk line roads from the south end of the county to St. Joseph—the Niles road and the Lake Shore road—and one state trunk line road from St. Joseph to county line on the north. These roads are built with 24 ft. grade between side ditches and are paved for a width of 16 ft. The other roads are graded to a width of 24 ft. between side ditches and have a 12 ft. wide paved surface. The county receives $3,400 per mile from the state on the state trunk lines and $1,300 per mile on the 12 ft. roads. The state also builds and maintains all bridges over 30 ft. span.

The county maintains all roads but receives for maintenance purposes each year from the state 2 per cent of the amount the state has paid toward construction. The roads are maintained by applications of about ¼ gal. per sq. yard. of bituminus material and a covering of torpedo sand.



Layout of Highway System of Berrien County, Michigan.

Will J. Cleary, St. Joseph, Mich., is County Engineer.

The city of Montreal is suing the Harbor Commissioners to the amount of $150,000 for the construction of a sewer and $6,000 a year for its maintenance. It is stated in the suit that wharves and piers built by the harbor authorities in 1834 caused stagnation, and that a breakwater built in 1898 diverted the current of the St. Lawrence River, necessitating the construction of the sewer.

DREDGING IN DELAWARE RIVER CHANNEL.

Bids Asked on 3,600,000 Cu. Yd. Job.

About $380,000 Available for Contractor's Estimates.

A 3,600,000 cu. yd. dredging job is being advertised for bids by the U. S. Government. The work calls for deepening the Delaware River on Bellevue, Cherry Island and Deep Water Point Lighthouse ranges. The first mentioned area is located about 27 miles below the foot of Chestnut St., Philadelphia, Pa. The Cherry Island and Deep Water Point Lighthouse ranges are located about 32 miles below Chestnut St.

A channel 600 ft. wide and 30 ft. deep at mean low water was previously dredged over these ranges, and the work of maintaining a 30 ft. depth along the center line of the channel is now being carried on by Government plant. The work now advertised consists in the excavation of a channel having a least bottom width of 800 ft., widened at the intersection of Cherry Island and Deep Water Point ranges, a least depth of 35 ft. at mean low water, and a total length of approximately 6 miles. The area to be dredged has a present depth of from 20 to 35 ft. at mean low tide. The mean range of tide at the locality is about 6 ft. and the maximum velocity of the normal tidal current is about 2.5 miles per hour. The usual working season is from March 15 to Dec. 31.

It is proposed to divide this work into three sections, F, H and J. Section F will extend from Station 155 to Station 159 on Bellevue range, a distance of 4,000 ft.; Section H will extend from Station 182 on Cherry Island range to Station 190 on Deep Water Point range, a distance of 8,000 ft.; Section J will extend from Station 190 downstream to include as much dredging as available funds will permit.

The estimated quantity of material to be removed, exclusive of allowable over depth, for Section F is 800,000 cu. yds. scow measurement; from Section H it is 1,360,000 cu. yds. scow measurement. The allowable over depth dredging (between planes of 35 ft. and 36.5 ft.) is 200,000 cu. yds for Section F and 350,000 cu. yds. for Section H. The amount of material to be removed from Section J will depend on the unit price bid and the funds available after reserving a sufficient amount to cover the probable cost of work in Sections F and H. The amount to be used as a basis in canvassing bids is 1,420,000 cu. yds. scow measurement. The allowable over depth dredging is 250,000 cu. yds.

The amount available for payments to contractors for all the work is approximately $380,000. The material to be removed is believed to be soft mud and firm mud, with an admixture of sand and in isolated instances, stiff clay, cobbles and gravel. These latter materials were found principally in Section F.

The method which has generally been used for disposing of material dredged from the Delaware River is to dump the material from scows into rehandling basins, from which it is pumped ashore above high tide by hydraulic pipe line dredges.

Bids will be received on the sections separately, on Sections F and J combined, Sections H and J combined, or on all three sections. The bids will be opened at noon, Nov. 22, at the office of the U. S. Engineer, Philadelphia, Pa.

A 700,000 Cu. Yd. Dredging Job at Norfolk, Va.

The Bureau of Yards and Docks, Navy Department, Washington, D. C., has re-advertised the work of dredging at the navy yard at Norfolk, Va. This improvement includes dredging to a depth of 35 ft. in an area in the southern branch of the Elizabeth River opposite the entrance to Dry Dock No. 3, and dredging an area at the southerly end of the Schmoele Tracts on the westerly side of the river, to a depth of 30 ft. The total estimated quantity in the first area is 493,750 cu. yds.; in the second area it is 134,200 cu. yds.

The work also involves dredging at the torpedo slips to depth of 17 ft., 22 ft. and 25 ft., the total yardage being 51,200 cu. yds.; dredging near U. S. receiving ship Franklin to a depth of 15 ft., 5,850 cu. yds. in all; and dredging area adjacent to North wharf at Naval Magazine to a depth of 22 ft., requiring about 18,600 cu. yds. of excavation.

The material to be dredged is believed to be mud, sand and clay, and some refuse material from sawmill work, sawdust, edgeings, etc.; also piles and remains of an old wharf.

An appropriation of about $145,000 is available. Bids on this work were opened previously on Oct. 9; the new bids will be received until 11 a. m., Nov. 27.

Harbor Development for Orange, Tex.

The city of Orange, Tex., is now calling for bids on the first work in connection with its proposed harbor development. The work advertised calls for the dredging a slip 3,000 ft. long and 26 ft. below mean low gulf level, with a bottom width of 200 ft. and slopes of 1½ to 1.

After the dredging is finished a creosoted timber dock with 35 ft. apron, 1,000 ft. long will be constructed. The wharf will be 12 ft. above mean low gulf level and will carry two railroad tracks. A warehouse will be built along the wharf. It probably will be constructed of steel framing and corrugated iron walls and roof. It will be provided with an electric overhead traveling crane. The principal commodity handled will be lumber. E. U. Henry is Engineer.

Sewerage Improvements for Lexington, Ky., to Cost $300,000.

The city of Lexington, Ky., proposes an expenditure of $300,000 for sewerage improvements. The development provides for the co-ordination of outfall lines and the collection and delivery of the sanitary sewages to a disposal plant where it can be properly purified to the extent necessary to prevent pollution in the stream into which it is discharged. A report on this undertaking has been submitted to the Mayor and City Commission by P. H. Norcross of Solomon-Norcross Co., Consulting Engineers, Atlanta, Ga. The city at present has about 41 miles of sewers receiving sanitary sewage. The greater part of these are vitrified pipe. These sewers are divided into the following classes: Sanitary sewers discharging into outfalls, 37.5 miles; combined sewers discharging into outfalls, 1 mile; combined sewers discharging into Town Branch, 2.5 miles. The natural drainage of the city is into Town Branch, which bisects the city and flows approximately west, and it is possible to collect practically all sewage at one central point, located in the western edge of the city, without resorting to pumpage. There are three mains or outfall sewers, commonly known as (1) North Main sewer, (2) Main outfall, and (3) South Main sewer.

The plan of improvement recommended by the engineer provides for the extension of the North Main outfall sewer under the L. & N. R. R. yards, then west parallel with the Town Branch to a point opposite the location where the South Main sewer and the Main outfall join. From here it would run almost due south to a connection with the Main outfall. The outfall would be extended under the Q. & C. bridge, across Town Branch (with an emergency overflow for storm waters) and thence to the site selected for the disposal plant.

The plant recommended will have an initial capacity of 3,000,000 gals. daily and will consist of screens and grit chambers, settling tanks holding two or three hours storage, sprinkling filters of such an area that the mean volume of sewage applied does not exceed 2,000,000 gals. per acre daily, sludge beds, chemical and bacteriological laboratory. The estimated cost of the development is as follows:

Extension of north main sewer under L. & N. R. R. tracks, thence along Town Branch to main outfall on Manchester St.	$ 18,000
Overflow diversion works, outfall sewer from Q. & C. crossing to disposal plant area, including proper drainage structures	72,000
Sewage disposal works	180,000
Land, right-of-way, legal, engineering and incidentals	30,000
Total	$300,000

SOME RESULTS OF NOV. 2 ELECTIONS.

Municipal Ownership Propositions Defeated

Many Bond Issues Authorized for Construction Purposes.

Many propositions of interest to engineers and contractors were submitted to the citizens for their approval or rejection at the elections on Nov. 2. At Detroit, Mich., the project for the municipalization of the local street railway system failed to receive the necessary three-fifths majority. The vote was 32,459 for and 35,340 against the plan. The citizens of Cleveland, O., also defeated the proposition for the purchase by the city of the street car lines. Cleveland voters, however, approved the franchises for the construction of two freight terminals by railroad companies. This work will involve an expenditure of about $30,000,000.

The New Jersey voters defeated the project for the purchase of the Wharton Tract which was desired for a state water supply development. In New York state the majority against the adoption of the revised constitution was over 400,000. Bridgeport, Conn., and Watertown, N. Y., adopted the commission form of government and Buffalo, N. Y., elected its first commissioners under the plan. In Pennsylvania the amendment to the state constitution authorizing the General Assembly to enact workmen's compensation laws was carried. The amendment authorizing the city of Philadelphia to increase its indebtedness 3 per cent for the purpose of constructing subways, elevated railroad and other transit facilities, and the construction of wharves and docks, etc., also received the necessary majority of votes.

A large number of bond issues, municipal, county and state, were voted on and in a majority of cases were authorized. Chief of these is the $27,000,000 bond issue for the completion of the barge canal system of New York state. Returns thus far received indicate that the proposition received the necessary number of votes. In Ohio 11 counties voted on special road tax levies. Auglaize was the only county to defeat a levy. The counties voting in favor were Ashland, Coshocton, Fayette, Highland, Hocking, Montgomery, Muskingum, Richland, Trumbull and Washington. The favorable action of these counties will provide $1,000,000 for road purposes.

The following tabulation shows the action taken on some of the bond issues proposed by various cities and counties:

Town and purpose.	Amount.
Colorado:	
Pueblo, city hall	$ 300,000*
Kentucky:	
Bellevue, street improvements	22,000*
Lexington, sewerage	300,000*
New Jersey:	
Newark, memorial building	1,500,000*
Long Branch, fire apparatus	21,000†
Brandsville, purchase water works	.......*
Ohio:	
Dayton, municipal improvements	1,000,000*
Montgomery County, roads	460,000*
Toledo, schools	1,000,000*
Toledo, W. W. improvements	750,000*
Newark, municipal improvements	30,000†
Akron, school sites	400,000*
Lima, white way	60,000†
Lima, fire stations	34,000*
Columbus, hospital	25,000*
Linden Heights, streets	10,000†
Cleveland, grade crossings	1,600,000*
Cleveland, comfort stations	100,000†
Cleveland, school buildings	1,000,000*
Cleveland, widening Carnegie Ave.	300,000†
Glendale, water works and sewers	.......†
Wadsworth, purchase water and light plant	85,000*
Cuyahoga Falls, sewers	50,000*
Cincinnati, parks	1,250,000*
Cincinnati, W. W. and street improvements	.......†
Pennsylvania:	
Media, imp. water works	70,000*
Clifton Heights, school house	35,000†
Sharon, sewage disposal plant	185,000†
Harrisburg, bridge	300,000*
Harrisburg, fire apparatus	60,000*

*Carried. †Defeated.

$30,000,000 Railway Terminals at Cleveland, O.

Construction calling for an expenditure of perhaps $30,000,000 was made possible by the action of the voters of Cleveland, O., at the election on Nov. 2. The franchises of the Cleveland, Akron & Canton Ry. and the Cleveland & Youngstown R. R. were approved by the citizens. The first mentioned company proposes the building of a railroad subway under East 55th St. to the lake front, where it intends to establish piers and warehouses. The subway is planned as the central feature of a development along the lines of the Bush Terminal in New York City. The railroad would extend to Akron, Canton and southeastern Ohio. It is reported that the contract for the subway already has been awarded to the Foundation Co., New York City. This report cannot be confirmed at present, but it is stated on good authority that construction will be started in the spring.

The Cleveland & Youngstown R. R. proposition calls for the establishment of a high level freight yard in the lower Broadway section between East 9th St. and East 34th St. An expenditure of about $15,000,000 is proposed. This company already has done considerable construction and it is claimed that the work in Cleveland will be started as soon as the city approves the plans.

Buildings for Radio Station, Hawaii.

The U. S. Navy Department is calling for bids for construction of three buildings for its radio station at Pearl Harbor, Hawaii. These structures consist of an operating building, 47 ft. long, 26 ft. wide and 20 ft. high at the eaves, to be built of reinforced concrete; a powerhouse, 55 ft. 4 in. long and 39 ft. 10 in. wide of reinforced concrete and structural steel; and a chief operator's quarters to be built of wood and to be 64 ft. long, 47 ft. 4 in. wide and 12 ft. high at the eaves. The bids will be received until 11 a. m., Dec. 4, by the Bureau of Yards and Docks, Washington, D. C.

American Road Builders' Association.—At a meeting of the Board of Directors of the Association it was voted to hold the next convention and exhibition in January or February, probably at Cleveland or Pittsburgh. The decision to hold the annual good roads show in connection with the convention was made owing to what seems to be a very general demand for it from manufacturers. The Board also resolved not to participate as an association in the management or program of the International Road Congress to be held at Worcester, Mass., in December. The reason for this action is that the Association entered into an agreement in connection with the recent joint convention held at Oakland, Cal., to the effect that it would not hold another convention in 1915. It had been proposed by the directors of the congress at Worcester to set aside one day as American Road Builders' Association Day, and the directors of the latter association feel that an acceptance of the courtesy might be interpreted as a violation of the agreement.

PERSONALS

Mr. D. W. Cole, project manager of the Truckee-Carson irrigation project at Fallon, Nev., has been granted leave of absence from the Reclamation Service for a time, in order to attend to personal interests. It has been erroneously reported that Mr. Cole had resigned from the Service. Mr. Cole has been in charge of the Truckee-Carson project for five years past, during which time the Lahontan dam was constructed.

Mr. Edward H. Sargent has been appointed assistant engineer of water power, water storage and drainage for the New York State Conservation Commission. Mr. Sargent is a graduate of Massachusetts Institute of Technology, class of 1907. He entered the service of the New York City Board of Water Supply immediately upon leaving college as rodman, later becoming draftsman, instrument man, and then assistant engineer for the State Water Supply Commission. Upon the consolidation of that commission with the State Conservation Commission, he retained his position as assistant engineer. Mr. Sargent is an associate member of the American Society of Civil Engineers.

Mr. John T. Whistler, 212 Central Building, Portland, Oregon, who has been with the U. S. Reclamation Service at Portland for many years, has been appointed engineer on the International Joint Commission to determine questions relating to boundary waters between the United States and Canada. Mr. Whistler has been in the service since 1902 excepting the period between 1908 to 1913 when he was in private practice in Portland. During his service he has been engaged in investigations covering projects in Montana, Arizona, California and Oregon. From 1906 to 1908, inclusive, he was project engineer in charge of the construction of the Umatilla project in Oregon.

Brigadier-General Hiram M. Chittenden has resigned his position as commissioner of the Port of Seattle and will engage in flood control study in Ohio. During his Government service General Chittenden had charge of government work in Yellowstone National Park and on the Missouri and Ohio and other Western rivers, and of reservoir surveys in arid regions. He was chief engineer of the 4th Army Corps in the Spanish-American war and was retired for disability incident to the service in 1910. Since 1911 he has been port commissioner at Seattle and has been largely instrumental in perfecting the extensive scheme of port and waterfront improvements which are under way at that place. He is also an author of note, having published a number of books, some of which deal with irrigation and flood control work in which he has been engaged. He will be succeeded by Mr. Carl A. Ewald of Seattle.

Mr. Carl Howell Reeves, consulting engineer, has established an office at 444 Henry building, Seattle, to engage in general engineering practice, specializing in municipal and highway work, and street and interurban railways. He has been for some time connected with the Washington State Public Service Commission, in charge of tracks, roadways and bridges. He is a graduate of the University of Washington, class of 1901, and has been engaged as field engineer for Stone & Webster, and later for the Puget Sound Traction, Light & Power Company. Mr. Reeves is an associate member of the American Society of Civil Engineers, and a member of the Northwest Society of Engineers.

Mr. George Houston, water commissioner of Kalamazoo, Mich., has been granted leave of absence by the council on account of ill health. He will leave for the west in November expecting to remain away until April next.

Mr. L. A. Pockman, 423 Union League Building, Los Angeles, has been appointed safety engineer of construction, Department of Safety, Industrial Accident Commission of Los Angeles. Mr. Pockman will have supervision of, and power to enforce, safety provisions for workmen employed in the construction of buildings, bridges, tunnels, railways, sewers and all similar projects. His immediate concern will be the devising of means for insuring the safety of men employed in sewer construction and other excavation in Los Angeles. Mr. Pockman was assistant engineer to A. R. Baker, civil engineer, during the years of 1912 and 1913, and was employed on the Marin Municipal Water District at San Rafael, Calif. Later for a time he was assistant engineer to Walter H. Brown, civil engineer, for the Engels Copper Mining Company in Plumas County, California. Since the early part of 1914, Mr. Pockman has been associated with Mr. J. H. Dockweiler, consulting engineer of San Francisco.

Mr. F. C. Dressendorfer, who recently joined the engineering staff of the Turner Construction Company of New York City, is now superintendent and engineer of reinforced concrete structures, specializing in industrial plant erection. Mr. Dressendorfer began practical work in 1904 with the Girard Construction Company as rodman and was assigned as resident engineer in charge of railroad construction in 1906. He continued in that capacity until January, 1908, when the company was dissolved. For some time he was with the Barr Clay Company of Streator, Ill., as superintendent and engineer in charge of the reconstruction of the brick manufacturing plant. In September, 1909, he became connected with the Chicago & Northwestern Railway as assistant engineer. In 1910 he was placed in charge of new line work in Wisconsin. In 1911 he built the Fox River draw bridge and in 1912 he was engineer in charge of improvements at Milwaukee, including new freight terminal, reinforced concrete elevator, water supply, cooling plant and dock and dredging work. In 1913 he was in charge of extensive improvements at Clinton, Iowa. He resigned from the Chicago & Northwestern service in January, 1914, to enter the employ of John Marsch, contractor and builder of Chicago, as assistant superintendent in charge of bridge construction in Massachusetts.

CONTRACTORS.

The Northern Construction Company, of Elkhart, Ind., which was recently awarded the contract for 1,560,000 cu. yds. of ditches in the Big Gun Drainage District in Clay and Green counties, Arkansas, has been in the dredging and paving contracting business for the past fifteen years. The work of the company has included the construction of drainage ditches in Illinois, Iowa, Oklahoma, Indiana, Arkansas and Mississippi. Present contracts in addition to the one mentioned which amounts to $116,330, include work in Illinois, Arkansas and Mississippi on five large projects. Mr. G. C. Berkey is the manager for the company, Mr. L. W. Berkey and Mr. A. T. Anderson being his assistants.

OBITUARY

Augustus J. Du Bois, for 30 years professor of civil engineering in the Sheffield Scientific School, Yale University, died suddenly Oct. 19, at his home in New Haven, Conn., aged 66 years. He was a native of Newton Falls, Mass. He was widely known as an author on engineering subjects, especially on stresses in framed structures.

H. C. McCartney, civil engineer, connected with the land department of the Southern Pacific Railway, died at Los Angeles Oct. 16. Mr. McCartney was assistant chief engineer on construction of the Western Pacific Railway, and was also connected with the building of the Northern Pacific, the Union Pacific and the San Pedro, Los Angeles and Salt Lake Railway.

Samuel J. Quay, for seven years superintendent of the Waco, Texas, water works, died October 30 as the result of injuries sustained in an automobile accident. Mr. Quay was formerly a member of the water commission of Waco, and later for one year assistant to the superintendent of water works. Since his appointment to the office of superintendent, the Waco plant has been materially improved and a new $375,000 filtration plant has been built. It is said that during flood times when East Waco levees overflowed, Mr. Quay was an indefatigable worker in trying to protect the East Waco pumping station, spending night and day as director of gangs of laborers on the levees. He reorganized the water system throughout the city and brought the plant to an efficient standard.

CIVIL SERVICE NEWS

The Illinois State Civil Service Commission announces the postponement of the examination for Waterways Engineer. This action was caused by the fact that a large number of applications have been received from all parts of the country and that many of the applicants would find it difficult if not impossible to come to Illinois for an examination. The Commission has therefore been obliged to change its plans in order to keep these competent men on its list of those seeking appointment to a position of unusual importance.

It has been decided to make this an "unassembled" examination as far as the written portion is concerned. This means that a set of questions concerning education, training and experience will be mailed to each applicant and he can fill out his answers to these inquiries, the information to be mailed to the commission at Springfield before some date to be fixed later.

The information furnished will be subject to verification and will be checked over by a competent board of examiners. Those whose education and experience indicate that they would be able to handle the duties of the position of Waterways Engineer will be directed to assemble at some convenient point in Illinois, probably Chicago or Springfield, for a personal interview with the board of special examiners. By this arrangement persons in distant parts of the country who may find it difficult to come to an assembled examination will be enabled to go through the preliminary portion without going to any expense and will not be forced to come to Illinois unless they really have a good opportunity of being finally placed on the eligible list.

The questions will be mailed to the applicants the first of December.

NEW CATALOGUES

Architect's Hand Book of Specifications.—Loose-Leaf, 8½-x11 ins. Trus-Con Laboratories, Detroit, Mich.

Contains 30 complete specifications covering use of waterproofings, damp-proofings and protective coatings upon general conditions and some special applications. Supplementary specifications are to be issued from time to time and can be added to the catalogue as received.

Culvert Forms.—Paper, folders. The Whalen Form, Syracuse, N. Y.

Shows a number of typical culverts built with the Whalen collapsible steel culvert form, the construction and application of the form, and New York State standard culvert sections.

Ozonators.—Paper, 8x10½ ins.; 2 bulletins. Sprague Electric Works, New York City.

Bulletin No. 49126, 8 pp., describing Sprague Electric Ozonators for use in cold storage warehouses, and Bulletin No. 49127, 4 pp., describing Ozonators for use in stores. Both are illustrated with views of typical installations and equipment.

Scherzer Rolling Lift Bridges.—Paper, 6x9 ins. The Scherzer Rolling Lift Bridge Company, Chicago.

Tells the story of the inception, development and use of the rolling lift type of bascule bridge, and shows views of bridges now in service or under way, describing the principal details in their design. Gives also a partial list of Scherzer bridges installed in various parts of the world.

Lettering Templets.—Paper, 6x9 ins.; 4 pp. Keuffel & Esser Co., New York City.

Describes "Simplex" Lettering Templets and glass and "Payzant" pens for use in lettering drawings, maps, show cards, etc. Shows stages in lettering process and various styles of completed lettering.

Friction Clutch.—Paper, 6x9 ins.; 8 pp. The Reliance Gauge Column Co., 5902 Carnegie Avenue, Cleveland, Ohio.

Catalogue C, describing the "Cleveland" friction clutch, claimed to be dust-proof, self-oiling, easily adjustable and simple in construction. Shows views and sections and gives dimensional tables, and price lists of clutches and parts.

CATALOGUE REVIEWS

Carnegie Shape Book.—Leather, 5x7¾ ins.; 312 pp. Carnegie Steel Co., Pittsburgh, Pa.

The fifth edition of the Carnegie Shape Book contains, with a few unimportant exceptions, profiles of all the sections rolled in the structural, plate, bar and rail mills of the Carnegie Steel Company, together with tables and other data in regard to these products. It supersedes the 1911 edition and presents some additional features, notably in the line of new sash and casement sections, automobile sections and some lighter weight structural sections.

The book is excellently printed, with convenient arrangement of tabular data and comprehensively indexed. Thin gilt-edged paper is used, which with a flexible green leather binding renders it a very presentable as well as a small-sized and easily handled reference book.

In respect to the new sections shown, mention may be made that besides the numerous lighter weight beams, channels, angles and the like which have been added, the book shows a 27-in. I-beam weighing 83 lbs. per foot, a new 21-in. I-beam and a 3½x6½-in. angle. A heavy 13-in. channel is also noted and a new heavy 6x6-in. angle. The tables on plates cover also nickel steel plates, and in rails 60 and 70-lb. sections of the American Railway Association rails are listed. A copy of the book may be obtained from the Carnegie Steel Company, Carnegie Building, Pittsburgh, at $1 per copy.

RAILWAYS

BIDS ASKED.

California:

San Francisco, Cal.—Until Nov. 24, by Board of Public Works, for construction of railroad from Rosasco to Hetch Hetchy dam site, for transporting materials for construction work. The line will be about 68 miles long and will cost about $1,700,000. Grading will average about 16,000 cu. yds. per mile. M. M. O'Shaughnessy is City Engineer.

New York:

New York, N. Y.—Until noon, Nov. 23, by Public Service Commission for the First District, 154 Nassau St., for track installation on White Plains road, extension of existing subway.

PROSPECTIVE WORK.

California:

Chico, Cal.—Southern Pacific is reported to have taken over Butte County R. R., and will extend it to Westwood to connect with Fernley & Lassen R. R.

San Francisco, Cal.—Board of Public Works will let contract in the near future for Church St. extension of the municipal railway system. M. M. O'Shaughnessy, City Engineer.

Iowa:

Muscatine, Ia.—The Iowa City-Muscatine Interurban Ry. Co., recently chartered, proposes to operate about 100 miles of trackage. It will electrify Rock Island R. R.'s western branch between Iowa City and Muscatine. A. D. Bowen, Muscatine, is President.

Kansas:

Columbus, Kans.—City has voted $20,000 in bonds to aid the Oklahoma & Interstate Ry. Co. in building interurban lines to connect Columbus with Galena and Commerce, Okla.

Topeka, Kans.—Kansas City, Mexico & Orient R. R. Co. has applied to State Public Utilities Commission for permission to issue $51,238,000 in stocks and bonds. It is stated that part of the proceeds will be used for immediate construction of the road from Wichita to Kansas City.

Kinsley, Kans.—Citizens of this place and five townships between here and Trousdale have voted $252,000 of bonds to aid in the construction of the Anthony & Northern R. R. extension from Trousdale to Kinsley. O. P. Byers, Hutchinson, Kans., is President.

Hutchinson, Kans.—Hutchinson St. Ry. Co. will construct new line on Carpenter St.

Michigan:

Detroit, Mich.—Proposition for city to buy lines of Detroit United Ry. was defeated by citizens at election on Nov. 2.

Mississippi:

Fernwood, Miss.—Surveys are under way for proposed line of Magnolia, Fernwood & Summit Electric Ry. Xavier A. Kramer, Magnolia, is Engineer.

New York:

Watertown, N. Y.—Emporium Lumber Co. proposes an extension of its road from Childwold on the Adirondack division of the New York Central Ry. to Cranberry Lake and thence to the Carthage & Adirondack R. R. at Newton Falls.

Ohio:

Canton, O.—Wheeling & Lake Erie R. R. has obtained right-of-way for a 2-mile spur track to circle the east boundaries of Canton.

Toledo, O.—Proposition for granting 25-year franchise to the Toledo Ry. & Light Co., was defeated at election on Nov. 2.

Oregon:

The Dalles, Ore.—Great Southern Ry. is reported to be contemplating extending its line to connect at The Dalles with steamers on the Columbia River.

Roseburg, Ore.—Surveys have been completed for the proposed line of the Roseburg & Eastern R. R. This project was promoted by Kendall Brothers and F. M. Von Planta, Portland, Ore. It is stated that construction will be started shortly.

Portland, Ore.—Oregon-Washington R. R. & Navigation Co. will expend about $800,000 for rail renewals on various parts of its main line between Portland and Huntington. The work will be done with company forces.

Rhode Island:

Providence, R. I.—City Council probably will be asked for a $300,000 appropriation for constructing railway from the city dock to a point of connection with New York, New Haven & Hartford R. R.

South Dakota:

Mitchell, S. D.—Dakota & Southwestern Ry. Co., incorporated recently, is reported to be planning to begin construction at once on its proposed line from Mitchell to Platte by way of Ola, S. D. J. Rosholt, Fairmount, N. D., President of the Fairmount & Veblen Ry., is interested in the new line. It also is stated that a well known railroad construction company of Minneapolis is interested.

Texas:

Seminole, Tex.—Texas & Pacific R. R. is reported to contemplate construction of branch to this place.

Utah:

Salt Lake City, Utah.—Salt Lake & Utah R. R. Co., according to reports, will start construction work in a few days on extension from Spanish Fork to Payson. Work will be comparatively light with the exception of one big cut.

Virginia:

West Point, Va.—Richmond, Rappahannock & Northern R. R. is reported to have secured all right-of-way and is understood to be planning to start construction in the near future on its proposed line from West Point to Urbana. Chas. L. Ruffin, American National Bank Bldg., Richmond, Va., is Chief Engineer.

BIDS OPENED; CONTRACTS LET

New York:

New York, N. Y.—New York Municipal Ry. Corporation has awarded contract to American Bridge Co., for furnishing steel for use in third tracking of Fulton St. elevated line in Brooklyn between Nostrand Ave. and Adams St., also for the Coney Island Terminal, the third tracking and reconstruction of elevated railroad at East New York and for the reconstruction of the Brighton Beach line from Church Ave. to Malbone St. Contract amounts to $2,274,700.

New York, N. Y.—Chas. A. Myers Contracting Co., Inc., has been awarded contract at $17,123, by New York Municipal Ry. Corp., for grading, removing and shifting tracks, laying new tracks for construction work, etc., for improvements in Freshpond Yards.

New York, N. Y.—New York Municipal Ry. Corp. has awarded contract to Connors Bros. Co., Inc., at $726,158, for construction of Second Ave. section of new elevated railroad. Work includes erection of steel work between Walnut St. and Cliffside Ave.

North Carolina:

Montezuma, N. C.—H. C. McCrary, Knoxville, Tenn., has been awarded contract for extension of the Linville River Ry. from Montezuma to Shulls Mills, N. C., 14 miles.

Ohio:

Cleveland, O.—Citizens voted at election Nov. 2, in favor of granting franchise to Cleveland & Youngstown R. R. Co., for building high level freight yard. Franchise also was granted to the Cleveland, Akron & Canton Ry. for constructing freight subway. These two developments will require expenditure of about $30,000,000. It is reported that subway work has been awarded to The Foundation Co., New York City.

Oklahoma:

Depew, Okla.—Sapulpa & Oil Field R. R. Co. is constructing with company forces a line from Depew to Drumright via Foxburgh and Shamrock. Work calls for 350,000 cu. yds. of earth excavation, 70,000 cu. yds. of rock excavation, 2,000 lin. ft. of trestles and 500 cu. yds. of masonry. J. T. Lantry, Supt. of Construction.

ROADS STREETS

BIDS ASKED.

California:

Huntington Beach, Cal.—Until 8 p. m., Nov. 15, by Charles R. Nutt, City Clerk, for paving on Main St. and portions of 7th, 6th, 5th and Utica Sts.

Connecticut:

Hartford, Conn.—Until 2 p. m., Nov. 15, by Chas. J. Bennett, State Highway Commissioner, for construction of 1,500 lin. ft. of standard wood guard railing in New Milford, and 450 ft. in Marlborough.

Weston, Conn.—Until 2 p. m., Nov. 15, by Chas. J. Bennett, State Highway Commissioner, Hartford, Conn., for about 8,425 ft. of native stone macadam construction in Weston. Plans and specifications with Town Clerk.

Middletown, Conn.—Until 2 p. m., Nov. 15, by Chas. J. Bennett, State Highway Commissioner, Hartford, for about 4,140 ft. of trap rock macadam construction in Middletown. Plans, etc., with Selectmen.

Florida:

Fort Myers, Fla.—Until Nov. 15, by County Commissioners, for clearing, grubbing, grading and timber bridges for highway to be built from Fort Myers to Marco. Work involves 128½ acres of clearing, 115,000 cu. yds. of grading, 22,500 lin. ft. of piling in bridges and 673,456 ft. B. M. lumber in bridges. T. S. Jenkins, Engineer, Fort Myers.

Pensacola, Fla.—Until 11 a. m., Dec. 4, by Bureau of Yards & Docks, Washington, D. C., for 85,000 sq. ft. concrete pavement at the navy aeronautic station, Pensacola.

Illinois:

Chicago, Ill.—Until 11 a. m., Nov. 13, by Board of Local Improvements, for 36 contracts for constructing cement sidewalks.

Berwyn, Ill.—Until 8 p. m., Nov. 16, by Board of Local Improvements, O. M. Lindahl, Secretary, for street paving, to cost about $74,000.

Indiana:

Brazil, Ind.—Until 10:30 a. m., Dec. 7, by County Auditor, for two limestone and gravel roads in Harrison Township.

Kentland, Ind.—Until 2 p. m., Dec. 6, by S. R. Sizelove, County Auditor, for a macadam road in McClellan Township.

Rensselaer, Ind.—Until 2 p. m., Dec. 7, by J. P. Hammond, County Auditor, for one-half mile of stone road in Walker Township.

New Albany, Ind.—Until 10 a. m., Nov. 24, by J. T. Miller, County Auditor, for construction of road in New Albany Township.

Tipton, Ind.—Until 10 a. m., Dec. 6, by Oscar Vanness, County Auditor, for the construction of gravel roads in Madison and Cicero Townships.

Kentucky:

Dayton, Ky.—Until 8 p. m., Nov. 15, by Will C. Martin, City Clerk, for bituminous macadam on Terrace Ave., and on Boone St.

Minnesota:

Excelsior, Minn.—Until 7:30 p. m., Dec. 7, by F. S. Skemp, Village Clerk, for paving with concrete, vitrified brick or creosoted blocks. Abbott & Budd, Engineers, 425 Kasota Block, Minneapolis.

Duluth, Minn.—Until 11 a. m., Nov. 12, by James A. Farrell, Commissioner of Public Works, for improvement of Railroad St.

Nebraska:

Omaha, Nebr.—Until 10 a. m., Nov. 23, by T. J. O'Connor, City Clerk, for paving on 41st St., 35th St., Cuming St., and other streets. Bids will be received on asphalt, stone, vitrified brick, creosoted wood block, asphaltic concrete, etc.

New Jersey:

Newark, N. J.—Until 3 p. m., Nov. 22, by County Freeholders, for improvement of South Orange Ave., in the City of Newark

Engineering and Contracting

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and to Methods and Cost of Construction**

EDITORS
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The Bulletin of the Engineers' Society of St. Paul.

The Civil Engineers' Society of St. Paul has taken a step forward. It begins with November the publication of a monthly bulletin. This publication "is for the purpose of giving to the society an organ through which it may express its views on affairs of public interest, and by which it may advocate a better understanding of the engineering profession in relation to the public welfare." It will be noted that the purpose of the "Bulletin" is not to put on record the technical papers and discussions of the society; there is already a place provided for such matters in the Journal of the Association of Engineering Societies. The Bulletin will be a record of Society civic and social activities and a medium for diffusing information about engineers and their work in advancing the affairs of the city and state and nation. Backed by real activity of the Society as an organization in the engineering affairs of its own city the Bulletin will as time advances gain vitality and force. There are few things which this journal has urged with more persistance than the duty of organized engineering to take active part in formulating public opinion in the conduct of engineering work. The editors of Engineering and Contracting welcome the "Bulletin" of the Engineers' Society of St. Paul and bespeak for it the support of the engineering industries of its home city.

A New Section in Concrete Road Specifications.

Our acquaintance with concrete road specifications is not encyclopedic but of a dozen or so of the most prominent we have somewhat detailed knowledge. None of these known specifications has a section stipulating the manner of proportioning the concrete. All of them prescribe the size of aggregate particles and in some measure the gradation in size of those particles and all tell how many parts of cement and of sand and of stone shall constitute the mixture. "This," it will be said, "is proportioning." In the meaning of ordinary practice it is. But it is not proportioning on the basis of volumetric analysis with a view of obtaining a uniform density of concrete. In possessing a section stipulating such proportioning the specification printed on another page is unique.

The question rises: Is such scrupulous care in proportioning essential? It is not commonly practiced in concrete road building, or, indeed, in concrete work of any sort. There come to mind some important examples of aqueduct concreting in which nicety of proportioning stands out prominently and, besides, there are occasional examples of other kinds of concrete structure. Generally, however, no meticulous regard for volumetric analysis of concrete materials troubles the average American engineer or contractor. Whether this is an occasion for swift criticism is not certain. The concrete technologist will of course assert that it is. And he will be entirely right from his viewpoint. The average concrete road builder will just as certainly assert that all such refinements are not worth what they cost. And, using concrete as it is used in America so that amplitude of mass buries peccability of material, he too is not wrong according to his light. There is no escape from the fact that American concrete users have firm conviction that the best cure for ills of aggregates is an extra large dose of cement.

But does this condition portray sound scientific or engineering reasoning? It does not. It is cited here because it is a fact that exists. Some day it will cease to exist and then we shall all look back on concrete making as it is practiced today as a very crude process. We have asserted previously and will repeat here that no concrete road has yet been built which is so good a concrete road as can readily be built, or, we are confident, so good a concrete road as will be built generally in a very few years. The specification for precise proportioning worked out by Mr. Crosby is one of the steps toward this future better road. It sets on foot a refinement which, we are confident, time will advance to general adoption. Such obstacles as may delay the advance will not arise from doubt of theoretical merit but from fear that excessive trouble is entailed. As sponsor of the specification and as one who has practically tested its operation in road construction we invite Mr. Crosby to contribute his observations on the real importance of this obstacle.

"Chance."

Some months ago a prominent Army Engineer in search for a cheap and enduring revetment construction tried blowing with a cement gun mortar into gravel *in situ*. The experiment was remarkably successful. The mortar easily penetrated the gravel to a depth of 4 ins. and bound it into an excellent concrete. The cost of the "gunite" concrete was only two-thirds that of ordinary concrete. Recognizing the promise of the new method another Army Engineer tried it on other work. The first and many repeated trials were failures. A ¾-in. penetration of the gravel was about the best that could be obtained. The query then was: What made the original trial a success? It was pure chance. The gravel used in covering the bank was by mere chance of exactly the proper granulometric composition. An addition of fine particles would have made it impervious to penetration by the blown mortar; an addition of much coarser particles would have given a less dense concrete.

The lesson in this incident is not new. It is so familiar that engineers and contractors forget it. This fact is so well known to experienced manufacturers of construction plant that they always endeavor to guard against its danger to the success of any new device or process or material that they undertake to market. Mere chance, they well know, may spell condemnation of an article that, with any other set of conditions, would merit and bring commendation. So, also, mere chance may prove high virtue which would appear under no other circumstances. Any engineer and any contractor can call to mind instances of both sorts. But time and again he forgets the lesson and time and again on the showing of a single test condemns one thing and gives high praise to another.

Chance has no place in the theory of engineering. In its practice as every engineer knows chance often raises a task onto the firm ground of success or sinks it into the slough of failure. The lesson of engineering is that the possible influence of chance can never safely be forgotten. This is quite different from saying that it is wise ever to depend on chance. It is not wise. Also it is not wise to forget that chance, though unrecognized, may have had an important influence in deciding the success or failure in any single instance of a machine or process or material. In the incident narrated in beginning these remarks chance played a typical role. There was no selective thought exercised in choosing the gravel used in the original revetment work. Probably the single controlling idea was to get a fairly good gravel from the nearest source, and observe whether by blown mortar it would convert into concrete. It did. Chance made a success. Had the gravel come from another bank containing more sand chance would have made a failure.

When chance brings success there is likely to accrue triple gain and where chance brings failure the loss is two-fold. Using again our illustration, by the fact that the gravel first used happened to be a suitable one for the purpose there was the direct gain of a good, cheap job of revetment, there was gained the knowledge that a gravel could be converted into concrete by blowing mortar into it, and there was gained a future trial of the process which demonstrated that while a gravel might be made concrete by mortar blowing most gravels could not. Had chance given a sandy gravel for the original trial there would have been lost all that the trial cost in time and money and there would have been lost all incentive to try again and therefore all knowledge that under suitable conditions the process would succeed.

There is much more that could be said of chance in engineering but we conceive that we have chattered long enough. Science and philosophy and, we believe, religion, assume the law of causation to be universal in its reach. Chance as a fact is thus excluded from the universe. Therefore the circumstance which has been several times referred to and called chance is no more than an example of indeterminable operation of laws and causes. This conclusion leaves us with the science of engineering in such a dignified attitude that it is well not to comment further.

Highway Bridge Problems.

In reviewing past practice in the design and construction of highway bridges one can readily find much to criticise. The lack of engineering supervision, as a result of the practice —particularly in the Middle West—of permitting agents of bridge companies to design the bridges contracted for and built by them, was, of course, fundamentally unsound. It not only often resulted in unduly expensive structures, but it tended to minimize the importance of the details, with the result that the designs were unbalanced. As the bridge companies were not directly concerned with the floor surfaces or with the maintenance of the superstructures it was only natural that the flooring should be of light and unsatisfactory construction and the maintenance charges excessive.

Even though past practice involved many factors deserving of adverse criticism it is nevertheless true that there were comparatively few substructure failures in important structures. In most cases the abutments and piers, generally of stone masonry, were well constructed, and the footings were extended to safe depth, the work being done by masons skilled in this kind of work. Adequate waterways were generally provided, which greatly lessened the likelihood of failure. Of course, the bridges were often of excessive lengths, as a long span meant a commensurate profit to the bridge company; on the other hand, long spans did insure the placing of the abutments beyond the main channel of the stream, on firm subsoil.

The main criticism of past practice must be confined to the superstructures and to the prevailing methods of designing and letting the bridges to contract. Present designers have largely corrected the defects in superstructure design, and have developed more nearly permanent superstructures. The methods of letting bridge contracts have also been improved, and, in those states having highway commissions, we are generally assured of engineering supervision of construction. But we have not made a like advance in the design and construction of the bridge substructures. This has been due largely to the fact that designers have been slow to undertake systematic studies of such factors as the characteristics of subsoils, the amount and rates of rainfall, and the probable percentages of run-off in various localities. They have also generally failed to make thorough investigations and surveys of the bridge sites, with a view to selecting the best type of bridge for a particular site. The tendency toward the construction of permanent types of bridges has often led to the restriction of the waterway without a corresponding strengthening of the foundations against possible undermining. An examination of a number of so-called standard designs for substructures has convinced us that little work is justified in the preparation of standard substructures until the various states have completed systematic bridge surveys and have collected data on subsoil and flood conditions. Considerable sums will be required for work of this kind, but any expenditures made for such purposes will produce large future returns to taxpayers.

It has been estimated by one state engineer that from 40 to 75 per cent of all highway funds collected by the states of the Central West have been expended for the construction and maintenance of bridges and culverts, practically all of which may properly be charged to maintenance. That much still remains to be accomplished before a satisfactory solution of the highway bridge problem has been reached is evidenced by the fact that during the floods of 1915 at least 700 highway structures were damaged in Kansas, the estimated cost to repair and rebuild these bridges having been placed at $700,000. In Nebraska, the damage caused by floods during April and May of 1915 has been estimated at about $1,000,000; while the damage to highway bridges in Ohio, caused by the Ohio Valley flood of 1913, has been placed at $8,000,000. These losses do not include those suffered by the public in not being able to use the damaged highways. In most cases the bridge failures can be traced directly to the undermining of the foundations. Examples might be multiplied, but those given are sufficient to emphasize the need for systematic bridge surveys and for a thorough study of the problems of substructure design. In our zeal to construct large mileages of permanent highways we should not lose sight of the facts that our highway bridges are exceedingly important links in these highways and that any stretch of road is no more efficient than the weakest bridge along it.

Twelve Fold Increase in Efficiency of the Incandescent Lamp in 35 Years.

In 1880, the manufacture of electric incandescent lamps began at Menlo Park, N. J., with an output of 25,000 carbon lamps. In 1905 the output was 33,234,000 carbon lamps. In 1914 the output was more than 73,000,000 lamps, of which two-thirds were tungsten. The tungsten lamp was first used in 1907 when 52,000 were made. Astonishing as the increase in number of incandescent lamps has been, perhaps the most remarkable record in this industry is the record of efficiency.

Edison's first lamp, using a bamboo filament, yielded about one-seventh candle power per watt. The present gas-filled tungsten lamp yields 1.7 candlepower per watt. This is a 12-fold increase in illuminating efficiency. Furthermore the average useful life of lamps has increased 20 fold, for while the first carbon lamps had a useful life of only 50 hours the present tungsten lamps average 1,000 hours' life. These and other similar facts are given in *Electrical World*, Oct. 16.

When the tungsten lamp was first put on the market the managers and owners of electric lighting plants became very uneasy, for they feared a marked falling off in income as a consequence of the smaller amount of current required for equal illumination. But the lower cost of light per candlepower resulted in the use of more lamps and lamps of greater power, so that the earnings of central power plants increased. Lower unit prices do not always result in greater consumption of products or services, for much depends on the latent demand. This is particularly true of certain food products. But for the conveniences and luxuries of life there is a most elastic demand, so elastic that it often expands faster than the decrease in prices. This has been particularly noticeable in the electric field generally.

We have had occasion recently to comment on the remarkable achievements of the Bell telephone engineers in greatly extending, improving and cheapening telephone service. The government owned telephone systems of Europe lag far behind America. The same holds true of European lighting service. In England the municipalities own most of the gas lighting systems, and the cities have consequently been, from the start, strongly opposed to granting reasonable franchises to electric lighting companies. Where the English municipalities have themselves gone into the electric lighting business they have used none of the advertising and soliciting methods that American companies have developed. Furthermore there have been few consolidations of small, scattered electric power stations into large systems such as we have in this country.

Is it not more than a coincidence that under public ownership and extreme governmental restriction, neither the telephone nor the electric incandescent light has come into very common use in Europe? These and many other similar facts lead to the inference that great progress in any industrial line is attained only where there is great freedom and the attraction of liberal profits. Our public service commissions will do well to relax the severity of their regulatory rate cutting if they aim to encourage progress in the public utility field. It is easy to kill the ambition of inventors and that of their financial backers by holding down profits to 7 or 8 per cent on the investment in utility plants.

Without any governmental regulation of rates whatever, but as a result of invention, engineering and business push, the average unit cost of telephone and electric service has been reduced to less than one-half what it was 15 years ago. The service, moreover, is far better.

Striking as the progress in electric illumination has been, we may still look for great improvements. Indeed, it is safe to say that, within ten years, invention and engineering will effect many fold as great a decrease in the price charged per candlepower as will be effected by all the rate cutting of public utility commissions. This clearly is one of those industries whose rates of charge utility commissions may wisely leave almost entirely to commercial forces to "regulate." The General Electric Company alone maintains a large staff of scientists engaged in experimental work intended to increase the efficiency of the incandescent lamp. The remarkable gas-filled tungsten lamp is one of the achievements of this staff of inventing engineers. How positively puny as rate reducers are all utility commissions when their work is contrasted with that of the engineers of such a company as the one just named. Invention has multiplied the candlepower per kilowatt by 12, and has at the same time greatly cut the price per kilowatt hour. In a single decade invention has reduced the price of electric light per candlepower fully 75 per cent. Contrast this with, say, 15 per cent reduction in electric rates that utility commissions have forced upon some companies during the same time. Even in rate cutting the most radical politics limps far behind the fleet footed innovator whose goal is personal profit.

ROADS AND STREETS

Some Brick Paving Lessons Learned in Overcoming Faults of Original Designs, Greenville, Texas.

(Staff Abstract.)

Vertical fibre brick paving originated with the success of a 2¼-in., repressed vitrified brick, laid flatways, on Lee St. in Greenville, Texas, in the year 1906. It might be of interest also to know that this same city of northeast Texas was the first to lay vertical fibre brick, as standardized by the Western Paving Brick Manufacturers' Association.

During the construction of Lee St., as noted above, the brick were laid flatways to cover additional yardage only, as no particular test was intended. The street was constructed under the supervision of L. W. Wells, at present chief engineer and general manager of the Texas Midland R. R. Co.

The brick were laid on a 5-in. concrete foundation, and on a 1-in. sand cushion, and a cement grout filler was applied to the surface. Contrary to modern methods, no expansion joints were provided at any point, although the street was paved 40 ft. in width. This street, after nine years of traffic, is still in a serviceable condition, regardless of the fact that a street car track has been laid and numerous other openings made since the completion of the pavement. Figure 1 indicates the present condition of this pavement and notwithstanding the fact that replacement of openings was mostly done by inferior and indifferent workmen, the city has not, so far, expended a single dollar for maintenance. The favorable results from this pavement were responsible for the selection, by a majority of the taxpayers, of a similar type of pavement and award was made in February, 1913, for approximately 90,000 sq. yds. of 2½-in. vertical fibre brick.

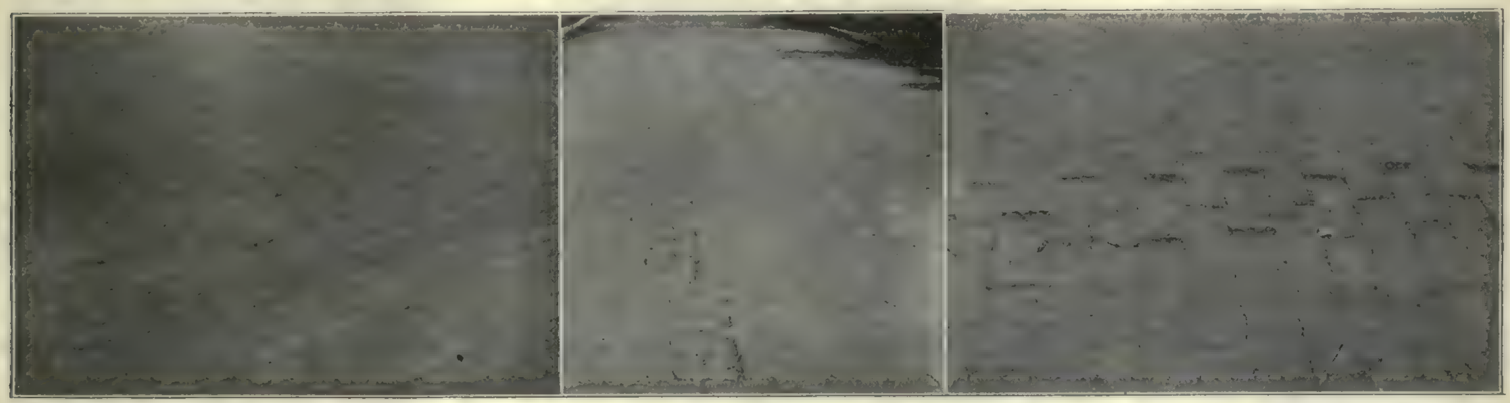
The specifications were drawn and the contract awarded a few days prior to the time that the writer assumed charge of the work, and very little investigation was necessary to learn that the specifications were drawn without proper consideration of the essential features. The crown, on the widest streets, namely, 40 ft., was not to exceed 4 ins., an insufficient amount when no adequate drainage was provided for.

The curb was specified as follows: Depth, 16 ins.; average thickness, 5½ ins. Curb to be reinforced with two ⅜-in. steel rods. No allowance was made for expansion, regardless of the fact that temperature changes amounted to as much as 110°.

The subgrade should have received the most careful consideration as to drainage and preparation, on account of the peculiar action of the soil during the hot dry seasons. The earth is subject to an excessive amount of contraction, causing large seams to open in every direction. The writer has often seen openings from 3 to 5 ins. in width, extending 20 or 30 ft. in length and over 5 ft. in depth. Back of the curb line the earth is often drawn 3 or 4 ins. away from the curb to its full depth, leaving an unsupported curb to meet the expansive force of the pavement. No consideration was given to this feature and no underdrainage was provided for. The following extracts from the specifications and contract will show that no provision was made to meet local and peculiar conditions:

> Said specifications are to be construed according to the letter thereof and no deviation therefrom shall be allowed. For instance, said specifications provide that sand and gravel used in the improvement shall be free from loam, clay, foreign substances, etc., and it is hereby agreed that sand and gravel containing the least particle of the above named articles shall not be allowed, and said specifications shall be strictly and literally construed in every particular and it is agreed that if the contractor does not strictly and literally follow the specifications in performing said work, all assessments hereunder are void, and it is further understood and agreed that any city official or any property owner may inspect the work at any time and may take samples of the material, on hand for the improvement, for the purpose of making tests. The City Engineer nor other person shall put any other construction than the above on the specifications.

Considering the above statements, together with the fact that the authority of the engineer was curtailed, it is evident that good results were not obtainable. These items have been offered to illustrate some of the conditions under which the pavement was laid and also to show what an engineer may encounter, in some of the smaller municipalities, that have failed to adopt standard specifications. The above facts must also be considered before any criticism can be justly made of the final results. Before construction was started the writer requested authority to make various changes in the plans and specifications in order to eliminate some of the impossibilities and to secure better results. Authority was not granted and the writer started the construction, of an experimental type of pavement, under adverse conditions.



Views of Vertical Fibre Brick Pavement in Greenville, Texas.
Fig. 1. View of 2¼-In. Repressed Brick Pavement Laid in 1906. Fig. 2. Seams in Pavement Due to Earth Contraction and Subgrade Movement. Fig. 3. Spreading of Brick Due to Expansion Joints.

The subgrade was prepared and thoroughly rolled with a 10-ton roller. Each 1,000 sq. yds. received at least five hours continuous rolling. On this subgrade was placed a 4-in. bank run, gravel concrete. A 1½-in. sand cushion was then spread with a suitable template. (No provision made for the rolling of this cushion.) The wearing surface, 2½-in. vertical fibre brick, laid flatways, was then placed and rolled with a roller having a compression of 250 lbs. per lineal inch of tread. To this surface was applied a hot bituminous cement coating. No melting point, penetration or other requirement being specified, any grade of bituminous cement could be used, regardless of its unfitness. A thin layer of sand was then applied and the street opened to traffic.

With the aid of the manager of the street railway company the writer was able to have several streets readvertised for bids, in order to eliminate a freak design, for street car track construction, and to substitute a simple but substantial plan. For the wearing surface, between the rails, special shaped filler and nose blocks were made so as to permit the brick being laid parallel to the track. Thirteen bricks being required to fill the space between the rails. This type of construction permitted the brick to be laid without batting and, after the application of the bituminous filler a rigid and impervious surface resulted. After two years of traffic no disintegration has appeared.

TABLE I.—TEST NO. 1 OF 2½-IN. VERTICAL FIBRE BRICK.

Sample No.	Weight Dry, ozs.	Weight Wet, ozs.	Absorption Ounces.	Absorption Per cent.
1	117½	122½	5	4.25
2	118	122½	4½	3.81
3	116½	121	4½	3.86
4	118	123	5	4.23
5	120½	126	5½	4.56
6	118½	124	5½	4.64
7	118	122½	4½	3.81
8	118½	123½	5	4.22
9	119	123½	4½	3.78
10	117½	122½	5	4.25
11	118½	124	5½	4.64
12	118	122½	4½	3.81
Average	118	123	5	4.15

The contract price for completed pavement (including excavation the thickness of the pavement) was $1.70 per square yard. Street car track construction $2.52 per lineal foot.

The brick used in this work were made at Boynton, Okla. Standard abrasion tests were made of average samples, after delivery, and at the place of manufacture. The results were within the requirements of the specifications. Upon receipt of the first consignment of brick, the writer selected twelve average samples for the purpose of testing absorption and wearing qualities. The samples were dried for a period of twenty-four hours and weighed. Immersed for a like period and reweighed, with the results in Table I.

TABLE II.—TEST NO. 2 OF 2½-IN. VERTICAL FIBRE BRICK.

Sample No.	Weight Dry, ozs.	Weight Wet, ozs.	Absorption Ounces.	Absorption Per cent.
1	108	115	7	6.48
2	108	113½	5½	5.09
3	107	112	5	4.67
*4	.....	.....	...	....
5	111½	116½	5	4.52
6	110	115½	5½	5.0
7	109½	113½	4	3.65
8	109	115	6	5.50
9	109½	114½	5	4.56
*10	.....	.....	...	....
11	108½	114½	6	5.53
12	109	113	4	3.67
Average	109	114.3	5.3	4.86

*Broken.

The samples were then placed, during construction, at well defined locations, and were subjected to ordinary traffic for a period of about 25 months. The samples were then removed, cleaned and tested under the same conditions as at first, with the results in Table II.

By comparison it is readily seen that in a period of about two years the brick lost in weight an average of 9 ozs. or about 7.63 per cent. This loss was due to the wearing away of the roughened surface and took place in a period of 60 days after the disappearance of the asphaltic protection coat. The slight change in absorption is of little importance and the irregularities noted were due, no doubt, to the retention of small particles of bituminous cement at the time of the last test.

The movement of the subgrade, as previously noted, made its appearance during the early part of the construction work. Experiments were made with the subgrade, to determine if possible, what degree of moisture would give best results. By observation of the first few streets constructed, it was found that a very moist subgrade, with gravel or stone rolled in, gave less trouble from movement than one thoroughly compacted. This was due, no doubt, to the retention of moisture long enough to pass the dry season.

The streets that were laid upon subgrades prepared in the usual manner, have been attacked by contraction, causing the concrete base to fail and open in ragged seams. (In some cases as much as 3 ins.) This permitted the sifting of the sand cushion, leaving the brick unsupported. The filler being unable to retain the brick in place, very little traffic was necessary to force the brick out of alignment. The attached Fig. 2 shows the action of contraction on the wearing surface. This same peculiar earth movement has caused the bulging, to a very great extent, of other types of pavement in Greenville, but on account of the pliant wearing surface, no seams have opened in any bituminuos pavement.

The first item in the specifications to cause trouble was the placing of continuous reinforcement in the curb. This was overcome by making a through expansion at each 24 ft. and at return curbs. This has prevented buckling to a great extent, and the rods when properly place, aided in keeping the curb in alignment.

A 1-in. bituminous expansion joint was to be provided at each curb line and a number of streets were laid before the writer could omit them. Spreading of the wearing surface, Fig. 3, has resulted on every street laid with the joints. The seams, caused by this spreading, do not effect the wearing qualities of the pavement, but detract from its appearance to a great extent. Omission of the expansion joints has materially lessened this defect.

The specifications stated the following: "The top surface shall be rolled with a roller weighing not less than 250 lbs. per lineal inch of tread." This amount of compression forced the sand, in places, to the top of the brick, and the use of a lighter roller being forbidden, a heavy sand containing about 15 per cent of clay was substituted with good results. The heavy roller shattered a great number of the brick by compressing them against some of the larger pebbles contained in the sand, and the replacement of the broken brick resulted in a partial destruction of the contour of the pavement.

The specifications further stated that the spreading of the sand on the surface should not take place until the bituminous cement became dry, and then made to adhere to the brick. Such poor results followed this method that an asphalt having a proper penetration and melting point was applied at a temperature averaging 400° and the sand placed immediately after the spreading of the filler. This gave good results, and at present some of the streets retain this surface.

By a comparison of this pavement, with several other types in the same city, it is found that during the excessive heat of summer, about 10 per cent more dirt accumulates along the curb lines, due to the softening of the asphalt filler and when ground in by traffic, the ordinary broom sweeper or flusher fails to dislodge it. This one item is about the only objection the writer finds and in towns that have no adequate system of street cleaning, this objection is not serious.

Repairs are easily and quickly made by unskilled labor, and the only equipment necessary is a small kettle for heating the asphalt. The writer has repaired nearly 80 openings, since the pavement was completed, at an average cost of 68 cts. per sq. yd. This cost included the cleaning of bricks, replacing concrete base, sand cushion and applying the necessary filler. After a few weeks traffic, a close inspection is necessary to determine where the original pavement had been disturbed.

The claims of the manufacturers, that this pavement is the most noiseless pavement known, is hardly a point for discussion, for on account of the increasing use of motor vehicles, pavements, excellent in every other respect, which were formerly discriminated against on account of the excessive noise that horse drawn vehicles made on them, may now be freely used, because it is doubtful if a motor vehicle makes more noise on any one kind of pavement than on any other.

The cheapness, in first cost, ease of construction and repair and its evident stability seem to be features that make this pavement worthy of serious consideration in the selection of a street pavement, especially in the municipalities that are unable to maintain expensive repair equipment and experienced workmen.

ACKNOWLEDGMENT.

Abstract from a paper before the American Society of Municipal Improvements by A. D. Duck, City Engineer, Greenville, Texas.

A New and Different Specification for Concrete Roads.

(Staff Abstract.)

At the recent meeting of the American Society for Municipal Improvements a new specification for concrete roads, presented by W. W. Crosby, consulting engineer, Baltimore, Md., and modified by the General Committee on Standard Specifications, was adopted. This specification is different in respect to the proportioning of mixture. In no specification that we call to mind are the granularmetric composition of the aggregates specified so particularly or is the proportioning based so precisely on void determinations. We have given the one-course pavement specifications here in full but the clauses suggested for special consideration are those numbered two and three, those under "Proportions, and clause No. 14.

PROPOSED SPECIFICATIONS FOR ONE-COURSE CONCRETE STREET PAVEMENT.*

1. Cement.—The cement shall meet the requirements of the Standard Specifications for Portland Cement, adopted by the American Society for Testing Materials, August 16, 1909, with all subsequent amendments and additions thereto adopted by said society.

2. Fine Aggregate.—Fine aggregate shall consist of natural sand or screenings from hard, tough, durable crushed rock or gravel, consisting of quartzite grains or other equally hard material graded from fine to coarse, with the coarse particles predominating. Fine aggregate, when dry, shall pass a screen having four (4) meshes per linear inch; not more than twenty-five (25) per cent shall pass a sieve having fifty (50) meshes per linear inch, and not more than five (5) per cent shall pass a sieve having one hundred (100) meshes per linear inch. Fine aggregate shall not contain vegetable or other deleterious matter nor more than three (3) per cent of clay or loam.

Fine aggregate shall be of such quality that mortar composed of one (1) part Portland cement and three (3) parts fine aggregate, by weight, when made into briquettes, shall show a tensile strength (at seven (7) and twenty-eight (28) days) at least equal to the strength of briquettes composed of one (1) part of the same cement and three (3) parts Standard Ottawa sand by weight. The percentage of water used in making the briquettes of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand briquettes of standard consistency. In other respects all tests shall be made in accordance with the Report of Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

3. Coarse Aggregate.—Coarse aggregate shall consist of clean, tough, crushed rock or gravel, or slag of approved quality in graded sizes, free from vegetable or other deleterious matter and containing no soft, flat or elongated particles.

The sizes of the coarse aggregate shall be such as to pass one and one-half (1½) inch round opening, and shall range from one and one-half (1½) inch down, not more than five (5) per cent passing a one-quarter (¼) inch round opening, and with no intermediate sizes removed.

Its "coefficient of wear" as determined by the "Deval Test" shall not be less than twelve and its crushing strength shall not be less than twenty thousand (20,000) pounds per square inch.*

3a. Mixed Aggregate.—Crusher-run stone, bank-run gravel or artificially prepared mixtures of fine and coarse aggregate shall not be used.

3b. Water.—Water shall be clean, free from oil, acid, alkali or vegetable matter.

II. PROPORTIONS.

4. All proportions of cement, fine aggregate and coarse aggregate shall be determined on the basis of volumetric analysis, with a view to obtaining a uniform density for the resulting concrete.

5. An examination of the coarse aggregate to be used shall be made and the voids therein determined. The amount of mortar (fine aggregate and cement mixed with water) to be used shall then exceed these voids in volume by not less than five (5) nor more than ten (10) per cent of the total mass of the coarse aggregate.

6. An examination of the fine aggregate to be used shall be made and the voids therein determined. The amount of cement to be used shall then exceed these voids in volume by not less than five (5) nor more than ten (10) per cent of the total mass of the fine aggregate.

6a. (Added by General Committee.) In no case shall the volume of fine aggregate be less than one-half the volume of the coarse aggregate, nor shall the proportion of cement to fine aggregate be leaner than one (1) or two (2). A cubic yard of concrete in place shall contain not less than seven sacks of cement.

7. The amount of water to be used shall be determined by trial mixtures with the coarse aggregate, fine aggregate and cement in the proportions as above determined until a satisfactory consistency is obtained in the wet concrete, which consistency shall be such as to permit the concrete to be readily deposited in place and yet hold its shape when struck off by the template and at the same time not to bring about a segregation of the different sizes of material in handling. Every effort and precaution shall be used to secure a constant uniformity in the consistency of the mix.

III. SUB-GRADE.

8. Construction.—The bottom of the excavation or the top of the fill when completed shall be known as the sub-grade and shall be at all places true to the elevation as shown on the plans attached hereto.

The sub-grade shall be brought to a firm, unyielding surface by rolling the entire area with a self-propelled roller weighing not less than five (5) nor more than ten (10) tons, and all portions of the surface of the sub-grade which are inaccessible to the roller shall be thoroughly tamped with a hand tamp weighing not less than fifty (50) pounds, the face of which shall not exceed one hundred (100) sq. ins. in area. All soft, spongy or yielding spots and all vegetable or other perishable matter shall be entirely removed and the space refilled with suitable material.

When considered necessary or of assistance in producing a compact, solid surface, the sub-grade before being rolled shall be well sprinkled with water.

When the concrete pavement is to be constructed over an old pavement composed of gravel or macadam, the latter shall be entirely loosened and the material spread for the full width of the pavement and rolled. All interstices shall be filled with the fine material and rolled to make a dense, tight surface.

9. Acceptance.—No concrete shall be deposited until the sub-grade is checked and accepted by the engineer.

IV. FORMS.

10. Materials.—Where forms are required, they shall be free from warp, of sufficient strength to resist springing out of shape. Wooden forms shall be of not less than two (2) inch stock.

11. Setting.—The forms shall be well staked or otherwise held to the established line and grades. Where the curb is to be constructed integrally with the pavement, the upper edge of the side forms shall conform to the top of the curb.

12. Treatment.—All mortar and dirt shall be removed from the forms that have previously been used.

13. Precautions shall be taken to prevent leaks through side forms that would allow the cement or mortar to be carried out of the coarser aggregate along the edges of the roadway.

V. MEASURING MATERIALS AND MIXING CONCRETE.

14. Measuring Materials.—The method of measuring the materials for the concrete, including water, shall be one which will insure separate and uniform proportions of each of the materials at all times. A bag of Portland Cement (94 lbs. net) shall be considered one (1) cu. ft.

15. Mixing.—The materials shall be mixed in a batch mixer of approved type and mixing shall continue after all materials are in the drum for at least one (1) minute at a minimum speed of twelve (12) revolutions per minute. The drum shall be completely emptied before receiving materials for successive batches.

16. Retempering.—Retempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted.

VI. PLACING CONCRETE.

17. Placing Concrete.—Immediately prior to placing the concrete, the sub-grade shall be brought to an even surface. The surface of the sub-grade shall be thoroughly wet, but shall show no pools of water when the concrete is placed.

After mixing, the concrete shall be deposited rapidly upon the sub-grade to the required depth and for the entire width of the pavement in successive batches and in a continuous operation without the use of intermediate forms or bulkheads between expansion joints.

In case of a breakdown, concrete shall be mixed by hand to complete the section or an intermediate transverse joint placed at the point of stopping work. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used in the work.

18. Finishing.—The surface of the concrete

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*Specifications regarding both joints and reinforcement are purposely omitted from these specifications, in order that the freest opportunity may be afforded for their addition in any particular case, according to the opinions of the engineer in charge, under the local conditions.

*Figures should be suited to local conditions.

shall be struck off for the entire width of the pavement and from back to back of integral curbs when used, by means of a template or strikeboard. Any holes left by removing any material or device used in constructing the joint shall be immediately filled with mortar composed of one (1) part cement and two (2) parts of fine aggregate. Concrete adjoining metal protection plates at transverse joints shall be dense in character and shall be given a smooth finish with a steel trowel for a distance of six (6) ins. on each side of the joints.

After being brought to the established grade with the template or strikeboard, the concrete shall be finished from a suitable bridge, no part of which shall come in contact with the concrete. If approved by the engineer, the contractor may use a mechanical striking and finishing machine. The concrete shall be finished with a wood float in a manner to thoroughly compact it and produce a surface free from depressions or inequalities of any kind.

The finished surface of the pavement shall not vary more than one-quarter (¼) in. from the true shape.

VII. PROTECTION.

19. **Curing and Protection.**—Excepting as hereinafter specified, the surface of the pavement shall be sprayed with water as soon as the concrete is sufficiently hardened to prevent pitting, and shall be kept wet until an earth or other approved covering is placed. As soon as it can be done without damaging the concrete, the surface of the pavement shall be covered with not less than two (2) ins. of earth or other material approved by the engineer, which cover shall be kept wet for at least ten (10) days. When deemed necessary or advisable by the engineer, freshly laid concrete shall be protected by canvas until such covering can be placed.

Under the most favorable conditions for hardening in hot weather, the pavement shall be closed to traffic for at least fourteen (14) days and in cool weather for an additional time, to be determined by the engineer.

At the season of the year when the average temperature is below 50 degrees Fahrenheit, sprinkling and covering of the pavement may be omitted at the direction of the engineer.

The contractor shall erect and maintain suitable barriers to protect the concrete from traffice and any part of the pavement damaged from traffic or other causes, occurring prior to its official acceptance, shall be repaired or replaced by the contractor at his expense, in a manner satisfactory to the engineer. Before the pavement is thrown open to traffic the covering shall be removed and disposed of as directed by the engineer.

20. Temperature Below 25 Degrees Fahrenheit.—Concrete shall not be mixed or deposited when the temperature is below freezing.

If at any time during the progress of the work the temperature is, or in the opinion of the engineer will, within twenty-four (24) hours drop to thirty-five (35) degrees Fahrenheit, the water and aggregates shall be heated, and precautions taken to protect the work from freezing for at least ten (10) days. In no case shall concrete be deposited upon a frozen sub-grade.

WATER WORKS

The New Well Water Supply of Galveston, Texas.

Contributed by H. G. Wheaton,
Kansas City, Mo.

Sometime ago the Commissioners of Galveston, Texas, realized that the city's water supply was becoming inadequate for the population of 80,000 and began casting about for an additional supply. The Layne and Bowler Co., water supply contractors of Houston, were engaged to assist Mr. W. S. Burgess, the Galveston water commissioner, in solving the water supply problem. The difficulties of the situation were considerably enhanced by the city's location which is on an island in the Gulf of Mexico. It was found after drilling a good many wells on the island, ranging in depth from 300 to 1,500 ft., that the water could not be used for domestic purposes as it was too salty. About all it could be used for was for cooling purposes, breweries, ice plants and fisheries.

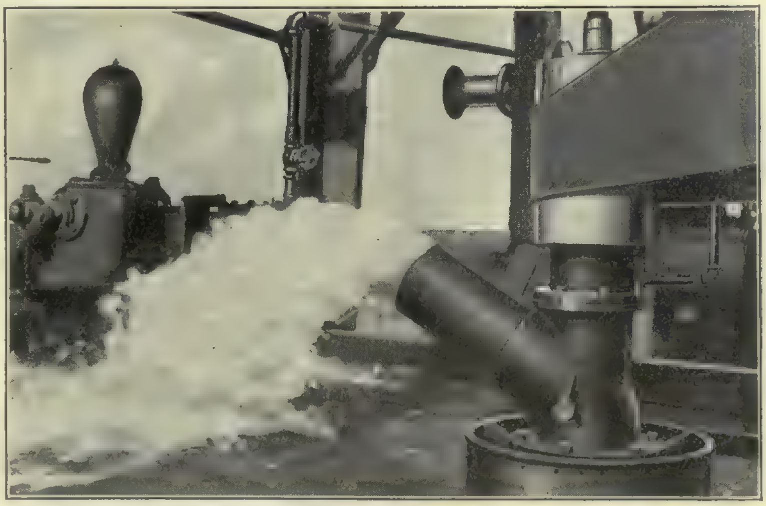
Accordingly the wells on the island were abandoned and wells were drilled 17 miles distant on the main land, near the city of Alta Loma, Texas. The pipe line to supply the city extends across the bay a distance of over two miles. During the recent destructive storm the main pipe line across the bay was badly damaged, causing much suffering on the island on account of the water supply being cut off. The expense of repairing this line will be very great. Temporary repairs were made as soon as possible after the storm, so that now Galveston is getting plenty of water again. The writer is informed that during the shortage of water it sold for as high as 10 cts. per glass. However, this condition did not exist for very long.

A plant was installed in January, 1914, by the Layne and Bowler Co., under a guarantee of a stipulated quantity of water, or no pay. The company guaranteed only 2,000,000 gals. per day but furnished wells with a capacity of 3,000,000 gals. Their wells, two in number, are located close to the 30 old wells, which are being pumped with air, at a cost of 3 3/10 cts. per 1,000 gals. Under the Layne & Bowler installation the cost is 9/10 ct. per 1,000 gals. The old wells with the old type installation, produced only a maximum of 4,000,000 gals. a day. Nearly all of the old wells were 8-in. wells, that is, 8 ins. at the top but finished with a 6-in. strainer.

The new wells are 24 ins. in diameter at the top down to a depth of about 80 ft., and from there on down they are 12 ins. in diameter. They are equipped with the Layne Keystone wire screen and the Layne turbine pump direct connected to a 25 hp. electric motor, 220 volt, 60 cycle. The water is pumped into the same reservoir used by the old system. These wells are about 850 ft. deep and produce water of good quality. The pit, or upper part of the wells, is connected to the lower 12-in. portion with a Layne interlocking coupling, and from the bottom of this pit, which is 24 ins. in diameter, on down to the screen the casing is 12 ins. in diameter. The screen, 12 ins. in diameter, is a wide Keystone. The 24-in. piping in the pit is No. 6 gage and is made of Keystone metal, or copperized steel, which is rust resisting. The formation penetrated is composed of loose sand rock and hard packed sand, having a porosity of about 22 per cent.

THE PUMPS.

The bearings used in the pumps are of the highest class phosphorous bronze type. They are fully protected from sand and are oil lubricated and water cooled, causing the minimum of friction. The electricity for operating the Layne & Bowler pumps is furnished by a 75 hp. crude oil engine direct connected to a generator. It operates at a fuel cost of $2.20 per 24 hours, present prices. The wells are about 1,500 ft. apart and the pump motors are operated from the pumping station without the necessity of any one going out to the wells to start or stop them. This type of pump can be made to work automatically, regulated by the height of the water in the reservoir. That was not considered necessary, however, in the Galveston installation because engineers are on the ground at all times looking after this work. The pumps are of the one-stage centrifugal type, and are running at a speed of 860 r. p. m. with the vertical motor direct connected.



View of Layne and Bowler Well Pumping Installation, Galveston, Texas, Water Supply.

The five reasons for the greater yield of the new wells over that gotten from the old wells are: (1) The bore is larger in diameter; (2) more screen is used; (3) proper location and installation of the wells where the sand was coarsest and thickest; (4) wells are installed far enough apart so that one will not affect the other; (5) using a Layne screen, the entire strainer feeding into the well, causing a maximum yield and minimum pull down. The reason this screen produces more water than the ordinary screen is because the openings in it are larger than in the ordinary screen, such as was previously used, and are so shaped that the sand cannot enter the well without being pumped out. This means that the screen cannot clog, but is always clean on the outside as well as on the inside. The screen is made of Keystone galvanized wire wrapped on the perforated 12-in. line pipe. Its length is 82 ft. in one well and over 100 ft. in the other.

The fuel cost for the Alta Loma steam plant is about $54 per 24 hours in pumping about 4,000,000 gals. Allowing 20 per cent of this as used in pumping the water through the mains to Galveston leaves a cost of $43.20 per 24 hours for handling 4,000,000 gals. with air, against a cost of $2.20 per day for handling 2,000,000 gals. with the oil engine and Layne system. This means a saving in fuel in favor of the Layne system with an oil engine over the steam operated air system of $9.70 per 1,000,000 gals. pumped.

Mr. John B. Hawley, engineer, of Ft. Worth, recommended the Layne and Bowler system to Galveston. Mr. W. S. Burgess is water commissioner, Mr. A. T. Dickey city engineer and Mr. E. J. Owen is chief engineer at the pumping station.

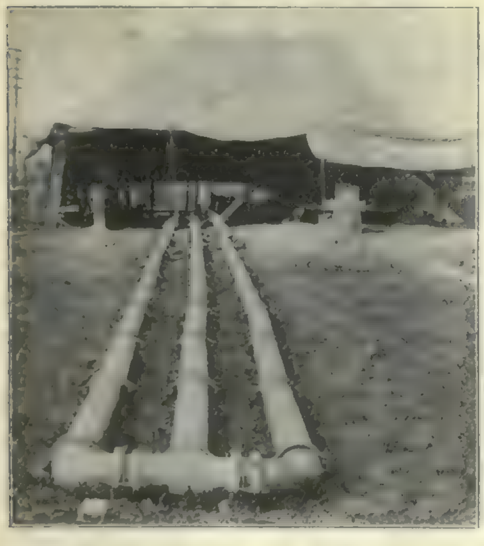
Using Compressed Air to Clean Sand Out of Driven Wells at Detroit.

(Staff Article.)

Real estate operators, on the outskirts of Detroit, Mich., frequently install water works systems to supply new subdivisions. The water supply is easily secured from driven wells sunk to the water-bearing sands which underlie practically the entire southern peninsula of the State. Such a system was recently installed in Mr. B. E. Taylor's Strathmore Subdivision of Detroit. The system was designed by Patrick W. Keating, Consulting Engineer, and installed by W. L. Dillon, 1503 Kresge Bldg., Detroit.

The supply in this case was derived from three 8-in. wells having an average depth of about 220 ft. The wells are cased to the full depth and are provided with Cook well screens at the bottom. Two of the wells were placed in service shortly after their completion and considerable trouble was experienced from the presence of sand. The third well was drilled in January, 1915, and a pumping test developed a flow from this well of 300 gals. per minute. It was not put in service until July, 1915, and at that time the lower 15 ft. of the well was completely filled with packed sand. So much trouble had been experienced from sand in the wells under operation and, it being impossible to utilize the third well on account of the large amount of sand it contained, it was decided to rig up a compressed air plant with which to remove the sand from all the wells.

A view of the air compressing plant is shown herewith. The compressor was of Chicago Pneumatic Tool Co. manufacture. As no air receiver was at hand one was improvised, as shown in the view, from 216 ft. of 6-in. Universal cast iron pipe. An average air pressure of 150 lbs. to the square inch was maintained. The third well, which had stood idle for six months, was the hardest to clean and as the methods employed in cleaning it were used on all the wells they are here described.


View of Air Compressor Plant Used in Freeing Driven Wells of Sand at Detroit, Showing Improvised Air Reservoir.

A 2-in. wrought iron pipe was taken off the improvised air receiver and extended, through a bushing in the well casing, down to the middle of the sand in the well, where it terminated in a 1-in. nozzle. Air was then admitted to the sand under 150 lbs. pressure and water and sand were forced out of the upper end of the well casing, which was left open. This method was continued as long as it did any good and a considerable portion of the sand was removed in this manner. A Fairbanks-Morse electrically driven plunger pump was then attached to the upper end of the casing and placed in operation while air was again forced into the casing below this suction connection. This was continued until the well was free of sand. On this well two days were required to remove all the sand and in making the plant changes mentioned.

After the wells were cleaned the Universal pipe used in the receiver were laid in the distribution system.

For this information we are indebted to Mr. W. E. Holland of the Chicago office of the Central Foundry Co. of New York City.

An Interesting Example of the Surface Pollution of a Deep Well Water.

(Staff Abstract.)

Driven wells, if the yield of water is sufficient, are generally regarded as one of the best sources of public water supply, but care must be exercised that the naturally pure water at the bottom of a driven well is not polluted and cannot become polluted by organic and perhaps infectious matter from surface and ground sources.

A short time since there came under my observation the case of a water supply from driven wells which furnished some new and interesting information to me. A tube well had been driven to a depth of 120 ft., tested for capacity, found to yield a satisfactory volume of water, and samples of the water when analyzed were in all respects excellent. A second well located 250 ft. distant, driven to the same depth, through the same strata, into the same water-bearing sand, when tested for water quality was found to be of about the same chemical and physical character as the water from the first well, but contained in all samples abundant colon bacilli and showed decided sewage pollution.

The first well was satisfactory as a source of domestic water supply, the second well was not, and yet from all outward appearances there was no reason why there should have been any difference between the sanitary analyses of samples of water from the two wells 250 ft. apart and driven into the same water-bearing strata.

The first well when tested was pumped to a point of discharge where it flowed away in surface channels, which were not in connection with the water-bearing strata from which the water was drawn, and the test samples collected, from the unpolluted source 120 ft. below ground level. The water from the second well upon pumping for yield was discharged into an abandoned and forgotten privy vault, about 12 ft. from the well, not known to the officials in charge of the work, and from this vault or cesspool the colon bacilli were carried through the porous strata to the drive pipe of the well and mixed with the water from the strata which furnished the well supply, and came to the surface by pumping, and were found in the test samples of water taken for analysis.

There was thus established a circulation of water from the unpolluted source to the abandoned vault, and from the vault through the porous earth and drift materials to the strainer at the bottom of the drive pipe, the water from the test pump percolating through the disturbed drift materials alongside the drive pipe to the safe strata below, and in this manner polluting what was naturally an excellent water source.

From a paper by John W. Hill, Consulting Engineer, Cincinnati, Ohio, before the Central States Water Works Association.

Excavation from Gaillard Cut during October amounted to 1,079,663 cu. yds., as compared with 1,052,586 cu. yds. in September, 991,879 cu. yds. in August, and 692,109 cu. yds. in July. In October 872,952 cu. yds. were taken from the bases of the Culebra slides.

The Sky-ad As a Water Works Publicity Measure.

(Staff Article.)

Water superintendents and managers who operate their plants along progressive business lines are always seeking effectual methods of advertising their product. The sky- or kite-ad is an effective form of advertising. It is aimed at the well known human frailty which prompts all mankind to gaze with rapt attention at anything in the sky which is at all different from the well-behaved heavenly bodies. We do not know of any case in which a kite-ad has been used in advertising the water works business.

Suggested Form of Kite-Ad for Use in Advertising the Public Water Supply.

The accompanying photograph is, therefore, something of a fake. The kite in the cut originally bore the suggestion to "Cook with Gas." One of our draftsmen changed it to read: Use City Water.

The "Cook with Gas" kite was actually used by the Grays Harbor (Wash.) Gas Co. The kite shown is of the Malay type, 7 ft. high and 7 ft. wide. This type of kite does not require a tail as it steadies itself in any breeze from 2 to 40 miles per hour. For an entire week the Gas Company paid no attention to this aerial signboard since it was anchored to a chimney on the roof of the company's building. It attracted a great deal of attention and much favorable comment, according to The Gas Record.

An Effective Argument for the Ownership of Water Services by the Utility.

(Staff Abstract.)

In Philadelphia the water service pipes are owned by the consumer. That this is wrong in theory and results in no end of trouble and expense in practice is the conviction of the official of the Bureau of Water, as noted in the latest annual report of M. L. Cooke, Director of the Department of Public Works. He says:

The city should take over the ownership of the pipes lying between the street main and the house line. In discussing this matter the Chief of the Bureau of Water says:

A report comes to the Water Bureau of a leak in the street, probably endangering traffic. The Water Bureau men proceed to the spot and dig up the street to locate the leak. If it is in the main pipe, or the ferrule in the main, the Water Bureau men can make repairs and finish the job. If it is in the service pipe leading to a private property, they cannot make the repairs. The householder is notified, and if the leak is such as to cause damage or endanger property or traffic, the water is shut off at the main thereby depriving the property of water. The hole is then filled up so that traffic may not be interrupted. The property owner then secures the services of a plumber who proceeds to the City Hall to take out the necessary permit, after which he returns to the leak and re-excavates the hole which the Water Bureau has filled up. After making repairs, the plumber notifies the Water Bureau and an employe is sent to turn on the water. The plumber then fills up the hole, and the Highway Bureau subsequently repairs the pavement.

Some red tape, all right!

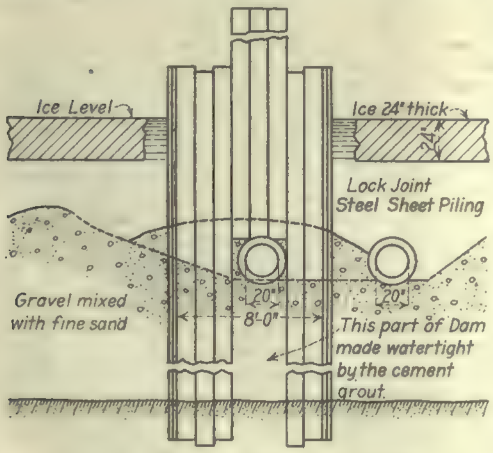
More and more it is going to be against public interest to have private parties tear up the streets. The price we pay for poor work both below the street and through the paving itself is such as makes a change in our policy in this matter seem desirable. During last year 2,000 permits were issued for street openings on account of leaks in water service pipes. In each instance, of course, and for the reason above given, the trench was opened twice.

Methods Employed in Repairing a Submerged Water Main at Edmonton, Alberta.

(Staff Abstract.)

The water supply of Edmonton, Alberta, is taken from the North Saskatchewan River at a point inside the city. It is purified by sedimentation, filtration and sterilization. Until 1912 the portion of the present city which lies south of the river was the town of Strathcona and that to the north of the river was Edmonton. In 1912 the towns amalgamated and took the name of Edmonton. Before this union was effected each town had its own pumping station, afterwards, the use of the Strathcona station was discontinued and the Edmonton station, being the larger and better equipped, was extended. It, in conjunction with increased filtration capacity, now supplies the entire city. The fact of the pumping and filtration plants being situated on the north side necessitates the supply for the south side being conveyed across the river, this being accomplished by means of two parallel, 20-in. diameter, cast-iron submerged mains. These mains were laid following the amalgamation, and the execution of the work presented no unusual engineering features. Similar submerged mains are to be found at many points.

The Saskatchewan River flows through a deep ravine, the bed of which is approximately 200 ft. below the tableland on which the principal parts of the city stand. The pumping plant is situated on flats on the north bank, at a level intermediate between the river bed and the tableland. While the normal pressure in the mains on the tableland is about 45 lbs., in those on the flats it is much higher, and particularly in the submerged mains above referred to, where it is as high as 135 lbs. If necessary, these pressures can be raised to 75 lbs. and 165 lbs., respectively, to cope with an exceptional fire, but as a rule any pressure above the normal required for fire purposes is supplied by the movable equipment of the fire brigade.


Ice Level
Ice 24" thick
Lock Joint Steel Sheet Piling
Gravel mixed with fine sand
20"
20"
8'-0"
This part of Dam made watertight by the cement grout.
Hard Pan and Coarse Gravel

Sketch of Steel Sheet Pile Cofferdam Around Break in Submerged Water Main, Edmonton, Alberta, Showing Portion of Stream Bed Under Pipe Grouted Under Pressure to Make Dam Watertight.

Strictly speaking, one line of 20-in. diameter pipe would have been ample for all the needs of the south side district, but the city commissioners, on the advice of their engineers, sanctioned the construction of the double line, it being their opinion that, with such a provision, the possibility of any prolonged interruption to the supply would be practically eliminated. Subsequent events proved that such a margin of safety was not only advisable but necessary.

At various stages in the progress of the work tests were applied to the mains and satisfactory results secured, but after they were lowered into position and all contingent works completed, the final test under a pressure of 180 lbs. was applied, when the gage unexpectedly dropped, and it became apparent that a serious leakage had developed in one of the lines. Investigation revealed the fact that one 12-ft. length of pipe had burst during the test, the fracture being about 4 ft. long and extending from a point within a few inches of one flange, in a direction parallel to the long axis of the pipe. The location of the failure on the submerged line was 120 ft. from the south bank of the river.

The purpose of this article is to describe briefly how the repairs were carried out, the broken 12-ft. length of pipe being removed and a sound one substituted. Fortunately it was possible to undertake the repairs before the end of the winter, while the water level in the river remained at its minimum, and the ice was in good condition.

The two 20-in. submerged mains were laid in a trench dredged in the bed of the river. The pipes were 6 ft. apart, center to center, and parallel. The trench depth was 3 ft. 6 ins. and its bottom width 10 ft. The accompanying sketch shows a cross-section of the cofferdam constructed around the broken pipe. Lock Joint steel sheet piling was used, the length of the dam being about 24 ft.

It would have been a comparatively simple matter to secure a watertight cofferdam had it been possible to use this piling across the full width of both ends of the dam, but the position of the pipe prevented so simple a solution of the matter.

The material forming the river bed at the point in question consists of gravel mixed with a comparatively large proportion of fine sand, which overlies for a depth of several feet a firm stratum of coarse gravel and hardpan firmly cemented together, into which the sheet piling was driven.

Several attempts were made to complete the ends of the cofferdam above and below the pipe, but without success, and much delay and expense might have been entailed had not the superintendent in charge of the work conceived the idea of forcing grout into the gravel and sand at these points by means of a hand pump—an idea which was put into operation with immediate and complete success. The cement was mixed in deep steel wheelbarrows, and reduced to the consistency of cream with water in which had been dissolved soda crystals, the latter being used to hasten the setting of the cement. The pump was operated by four laborers, and was found capable of exerting a pressure of 40 lbs. when previously tested with water against a pressure gage.

The work of pumping the grout had to be carried out with the utmost despatch in order to prevent the pump from becoming choked, each batch of grout being handled quickly, and the pump thoroughly washed out after dealing with each batch. In all, 22 bags of cement were used, and within a period of 60 hours the cofferdam had been pumped dry.

The subsequent work of removing the broken pipe, and replacing it with a sound one was successfully and expeditiously performed.

The work of laying the double line of submerged mains, and the execution of the repairs above explained, were carried out under the direction of Mr. J. Ryan, superintendent of works for the city.

ACKNOWLEDGMENT.

From an article in The Canadian Engineer, by Mr. James Hamilton, Assistant Engineer, Sewer Department, Edmonton, Alberta.

Procedure at Kalamazoo in Case of Excessive Meter Registration.

(Staff Article.)

When the meter reader of the Kalamazoo, Mich., water department finds a meter which registers in excess of what should be expected from the past rate of consumption, he so notifies the Water Commissioner, who then at once notifies the consumer that his rate of consumption is excessive. A copy of the printed form of notice used for the purpose of acquainting property owners with such excessive readings, as soon as found, is shown herewith.

The meter reader is required to take note of such excessive readings, and to report at the close of the day any that he may have found. One of these printed notices is then filled in and mailed. The department has a bound book of these blanks and a carbon copy of each one filled in is retained in the book for future reference. Water Commissioner George Houston advises us that this plan works out very satisfactorily and is very much better than having the meter reader advise the owners or tenants at the time of making the discovery of the excessive reading.

Meter Department. City of Kalamazoo.

Office of
WATER COMMISSIONER.

Kalamazoo, ...19....

M........................

....

The reading of the Water Meter at .... St. as reported by the Meter reader shows that .... cubic feet have gone through it since last read, which is a large amount for the place, and thinking there might be a leak of which you were not aware, we take this method of notifying you in order that you may have it looked after if you desire.

Remarks: ....

....

....

Respectfully yours,
GEORGE HOUSTON,
Water Commissioner.

Form Used by Kalamazoo Water Department in Notifying Metered Consumers of Excessive Rate of Consumption.

Performance of the New Orleans Water, Sewerage and Drainage Systems During the Recent Hurricane.

(Staff Abstract.)

The hurricane of Wednesday, Sept. 29, 1915, with its great rainfall, high winds and high tides, put all the systems operated by the New Orleans Sewerage and Water Board to the most severe tests. The following notes relating to the performance of these systems under stress are abstracted from a report by Mr. George G. Earl, General Superintendent of the Board.

The great storm began on the night of Sept. 28 with rain and a gradually increasing northeast wind. By 7 a. m. on the 29th the wind had increased to a gale of 40 miles an hour, and during the day both wind and rain increased in intensity until between 5 and 5:30 p. m., when there was a sustained wind velocity of 80 miles per hour, and velocities up to 120 and 130 miles for the hardest gusts, with 8.2 ins. of rainfall and a minimum barometer reading of 28.11 ins.

At 7 a. m. on the 29th the drainage system was operating normally, and as the rain increased the Central Power Station was able to operate all of the pumps necessary to take care of the water as it reached the seven pumping stations. The first indication of trouble was at 10:50 a. m., when heavy short-circuits occurred, and the pumps operating at

Stations 1, 3 and 7, and a few moments later at Station 6 went out of step.

OPERATION OF DRAINAGE SYSTEM STOPPED BY 6 P. M., SEPT. 29.

From 10:50 a. m. the drainage system was operated under increasing difficulty. Power was sent out into the transmission lines constantly until 5 p. m., and the pumps at the various stations were operated as best they could be, but were repeatedly put out of step by short-circuits caused by wires and trees falling across the transmission lines, which in turn caused interruption in the operation of the pumps.

The main line from Station 6 to Power House No. 2 was entirely put out of commission by a huge oak tree which fell across it, and the line to Station No. 1 was short-circuited by wires falling across it; so that Power House No. 2 was entirely out of commission.

At 4:35 p. m. the top 50 ft. of the 175-ft. steel stack of the Heine boiler battery at the Central Power Station broke off and fell through the roof of the boiler room, tearing down roof trusses and small steam and water pipes, but fortunately missing the main steam line by a few inches and falling in the space reserved for future boiler installations, so that none of the boilers were damaged and only the Heine boilers were put out of commission.

By 6 p. m. the storm had reached such magnitude that it was feared that the whole building would be destroyed, and as it had been found impossible to maintain current on any of the transmission lines after 5 o'clock, and the last generators had been shut down, the Chief Engineer ordered the men to the basement for safety, having first carefully examined all boilers and pipes and ascertained that, without further disaster, everything except the Heine boilers—that is, the eight Babcock & Wilcox boilers, could be operated.

During the day frequent advices were received of small overflows of various of the levees. Three of these were in the locality of the various pumping stations and were taken care of by the Sewerage and Water Board forces or by Sewerage and Water Board contractors working in the neighborhood.

At about 6 p. m. there was a slight lull in the wind, and shortly after a reversal of direction, with very high velocities for the greater portion of the night, but not nearly so high as during the afternoon.

DRAINAGE OPERATIONS RESUMED THURSDAY AND FRIDAY, SEPT. 30 AND OCT. 1.

The linemen were kept on duty all night, and early Thursday morning were sent out to clear the lines. All work was at a very great disadvantage because of lack of communication through telephones, and the board's Ford cars were put into service in all directions, and all available forces directed to stand by and co-operate with the Drainage Operating Department.

Some of the men from Central Power Station cleared the feeder to Station No. 3, and at 12:30 noon, two large pumps were started at that station. Current had to be taken off of this line, however, at 3:12 p. m. in order to enable the linemen to clear the lines going to Stations No. 6 and 7 of the tangle of wires of the electric light, telephone and telegraph companies at Frenchmen St. and the Louisville & Nashville R. R. crossing. At 7:20 p. m. this was accomplished, and lines to Stations 6 and 3 were cleared and two large pumps started at each of these stations.

On Friday, Oct. 1, at 8:40 a. m., the pumps were also started at Station No. 7. Line troubles still made it impossible to operate at all from Power House No. 2, or to operate any of the pumps at Stations 1, 2 or 5, and since the water had accumulated in the low areas which Stations 1 and 2 could not relieve until Stations 6 and 7 had removed the greater portion of the water thus accumulated, there was nothing to be gained by the operation of Stations 1 and 2. Station 5 could have helped Station 3, but was of relatively little importance, being only of small capacity.

LEVEES BELOW MAXIMUM LAKE LEVEL.

On Thursday morning the lake level still maintained its maximum elevation, and there were numerous points along the various navigation and drainage outfall canals and on the rear protection levees where lake water was entering the city in large amount. The overflow from these sources, added to the average of about 7¼ ins. of rainfall, was a most discouraging feature of this day's development, and added materially to the delay in getting all parts of the city free of water.

LEVEES SHOULD BE RAISED.

The tidal elevation of 26.2 C. D. is several inches above any previous record, and our levels indicate that stretches of protection levees on the lake front, or along the navigation or drainage outfall canals, aggregating some seven miles, are slightly below this elevation with very considerable lengths of depressions which are very materially below said elevation. In view of this new high-tide record and the condition, as above stated, the recommendation of the Chief Engineer of the Orleans Levee Board looking toward more substantial and higher levees for the protection of the city against lake tides is heartily endorsed. The Sewerage and Water Board is constructing its own outfall pumping stations with a view of being able to maintain them in operation with a maximum water elevation of 30 C. D. on their discharge side.

By Friday night the area between the two navigation canals was practically free of water, and by Saturday night most of the water had been removed from the large low area above the New Basin Navigation Canal, and back of Clara St.

The portion of the city below Elysian Fields Ave. and back of St. Claude Ave., however, which is very sparsely settled, was not relieved of water until Wednesday, Oct. 6, despite the fact that the pumps at Station 3 operated continuously from the afternoon of the day following the storm. This was due to the crevasses in the levee along Florida Ave. and to other overflows of levee lines protecting this area.

DAMAGE SUSTAINED BY SEWERAGE AND WATER BOARD.

At all of the Sewerage and Water Board stations and at the Washington Ave. Yard, more or less damages have been sustained, mostly to the roofs of the buildings; slates, tiles, etc., having been blown off. No material damage has been suffered by the machinery, although some of the motors were wet and had to be thoroughly dried out before they could be safety operated.

Temporary repairs to the roofs were made and permanent repairs will be made as soon as the necessary material can be procured.

The greatest damage is in the breaking off of the upper portion of both stacks at the Central Power Station, and the destruction of the stack at Station No. 5, and the breaking in of the roof at Station 5 and the Central Power Station, where one stack fell through same. At the Central Power Station, with oil fuel, much shorter stacks will answer equally well, and there will, therefore, be no necessity to renew the long stacks which were required in the original construction when coal was used as fuel. At Station 5 a somewhat shorter stack can be substituted, with temporary repair of roof, since the old station will probably go out of commission as soon as the new station now under construction is completed.

At Central Power Station the roof of one of the great fuel oil tanks was torn off and carried 300 ft., and fell upon the pipe line leading from another of these tanks, breaking same outside of the masonry wall provided to impound the oil in said tank in case of a break in the tank, thus allowing the escape of some 2,000 barrels of fuel oil.

UNDERGROUND CABLES PROBABLY NO MORE CERTAIN OF OPERATION.

Following this storm, a general and careful overhauling of the transmission lines will be necessary. The greater part of the troubles on these lines were due to the fact that telegraph, telephone and electric light and other wire lines crossed over same and fell upon them, causing short-circuits, or that trees fell across them, tearing them down. The line from Central Power Station to Station 5, however, is in very soft ground and was blown over in many places, and a few poles on other lines, subjected to unusual stresses and so located that satisfactory guy wires could not be used, or where other special conditions existed, were also badly bent over. We have often had the suggestion that underground cables would avoid line troubles of the character occasioned by this storm. To some extent they would, but the cost of an underground system is absolutely prohibitive, and underground systems, we know from experience, are also subject to troubles of other kinds, and in case of trouble in an underground system following a great storm, where the ground through which it passes is under water, the difficulty of quick location of the trouble and of its prompt repair is even greater than with an overhead system. Pumping stations, each operated by steam, or other power at each station, is another solution which various critics of the existing system occasionally advise. Not being responsible in any way for the original adoption of the general system now in use, I can say, without hesitation, that I know of no other system that could have been adopted which would have given a better service during the hurricane or remained in service longer or gotten back into service more promptly than the system here in use, and especially of none which can be more economically or satisfactorily operated.

OPERATION OF SEWER AND WATER SYSTEMS.

During the late afternoon of the storm of Sept. 29, as an example of underground lines and the troubles which a hurricane may cause to them, it may be noted that falling walls in several cases caused the breaking of water mains, or of large connections, or of fire hydrants in various widely scattered parts of the city, and the water consumption rate was more than doubled, resulting in a slight reduction of pressure in New Orleans, and for a short time a considerable reduction in Algiers. Until these various breaks were all located and closed, the filters and pumps were called upon to furnish an excessive amount of water, which they did; and the clear water reservoir also was drawn upon very heavily Wednesday night and on Thursday. The output from the filters, however, was maintained fully up to the usual standard, though the forces at both the pumping station and at the water purification station were pushed to the utmost to maintain the supply and pressure.

It is fortunate that the largest break which was caused by a falling church steeple happened to be in an 8-in. line, instead of in a 12 or 20-in. line, and in an area which was not flooded after the storm, so that it was located and closed early Thursday morning. A break in a larger main, or in a main in a locality where prompt discovery and closure would have been far more difficult, could easily have occurred and might have given very serious trouble.

In Algiers, the lowering of the pressure for a short time, due to a sudden break, caused the water to lower greatly in the standpipe during the heavy blow, thus exposing it to wind action without its full weight of water to resist same, and bringing unusual stresses upon its cast-iron foundation braces, several of which were cracked. These braces can be renewed of steel at comparatively small expense, and no considerable cost or damage will result.

The main sewage pumping station, the Algiers Station, and Station B at Jourdan Ave., were operated continuously during and after the storm, and the various substations, which were by-passed immediately after the storm, were put back into operation as soon as the flooding due to the storm water had been lowered in the various areas which they serve. The sewers, of course, were filled to the limit of their capacity with storm water, which entered as seepage water at the cement joints of the sewers themselves and of the house connection lines and into manholes in the higher portions of the city, and in the lower areas the water ran from the manhole tops into the nearest drains, when the water in the drains was first lowered. Additional pumps at the various sewer pumping stations, which pumps are now under contract, will largely eliminate such overflow from sewer manholes after the full equipment of drainage pumps, also under contract, is installed, since these latter will tend to the more prompt removal of storm waters through the drains themselves, and to the maintaining of water levels and conditions in the drainage system which will not throw so much drainage work upon the sewers, and will in turn permit of their more prompt relief.

CO-OPERATION OF BOARD'S DEPARTMENTS AND FORCES.

From what has been said, it will be noted that by Saturday night, following the storm of 7¼ ins. and the tidal overflow of levees in the rear of the city of very considerable extent, nearly all of the flooding, even of the lowest areas, had been removed and first aid applied to roofs, transmission lines, etc. This was only accomplished by the most arduous efforts not only of the drainage operating forces, under the direction of Mr. Alfred Raymond, but also by the co-operation of the sewerage and water operating forces, the drainage maintenance and construction forces, under Mr. Alfred F. Theard, and the sewerage and water maintenance and construction forces, under Mr. John T. Eastwood. Telephones were not available almost anywhere. The Ford cars had to, and did, take their place, and had to go through storm and water to carry messages, to obtain men or to get material. The Washington Ave. Yard was all but inaccessible, due to fallen wires, and to the high water in the Claiborne Canal. One team of mules belonging to the board was killed by a live wire at the bridge at Washington Ave. and Claiborne St., and others escaped by narrow margins.

BRIDGES

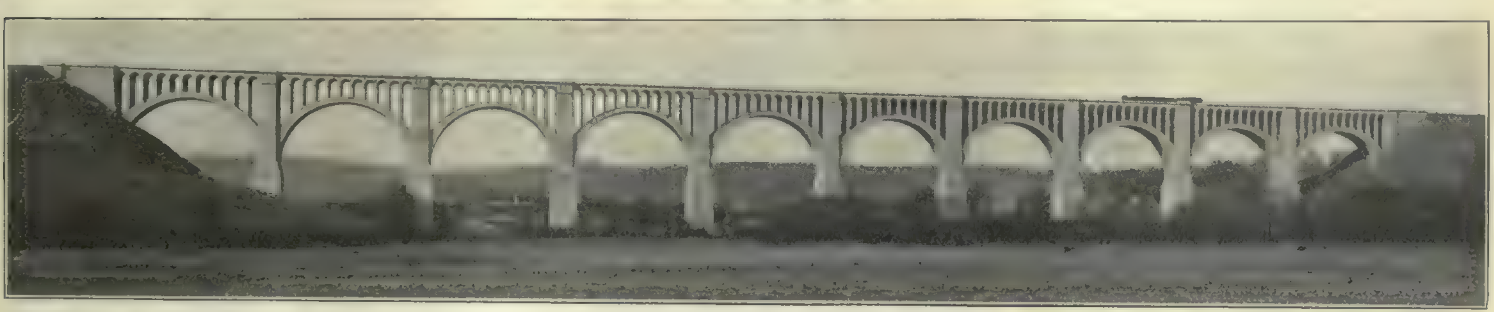


Fig. 1. View of Tunkhannock Creek Viaduct Recently Completed at Nicholson, Pa., as a Part of the Delaware, Lackawanna & Western Railroad's New 39.6-Mile Cut-Off.

Some Features of the Tunkhannock Creek Viaduct Recently Completed at Nicholson, Pa.

(Staff Article.)

On Nov. 6, 1915, the Delaware, Lackawanna & Western R. R. placed in service its new 39.6-mile cut-off between Clark's Summit and Hallstead, Pa., constructed at a cost of about $12,000,000. Although the new three-track line does not deviate widely from the old location, its maximum divergence being about 1½ miles, it saves a distance of 3.6 miles, and greatly reduces the grades and curves. The maximum grade has been reduced from 1.23 per cent to 0.682 per cent, while the curvature has been reduced from a total of 3,970° to 1,570°. The principal structures along the new line are the Nicholson Tunnel, a double-track bore 3,630 ft. long; the Martin's Creek Viaduct, a three-track concrete structure having a maximum height of 150 ft. and a length of 1,600 ft.; and the Tunkhannock Creek Viaduct.

The dominant feature of the new line is the Tunkhannock Creek Viaduct, a double-track structure having a length of 2,375 ft. and a maximum height of 240 ft. This viaduct (see Fig. 1) is composed of ten 180-ft. and two (buried) 100-ft. semi-circular arch spans springing from solid piers founded on bedrock. The divided arch ring supports transverse spandrel walls, upon which rests a floor system consisting of semi-circular spandrel arches. The magnitude of the structure and the architectural treatment of it are clearly shown in Fig. 2, which is a close view of the second span from the north end. The following data on this viaduct are of interest:

The deeper piers have a section of 40x46 ft. below the ground surface, while above ground all piers are 36 ft. 6 ins. by 43 ft. 6 ins. up to a plane 17 ft. 6 ins. below the springing line of the arches. The deepest pier extends 98 ft. below the ground surface, and at this pier it is 304 ft. from the bottom of the foundation to the highest point of the masonry.

As shown in Fig. 1, the 100-ft. span at each end (termed an "abutment span") is entirely buried by the approach embankments. Each end span is composed of two arch ribs, 5 ft. 6 ins. thick at the crown and 12 ft. wide. These ribs are spaced 22 ft. on centers, leaving a 10-ft. space between them. The two ribs of

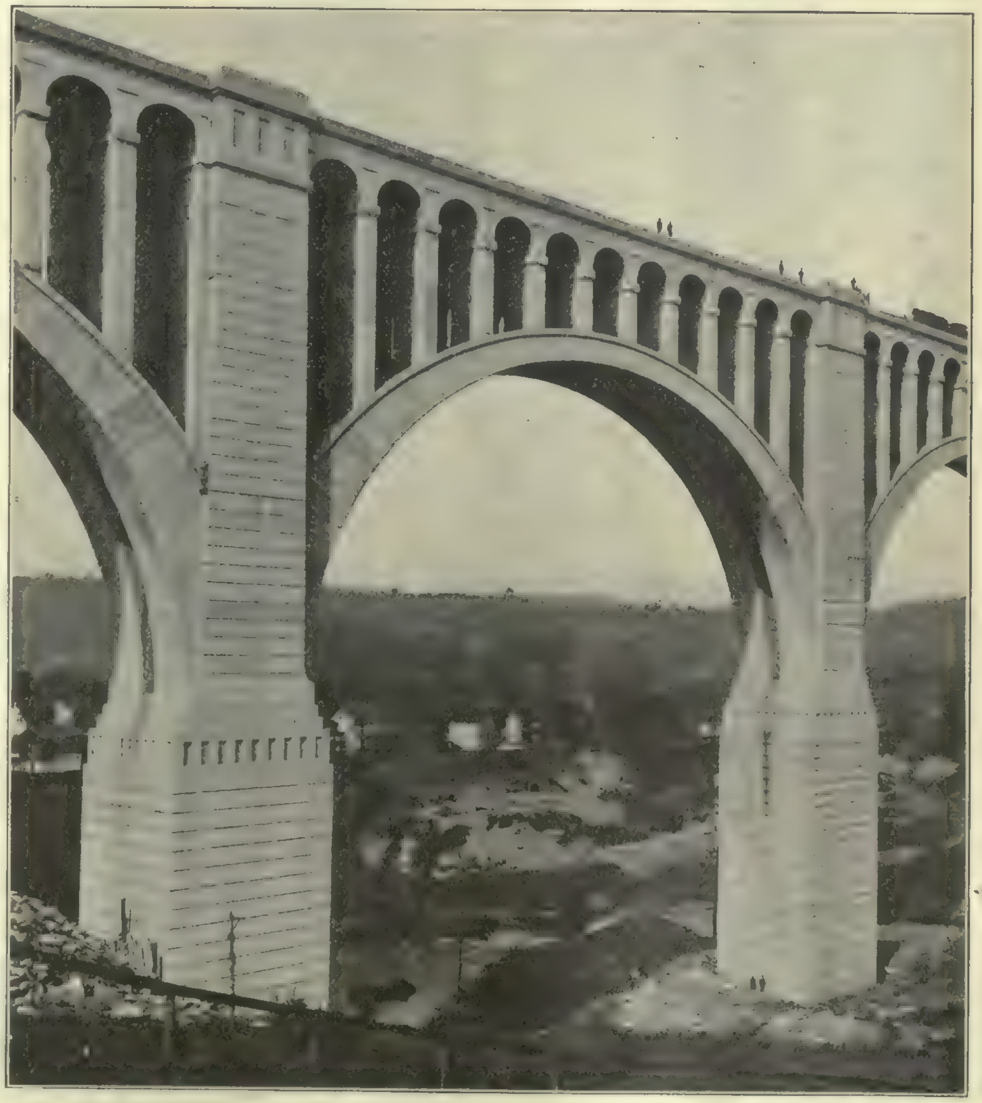


Fig. 2. Close View of a 180-ft. Arch Span of Tunkhannock Creek Viaduct Showing Architectural Treatment and Magnitude of the Structure.

each span are tied together with four reinforced concrete struts. They support reinforced transverse walls, on which rests a reinforced concrete floor slab varying in thickness from 1 ft. 9 ins. to 2 ft. 6 ins. The floor slab extends a few feet beyond the crown of the arch, and the space between the arch ring and the floor slab is closed with an 18-in. longitudinal curtain wall along each outside face, so that when the embankments are completed these abutment spans will have the appearance of U-abutments.

Each 180-ft. span is composed of two arch ribs, 8 ft. thick at the crown and 14 ft. wide. These ribs are spaced 20 ft. on centers, leaving a 6-ft. opening between them. The ribs carry reinforced transverse spandrel walls which vary in thickness from 3 ft. 2 ins. to 4 ft. 8 ins. The spandrel walls are arched over the space between the ribs and carry a floor system composed of 13-ft. 6-in. semi-circular spandrel arches having a thickness at the crown of 1 ft. 9 ins. The parapet wall, which extends the entire length of the viaduct, rises 7 ft. 3 ins. above the viaduct floor, while the pilasters at the piers extend 3 ft. above the top of the pilaster walls.

The viaduct contains 165,000 cu. yds. of concrete and 1,200 tons of reinforcing steel. (For a comprehensive article on the design and construction features of this viaduct see Engineering and Contracting of Apr. 1, 1914.)

The viaduct was designed and constructed under the direction of the engineering department of the Delaware, Lackawanna & Western R. R., of which G. J. Ray is chief engineer and F. L. Wheaton is engineer of construction. It was built by Flickwir & Bush, Inc. We are indebted to Mr. Ray for the illustrations here shown.

Design and Construction of a Reinforced Concrete Truss Bridge With Braced Counterfort Abutments Near Merthyr, Wales.

(Staff Abstract.)

The following data refer to a reinforced concrete truss bridge built for the Nixon Navigation Co., Merthyr Vale, Wales, to convey the refuse colliery shale from a mine to a new site across the tracks of the Rhymney Ry. and the Glamorganshire Canal. At the bridge site the railway and canal are about 80 ft. apart, the embankments for which are of considerable height. Owing to the required height of the abutments, to the difficulty of transporting materials to the site, and to the somewhat unstable character of the subsoil, due to underground workings, it was decided to use the braced type of reinforced concrete abutment.

The bridge, which consists of two 93-ft. 10-in. spans, provides a vertical clearance of 20 ft. for the railway (see Fig. 1). It is on a grade of 5.55 per cent. The distance between the inner faces of the abutments is 187 ft. 8 ins., and the heights of the abutments are 44 ft. and 46 ft., respectively, for the canal and railway sides. The center pier has a height of 55 ft., a width of 14 ft. 6 ins., and a thickness of 6 ft. It is of the hollow type, with two latticed sides. The trusses are of the Warren type, their height, from center to center of chords, being 10 ft. and the panel length 11 ft. 8 ins.

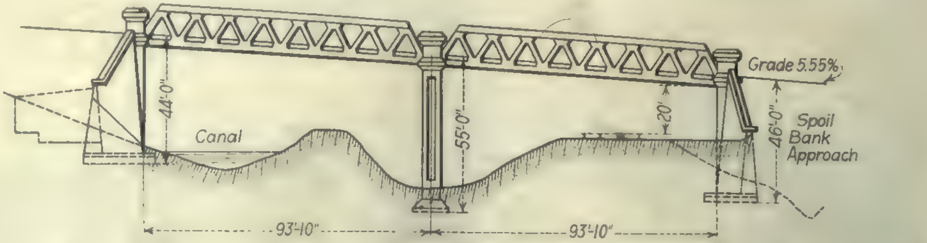


Fig. 1. General Elevation of Reinforced Concrete Truss Bridge Near Merthyr, Wales.

In addition to its own weight, the bridge was designed for a live load of 170 lbs. per square foot and a ballast load of 50 lbs. per square foot.

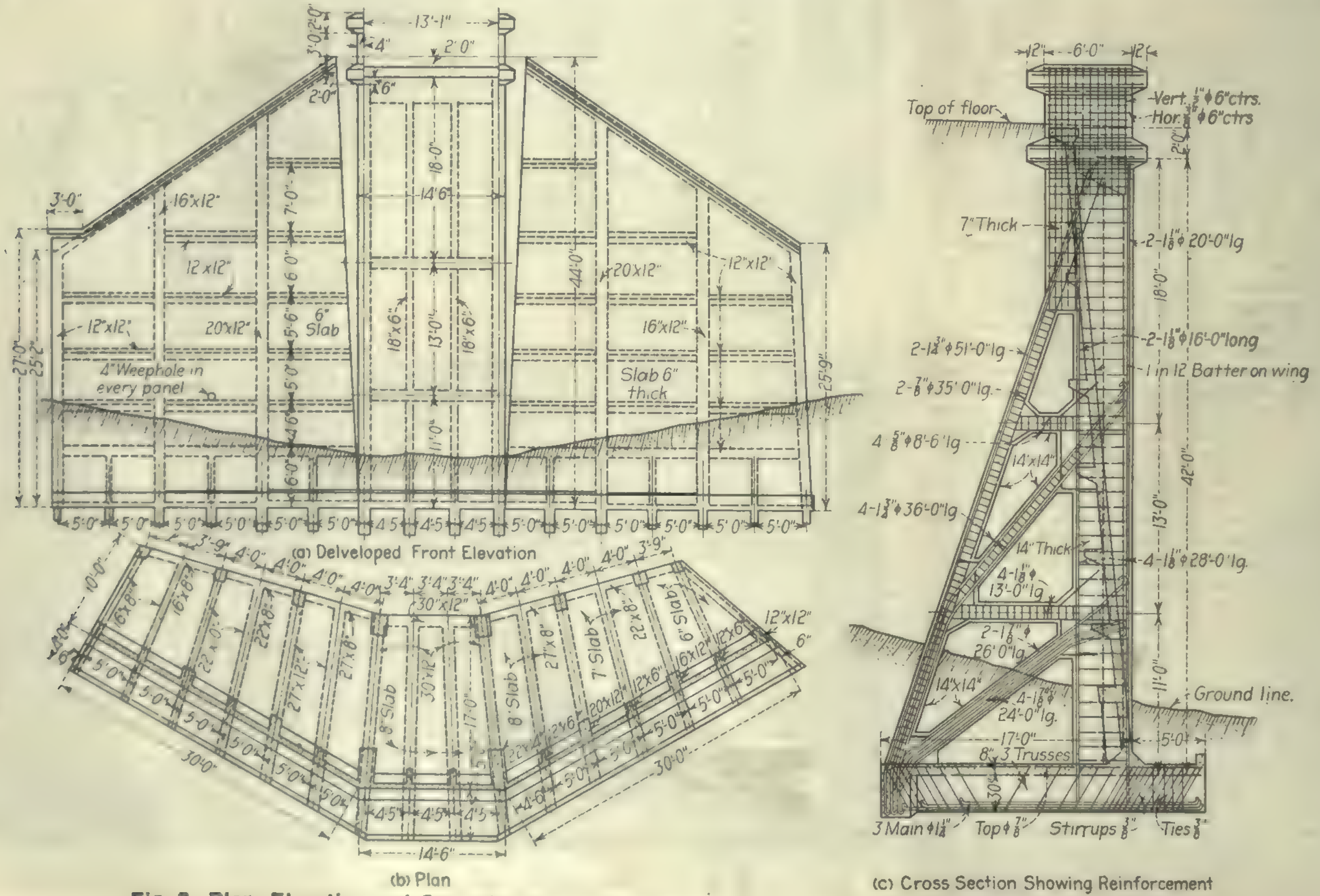
For the abutments and pier the concrete proportions are: 1 bag cement (11 bags per ton), 4½ cu. ft. sand, and 9 cu. ft. chippings. For the trusses a concrete mixture consisting of 1 bag cement, 3½ cu. ft. sand, and 7 cu. ft. chippings was used. Crushed pennant of very close texture was used for the chippings, and crusher dust from the same stone was used for sand. A very satisfactory concrete with an excellent surface was obtained.

SUBSTRUCTURE DESIGN FEATURES.

The abutments are of a very light design and show a large saving over other types of construction. The erection is somewhat complex, but it presents few difficulties to men experienced in this class of work.

Abutment at Canal Side.—Figure 2 shows a plan, elevation and cross section of the abutment at the canal side of the bridge. Under the trusses, which are spaced 10 ft. 10 ins. on centers, the abutment wall is vertical and is 44 ft. high by 14 ft. 6 ins. wide. The wing-walls extend 30 ft. on each side, at an agle of 30° with the face of the abutment wall; they are battered 1 in. in 12 ins. The walls are finished with a molded cap and coping, as shown in Figs. 1 and 2, the general effect of which is very satisfactory. The wall slab is 6 ins. thick throughout, and is supported by horizontal beams stretching between counterforts, spaced according to the computed earth pressure. The slab is reinforced horizontally and vertically on both faces with ⅜-in. and ¼-in. bars, spaced from 4½ to 12 ins. on centers. The slab is well provided with weep holes. The horizontal beams were specially designed to resist the cantilever action produced by the downward pressure of the filling. It was also necessary to take into account this cantilever action in designing the slab.

As shown in Fig. 2 (c) the counterforts are



(a) Delveloped Front Elevation

(b) Plan

(c) Cross Section Showing Reinforcement

Fig. 2. Plan, Elevation and Cross Section of Abutment at Canal Side of Bridge Near Merthyr, Wales.

of the open braced type. They were designed as framed cantilevers about the base slab and supporting the wall slab, which resists the lateral earth pressure. Under the trusses these counterforts are 14 ins. square, but at other points they are 12ins. square; all connections are formed with substantial gussets, reinforced with ½-in. round bars. All the main tensile reinforcing bars spring from anchor blocks in the foundation slabs, where they are hooked around special bars placed in the under side of the foundation beams. As shown in Fig. 2 (c) these main tension bars branch off into the various bracings according to the forces which must be resisted; they terminate in ample return hooks near the face of the wall. Many of these bars are of large diameter and length, and after being bent to shape, were erected and secured in place by the scaffolding, which was erected beforehand for this purpose and was afterwards utilized for building forms and for concreting.

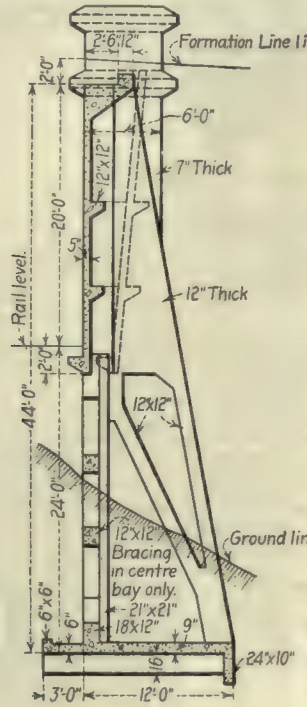
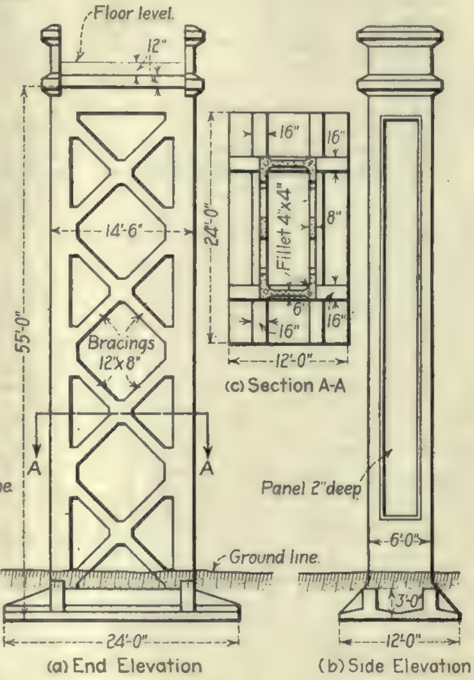


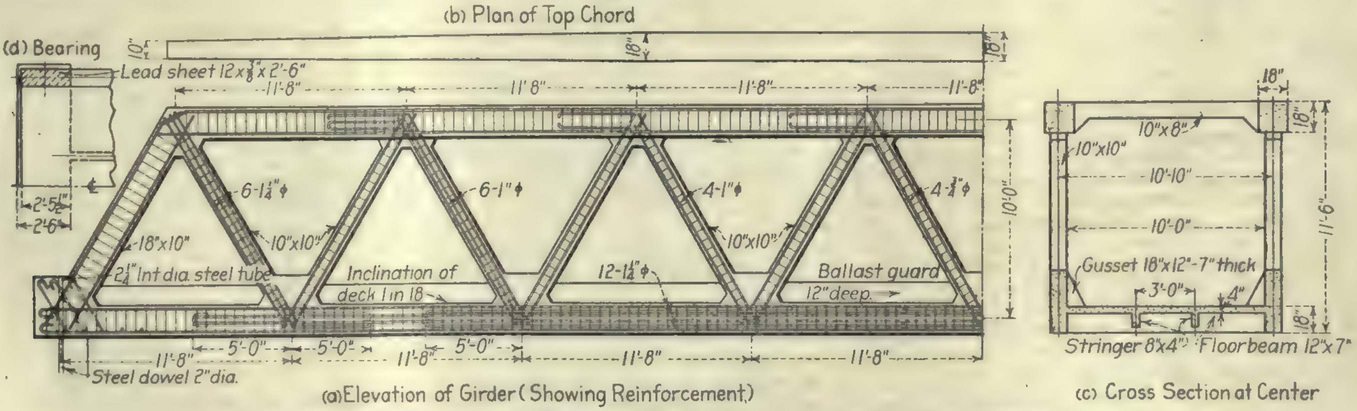
Fig.3



(a) End Elevation (b) Side Elevation (c) Section A-A

Fig.4

Fig. 3. Cross Section of Abutment Wall at Railway Side of Bridge Near Merthyr, Wales. Fig. 4. Plan, Side Elevation and End Elevation of Center Pier.



(b) Plan of Top Chord

(a) Elevation of Girder (Showing Reinforcement)

(c) Cross Section at Center

Fig. 5. Details of Reinforced Concrete Truss Spans of Bridge Near Merthyr, Wales.

The foundation slab (see Fig. 2b) is 22 ft. wide under the trusses, decreasing in width to 14 ft. at the ends of the wing-walls. At the abutment wall the toe projects 5 ft. beyond the face of the walls, while at the wings this projection is 4 ft. The slab, which varies in thickness from 6 ins. to 8 ins., is reinforced on both faces with 5-16-in. and 7-16-in. bars running in both directions. It is supported at short intervals by beams running from toe to heel, these beams varying in size from 8x16 ins. to 12x30 ins. The reinforcement for a 12x30-in. beam is shown in Fig. 2 (c). This reinforcement consists of three unit trusses placed side by side, each truss containing three 1¼-in. round bars. At the heel these transverse beams are supported by a main beam, which runs into the anchor blocks; while at the toe the transverse beams support a secondary beam which carries the outer edge of the slab. Special reinforcement is provided to resist the upward pressure of the earth, which tends to lift this beam and the slab from the transverse beams.

The abutment walls were designed to resist earth pressures in accordance with Rankine's theory, assuming the weight of the filling at 100 lbs. per cubic foot and the angle of repose at 36°. The resultant force was made to fall within the middle third of the foundation, and a factor of safety against overturning of at least 2 was provided. The girders were not considered to assist in resisting the overturning forces, although their weight was taken into account in finding the resultant force.

A stream flows into the canal near one side of the abutment, and a wing-wall, 36 ft. long, is provided to retain the embankment at this stream. This wall is banded to one of the wings of the canal abutment, at an angle of about 45°. At the junction the auxiliary wing has a height of 19 ft. 9 ins., reducing to 14 ft. at the other extremity. This wall is similar in design to the other walls, but the counterforts, which are spaced 9 ft. apart, are solid, 8 ins. thick, as it was not found economical to construct counterforts of the braced type for this height of wall.

Abutment at Railway Side.—The abutment at the railway side embodies some interesting features, owing to the fact that it will be buried up to the level of the railway tracks when the approach embankment to the bridge is made (see Fig. 1). A cross section of this abutment is shown in Fig. 3. By referring to this section it will be noted that the vertical slab is omitted for that portion of the wall which will be buried, thus saving a large amount of material and greatly reducing the proportions of the abutment, due to a corresponding reduction in the lateral pressure on the vertical slab.

The foundation slab of this abutment is 15 ft. wide at the abutment wall and 9 ft. wide at the ends of the wings. Its thickness varies from 6 ins. to 9 ins., the slab being supported by beams, as shown in Fig. 3. Cross braces are introduced in the center bay, under the vertical slab, to resist wind and other lateral forces, as this abutment is supported entirely on posts for the lower 24 ft. of its height.

Pier.—A light and economical design was also adopted for the center pier, details of which are shown in Fig. 4. The foundation slab is 12x24 ft., with an average thickness of 9 ins. The slab is reinforced with 5-16-in. and ⅝-in. bars, and is stiffened with 16x36-in. beams in both directions. The pier shaft is 6 ft.x14 ft. 6 ins. It is braced diagonally with 8x16-in. members in the plane of its end faces, and is solid over its side faces. With the exception of the paneled sides (see Fig. 4 b), which are 6 ins. thick, the faces have a thickness of 8 ins. The top of the pier consists of two beams connected by a heavy slab to form the bridge seat.

SUPERSTRUCTURE.

The trusses, which are spaced 10 ft. 10 ins. on centers, have a span, center to center of end bearings, of 93 ft. 4 ins., and depth, center to center of chords, of 10 ft. The lower chord has a cross section of 10x18 ins., and the upper chord a cross section of 18x18 ins. for the three center panels, tapering in the two end panels at each end to 10x18 ins. The end posts have a cross section of 10x18 ins., and the web members a section of 10x10 ins. Fig. 5 shows details of the trusses.

The lower chords are reinforced with twelve 1¼-in. round rods, arranged in two sets of six, as shown in Fig. 5, the bars overlapping in such a manner as to fit the bending moment diagram. In each case the reinforcing bars extend 5 ft. beyond the panel which they are intended to reinforce, and terminate in a hook of 6-in. inside diameter. Each set of six bars is bound together laterally with 3-16-in. ties (except at the hooks where the ties are 5-16-in. round), spaced 6 ins. on centers. The method used in fixing in place this reinforcement was as follows: One set of six bars was arranged on wood blocks, laid on the deck forms, the bars being fixed at the proper distances apart by wedging wooden spacers between them. The ties were then placed on the bars and wired to them at alternate intersections with No. 16-gage annealed wire. The unit frame thus formed was of sufficient rigidity to be lifted bodily.

The reinforcing bars in the web members were built in units in a manner similar to those for the chords. As shown in Fig. 5, the bars are carried 4 ft. horizontally into the chords, and are hooked at the ends. At the intersection of the upper chord and the end post the reinforcing bars of the web member were anchored by hooking them around the top bars of the end post and upper chord and returning the ends backs a sufficient distance into the member itself. At the end bearings the bars were arranged as shown in Fig. 5. The bars were bent cold on a frame consisting of a 12-in. square timber, 20 ft. long, on which were mounted the necessary studs. Heavy weldless tubes, sliding over the bars, were used as levers in bending the reinforcing bars. The reinforcement for the compression members was wired into units on templates.

In each span there are four 8x10-in. transverse braces in the plane of the top chords, each reinforced with four ⅝-in. bars, with 3-16-in. ties spaced 6 ins. on centers. These transverse members are provided with gusset ends.

The reinforced concrete floor slab has a thickness of 4 ins. This slab is supported on 4x8-in. stringers and 7x12-in. floorbeams (see Fig. 5 c). Additional transverse stiffness is provided by means of 12x18-in. gussets at each floorbeam.

Owing to the possibility of settlement of the foundations it was necessary to provide for movements at the end bearings of the trusses. As shown in Fig. 5 (d), the trusses rest on sheets of lead 12 ins. wide, 30 ins. long and ⅝-in. thick. A steel dowel, 2 ins. in diameter, projects from each bearing into a 2¼ in. internal diameter pipe embedded near the end of the truss, thus providing for free vertical movement.

FORMS AND FALSEWORK.

The forms for the trusses were carried on timber bents and towers, which supported longitudinal bearers consisting of 14x14-in. timbers, as shown in Fig. 6. The falsework was bolted together with 1⅛-in. bolts, with plate washers, and was erected with the aid of a derrick pole and hand winch equipped with blocks and tackle.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Charles E. Holloway, in *Concrete and Constructional Engineering* for July, 1915. The bridge was built under the direction of W. T. G. Marsh, engineer of the Nixon Navigation Co., of Merthyr Vale, Wales.

Pressures on Piles Supporting Masonry.

(Staff Abstract.)

Although textbooks on the design of retaining walls, piers, abutments, etc., usually contain formulas for determining the intensity of pressure for structures resting directly on the subsoil, they do not consider the case of a similar structure supported on piles. As the latter case is of frequent occurrence, a brief discussion of the systematic procedure for finding the pressure on a given pile for a wall, pier or abutment supported on piles will be given:

ASSUMPTIONS AND NOMENCLATURE.

In the necessary derivation of formulas in connection herewith it will be assumed:

(1) That all loads are carried by the piles.

(2) That all piles are alike and sustain the same load under like conditions.

(3) That the pressure on each pile is concentrated at the center of the pile.

(4) That all piles are driven vertical.

(5) That the tops of the piles are at the same elevation.

(6) That the masonry at the horizontal plane of the tops of the piles is rigid (which is equivalent to neglecting the slight continuous-beam action that actually takes place in that region).

The following notation will be used:

Aa, Ab, Ac = perpendicular distance between line A-A and piles, a, b, and c, respectively (see Fig. 1).

Ba, Bb, Bc = perpendicular distance between line B-B and piles a, b, and c, respectively (see Fig. 1).

G_1, G_2, G_3, …….. Gn = perpendicular distance between line G-G and rows 1, 2, 3, …….. n, respectively (see Fig. 2).

Gv = distance between the point where V must be applied in order to produce equal pressures on all piles and the actual point of application of V (see Fig. 2).

N_1, N_2, N_3, …….. Nn = number of piles in rows 1, 2, 3, …….. n, respectively (see Fig. 2).

Nt = total number of piles supporting the wall, pier or abutment under consideration.

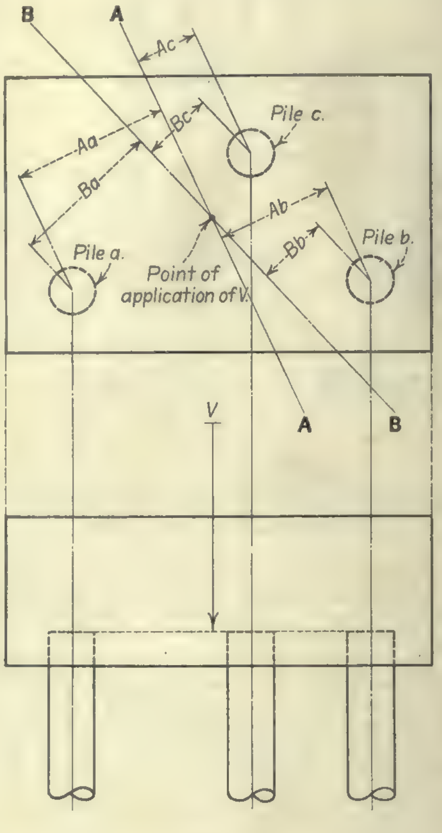


Fig. 1

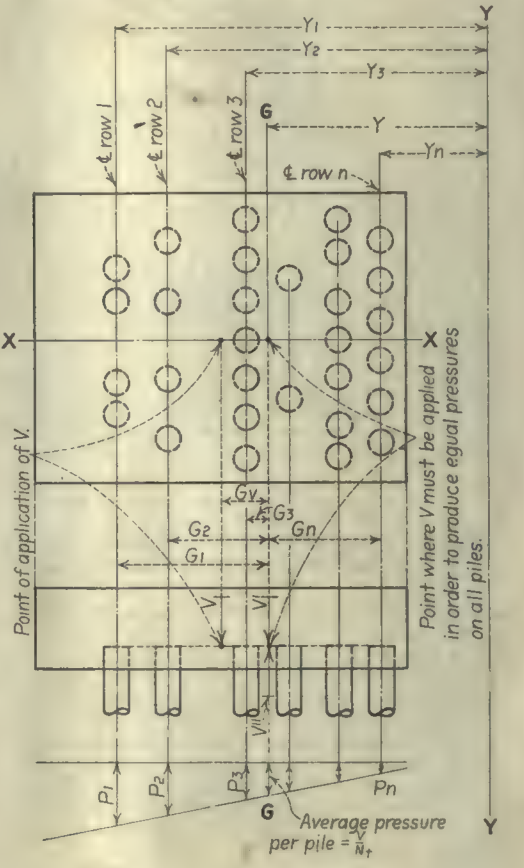

Y
Y1
Y2
Y3
G
Y
Yn
℄ row 1
℄ row 2
℄ row 3
℄ row n
X
X
Point of application of V.
Point where V must be applied in order to produce equal pressures on all piles.
Gv
G3
G2
Gn
G1
V'
V
V''
P1
P2
P3
Pn
G
Average pressure per pile = V/Nt
Y

Fig. 2

Diagrams Showing Nomenclature Used in Developing Formulas for Pressures on Supporting Piles.

Pa, Pb, Pc = total vertical pressure on piles a, b and c, respectively (see Fig. 1).

P'_1, P'_2, P'_3, …….. $P'n$ = vertical pressure per pile on piles in rows 1, 2, 3, …….. n, respectively, due to force V' (see Fig. 2).

P''_1, P''_2, P''_3, …….. $P''n$ = vertical pressure per pile on piles in rows 1, 2, 3, …….. n, respectively, due to couple V''—V (see Fig. 2).

P_1, P_2, P_3, …….. Pn = total vertical pressure per pile on piles in rows 1, 2, 3, …….. n, respectively (see Fig. 2).

V = vertical component of resultant of loads supported by the piles.

V' and V'' will be referred to later.

Y_1, Y_2, Y_3, …….. Yn = perpendicular distance between Y—Y line and rows 1, 2, 3, …….. n, respectively (see Fig. 2).

Y = perpendicular distance between Y—Y line and point where V must be applied in order to produce equal pressures on all piles (see Fig. 2).

SOLUTION OF GENERAL CASE.

To comprehend the amount of work involved in analyzing a perfectly general case consider the problem indicated in Fig. 1, where the magnitude of V and its point of application with respect to the piles, as well as the location of each pile, are known.

By assumption (1) all loads are carried by the piles, and therefore,

$$V = Pa + Pb + Pc \quad \ldots\ldots\ldots\ldots\ldots\ldots (a)$$

As the forces are in equilibrium, the sum of the moments of the piles on one side of any line passing through the point of application of V, about the line, must equal the sum of the moments of the piles on the other side of the line, about the line, or

$$Pa\,.\,Aa = Pb\,.\,Ab + Pc\,.\,Ac \quad \ldots\ldots\ldots\ldots (b)$$

$$Pa\,.\,Ba = Pb\,.\,Bb + Pc\,.\,Bc \quad \ldots\ldots\ldots\ldots (c)$$

From equation (b),

$$Pa = Pb\,.\,\frac{Ab}{Aa} + Pc\,.\,\frac{Ac}{Aa} \quad \ldots\ldots\ldots\ldots (d)$$

From equation (c),

$$Pa = Pb\,.\,\frac{Bb}{Ba} + Pc\,.\,\frac{Bc}{Ba} \quad \ldots\ldots\ldots\ldots (e)$$

Equating equations (d) and (e), and solving for Pb there results,

$$Pb = Pc \left[\frac{\dfrac{Bc}{Ba} - \dfrac{Ac}{Aa}}{\dfrac{Ab}{Aa} - \dfrac{Bb}{Ba}} \right] \quad \ldots\ldots\ldots\ldots (f)$$

Substituting this value of Pb in equation (d) there results,

$$Pa = Pc \left[\frac{\dfrac{Bc}{Ba} - \dfrac{Ac}{Aa}}{\dfrac{Ab}{Aa} - \dfrac{Bb}{Ba}}\,.\,\frac{Ab}{Aa} + \frac{Ac}{Aa} \right] \quad \ldots (g)$$

Using the values given by equations (f) and (g) in equation (a), and solving for Pc, we get

$$Pc = \frac{V}{1+\frac{Ac}{Aa}+\left(1+\frac{Ab}{Aa}\right)\left[\frac{\frac{Bc}{Ba}-\frac{Ac}{Aa}}{\frac{Ab}{Aa}-\frac{Bb}{Ba}}\right]} \quad \text{(h)}$$

That this method may be extended to solve problems comprising any number of piles is evident; but that it becomes impracticable if there are too many piles is equally obvious.

In practice, however, the piles generally are, or may be assumed to be, placed symmetrically about a given line, and the point of application of V usually falls, or may be regarded as falling, on this line.

SPECIAL CASES COMMONLY MET IN PRACTICE.

For the purpose of deriving practical formulas, it may, therefore, in addition to the assumptions already made, be further assumed: (7) That the piles are arranged symmetrically about a line passing through the point of application of V.

To analyze a general case under these conditions, consider the problem indicated in Fig. 2.

As before, the magnitude of V and its point of application with regard to the position of the piles are known.

To find the point where V must be applied in order to produce equal pressures on all piles, draw, conveniently distant from the last row of the piles, a line $Y—Y$, perpendicular to the $X—X$ line about which the piles are grouped symmetrically. The point in question is, of course, located on line $X—X$, and its distance Y from the $Y—Y$ line may be found by the following formula:

$$Y = \frac{Y_1N_1+Y_2N_2+Y_3N_3+\ldots\ldots+Yn\,Nn}{Nt} \quad \text{(1)}$$

Having located accurately to scale this point, draw through it and parallel to line $Y—Y$ the line $G—G$, and obtain by scaling the distances G_1, G_2, G_3, …….. Gn, and Gv.

At the point under consideration, we may, without changing the equilibrium, conceive applied two forces, V' and V'', of the same magnitude but of opposite direction, and each equal and parallel to V (see Fig. 2).

The single force V has now been replaced by a direct force V' which will produce equal compressive stresses in all piles, and by a couple $V''—V$ causing compression in the piles located on the same side of the $G—G$ line as the point of application of V and tension in the remainder of the piles.

The pressure per pile on the piles in any row, as row 1, due to the direct force V', may be found by dividing V' $(=V)$ by the total number of piles, or

$$\frac{V'}{Nt} = \frac{V}{Nt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

The stress per pile in the piles located in any row, as row 1, due to the couple $V''—V$, bears a certain relation to the stress per pile in piles located in any other row, as row 2; the stress in any pile being directly proportional to the perpendicular distance between the pile and the $G—G$ line; that is,

$$\frac{P''_1}{G_1} = \frac{P''_2}{G_2} = \frac{P''_3}{G_3} = \ldots\ldots = \frac{P''n}{Gn}, \ldots\ldots \text{(3)}$$

from which,

$$\left.\begin{array}{l} P''_2 = P''_1\,\dfrac{G_2}{G_1} \\ P''_3 = P''_1\,\dfrac{G_3}{G_1} \\ \ldots\ldots\ldots\ldots\ldots \\ P''n = P''_1\,\dfrac{Gn}{G_1} \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

The moment of the couple $V''—V$ $(=VG_v)$ is resisted by the sum of the moments of the stresses in the piles about the $G—G$ line, or

$$VGv = P''_1G_1N_1 + P''_2G_2N_2 + P''_3G_3N_3 + \ldots + P''n\,Gn\,Nn \ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Substituting in formula (5) the equivalent values given by formula (4), and solving for P''_1, we have,

$$P''_1 = VGv\,\frac{G_1}{G_1^2N_1+G_2^2N_2+G_3^2N_3+\ldots\ldots+Gn^2Nn} \quad \text{(6)}$$

The total pressure per pile on the piles in any row, as row 1, is equal to $P'_1 + P''_1$; or by combining formulas (2) and (6),

$$P_1 = V\left(\frac{1}{Nt} \pm \frac{GvG_1}{G_1^2N_1+G_2^2N_2+G_3^2N_3+\ldots+Gn^2Nn}\right) \ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

In formula (7) the plus sign is to be used if row 1 is located on the same side of the $G—G$ line as the point of application of V, and the minus sign if on the other side.

The pressure per pile on the piles in any row, as row 1, being known, the pressure per pile on the piles in any other row can be found graphically by laying off, to any convenient scale through the point where V must be applied in order to produce equal pressures on all piles, the average pressure per pile as given by formula (2), and in its proper position the known pressure per pile, and drawing a straight line through the extremities of these two values. A study of Fig. 2 will make clear the details of the procedure.

If it is found by investigation that some of the piles are in tension, that is, if a pull is being exerted on them, and if it is thought that this pull is too great, the problem should again be gone over, the piles on which the pull is beyond the allowable limit being ignored, as a decrease in the number of piles acting will sometimes materially increase the pressure on the piles farthest away from those in tension.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by R. P. V. Marquardsen, in the June issue of the Journal of the Western Society of Engineers.

Instructions Governing the Inspection of Bridges, Culverts and Waterways on the Missouri-Pacific Ry.

(Staff Abstract.)

The following set of instructions govern the inspection of bridges, culverts and waterways on the Missouri-Pacific Ry.

GENERAL INSTRUCTIONS.

Regular inspection of all bridges, culverts and waterways shall be made as follows:

Section foremen shall give similar attention to each bridge, culvert and channel each time they inspect the track. At least once each week and immediately following any unusual storms, casualties or other unusual occurrences, they shall stop and carefully examine each of such structures.

Supervisors, experienced bridge foremen or inspectors shall make inspections at intervals of approximately six weeks' with such additional and more frequent inspections of certain structures by the supervisor or his proper representative, as may be necessary in special cases.

Roadmasters, when passing over their track, shall give similar attention to the condition of bridges and culverts. In an emergency they shall report by wire to the division superintendent for immediate attention such repairs as they may deem necessary for safety.

The bridge engineer or his inspectors shall inspect, every six months, all girders, trusses, draw-bridges, large trestles and other bridges which may require such inspection, and shall examine the supervisor's inspection notes to see that the inspections are being carried out according to instructions. Records of such inspections shall be kept in the bridge engineer's office and information setting forth the conditions found by such inspections shall be furnished engineering and operating officers to such an extent as may be necessary. This inspection may be merged with the fall inspection below.

A special inspection shall be made each fall, generally during October and November, from which additional information shall be derived for determining the program for renewal, reconstruction, and general repairs during the ensuing year. This inspection shall be made by the engineer maintenance of way or an engineering department representative expert with reference to bridges, delegated by the authority of the chief engineer and the supervisor. In addition the general roadmaster, division engineer, or superintendent, whichever is in charge of the working forces, and the bridge engineer shall accompany the inspection parties as much as possible.

Copies of the notes of the fall inspection, which will be taken by the engineering department representative, will be furnished the supervisor, the superintendent, the engineer maintenance of way and the bridge engineer. The latter shall specify the improvement items which must be given special attention, each of such items to be worked out on its merits and covered by an A. F. E.

Recommendations for permanent structures shall be checked by the engineer maintenance of way and bridge engineer. The engineer maintenance of way shall certify to the sufficiency of the waterway, and that the proposed improvement will not interfere with possible changes in grade and alignment. The bridge engineer shall certify to the adaptability of the proposed structure and jointly with the engineer maintenance of way shall certify to the sufficiency of the waterway.

From the report of inspection and examination, as above, the character and extent of renewals and improvements will be determined. All changes, additions or expensive renewals of bridges, culverts or other important structures shall be made only upon properly approved plans, estimates and instructions of the engineering department, and when authorized by an approved A. F. E.

The receipt by the operating officers of a copy of the notes of the fall inspection, shall be understood as instructions for them to arrange for and to proceed with all repair items on bridges except those that will be covered by A. F. E.'s.

It will be the duty of the general roadmaster, division engineer or superintendent (whichever is in charge of the working forces on the division) to give bridge inspection and maintenance such attention as will insure that inspections are being made as required, that the work is proceeding consistent with the inspection notes, and that the structures are being maintained safely.

The roadmaster shall arrange to obtain the records of extreme high water at the time of each flood or extraordinary freshet, at all bridges, culverts and openings. Section foremen shall be instructed to go over their sections at such times and take the measurements from top of tie to the extreme high water mark, and report such measurements, giving the number of the bridge or opening to the roadmaster, who will furnish the information to the superintendent. The superintendent will forward copies of these data to the bridge engineer and engineer maintenance of way for record.

Monthly reports on the proper blanks shall be made by the supervisors, through the division office to the bridge engineer.

INSTRUCTIONS TO INSPECTORS.

(The numbers and directions in the inspection notes correspond with the numbers and abbreviations on the report blanks.)

Inspection note books shall be filled out at each structure after a careful examination has been made of each of the points itemized in the blanks, using, in cases where there are a number of spans in which defects are observed, a properly noted column for each span. When the spans are all in good condition, one column only need be used, but the number of spans should be noted.

Designate the separate spans of a bridge by numbering them in the direction of the bridge numbers on the division, and the separate bents or piers in the same manner, commencing with the abutment, bank bent or sill as number one. Designate the truss as the right or left, locating points on it by numbering the panels in the same direction as the spans are numbered.

When wooden structures are six or more years old, such members as by their position are particularly liable to decay shall be tested by boring, the holes being plugged up as soon as the inspection is completed.

When making the regular inspections the inspectors shall make a statement of the results of the last examination relative to such structures as required attention at that time, and in reporting on these structures special note shall be made as to whether or not the repairs and recommendations of the previous examinations have been fully carried out, and whether the work is in accordance with the standard plans.

INSPECTION NOTES.

1. Does the waterway require straightening, cleaning out or enlarging above or below the structure? Does the structure afford ample waterway? Is riprap needed to maintain the channel or protect the roadway?

2. Note the line and surface, also the condition of rails, joints and fastenings on bridges and approaches. See that rails are braced on curves where necessary, and that the track on the approaches is firmly bedded, avoiding shock or jolt to a train as it passes onto the bridge.

3. Note any rotten, split or otherwise defective bridge ties, giving the number, size and kind.

4. See if the guard rails are in line and bolted or spiked down tight. See if they are sound.

5. Note the condition of caps and stringers, particularly at points where they bear against other members.

6. Note if plumb and batter posts are crooked, split or decayed, and if the bents stand plumb.

7. See if trestle towers or bents are properly sway-braced, and all braces longitudinal and transverse are drawn up tight and have sufficient bolts or spikes to hold them properly.

8. Note particularly the condition of piles where they enter the ground or water. See that they stand properly.

9. Examine each pier and abutment as to joints, settlement, imperfect stones, cracks and other defects. Note if the work needs pointing or if cracks have opened since the last inspection. If the masonry is cracked or if any settlement or movement is detected, make such sketches and record such measurements as will enable the kind and amount of motion to be determined on a later inspection.

10. Note the condition of pedestal stones and make note of any debris on the bridge seats or around bridge bearings. Note if water collects on bridge seats and how the trouble can be remedied.

11. Note the condition of riprap, if any. If riprap is needed to protect foundations from scour, make note of the quantity required.

12. Note the condition of culverts and retaining walls and see if they are yielding by settlement or bulging from the pressure of the embankment.

13. Note the condition of the ring or covering stone of box or arch culverts.

14. Note the condition of paving and riprap, and see that same is so placed that it can not be undermined by washing.

15. Does culvert pipe need head or tail walls to protect the embankment from washing? Does it clean itself of water? Are any joints settled down or broken in?

16. Does a timber box need to be replaced with masonry or culvert pipe? If so, give the dimensions required to give ample waterway, and give the height from bottom of stream to rail.

17. See if bed plates and rollers are clean, and if the latter stand so as to move squarely back and forth with the trusses. See if the pedestals take even bearing on the rollers. Examine anchor bolts.

18. Observe particularly the condition of all timbers where corbels, wall plates or bolsters rest upon them. Note any appearance of crushing or decay.

19. Angle blocks and all cast iron members such as chord boxes, post shoes, etc., must be examined for cracks and for any indication of displacement by reason of the daps splitting or the timber crushing. A hole ¼ in. in diameter, if drilled at the end of a crack, will frequently stop its extending farther.

20. See that all chord and packing bolts are tight. Nuts on all bolts through guard rails, ties, stringers and floorbeams must be secured in place by burring the threads of the bolts at two or three places with a center punch or cape chisel.

21. Note the condition of the galvanized iron covering of chords and end posts of combination spans and of stringers and caps in trestles.

22. Notice particularly the connections between stringers and floorbeams; note if connecting angles are split, either in the angle or through the line of the rivet holes. Note the condition of the wooden stringers as to soundness and bearings.

23. Notice particularly the connection between floorbeams and trusses for evidence of imperfect bearing, or splitting of the connecting angles. If suspended, notice if they are up tight against the post feet, or are free to move.

24. Test the equality of the tension in the tie bars by springing them. Look for any signs of distortion or crookedness in the bars or the end panels of bottom chords. Counter, lateral and vibration rods must never be allowed to hang loose. They must not be adjusted while a load is on the bridge. They should be tightened enough to give close and even bearings, but must not be overstrained, as unnecessary strains are put in compression members if too much power is used in adjusting tension members. See that the center line of all tension members is the same as the line of strain.

25. See if posts, lateral struts and top chords are straight and free from twists. On wooden bridges see if braces are up in place, taking a square bearing at the ends, and note if any warping is evident. Note their condition as to soundness.

26. Examine all lateral connections, and see that lateral tension members are straight. Examine the bracing in steel trestles.

27. Make particular examination of all hangers, testing each nut to see that it is tight. A streak of white paint drawn across the nut and bearing will indicate any movement. These nuts should be screwed up tight and secured by burring the thread of the bolt and nut at two or three points with a center punch or cape chisel.

28. Note any pins which indicate movement of the members coupling on them, or that have loose nuts. All pins and nuts should have a streak of white paint across the nut and pin end.

29. All field-driven rivets in floorbeams and stringer connections and in the bottom of chord splices should be sounded lightly to see if they are tight, also lateral connection rivets in riveted trusses, and any intersection or other rivets which indicate by rust streaks, or otherwise, that there is movement at that point.

30. Note if there are any members, such as closed columns, pedestals, etc., which catch and retain water by reason of not having proper drain holes.

31. Note carefully the line of each truss by the top chord and by points on the floorbeams equidistant from the centers of the posts. Also note by the top and bottom chords whether the camber is true and uniform or irregular.

32. Look for loose rods, hangers, loose braces, unequal sized timbers and other defects which require adjusting in order that each of the different parts may have proper bearings and carry its proper part of the load.

33. Note any undue vibration or excessive deflection of the structure under live load, seeing if the two trusses have the same deflection.

34. See if any rust spots are apparent under the paint. Note if the structure needs repainting. Steel bridge work should be scraped and repainted as often as necessary to preserve from rusting. If painted recently, note the quality of the work.

35. Note such wooden structures as require barrels to add to their safety, giving the number required. State the condition of such barrels as may be in position. On all bridges of such magnitude as to require a watchman, there should be a foot plank between the rails, securely fastened to the ties to facilitate crossing the bridge quickly in emergencies, such as fire or danger to trains. Note if ladders, either fixed or portable, are required for the safety of the structure or to facilitate inspection.

36. See if material, driftwood, weeds, grass or other rubbish is properly removed and burned, or otherwise disposed of.

37. Note and report how much one end of a span kicks up when a train is on the opposite half of the span. Examine the end wedges for full and even bearing when driven. Examine worms and worm wheels for wear and breakage. Examine the shafting and gears to detect loose boxes and couplings, lost keys and broken or cracked gear teeth. Note the condition of the track at the ends of the span. Examine end ties, rail locks and rail sections to detect wear and loss of rigidity.

Note if the bearings under the end wedges are bolted down securely to piers. See that wedges, worms and bearings are properly cleaned and lubricated and that no accumulation of dirt or rubbish is permitted around center or end machinery. Note if friction clutches on the engine are worn or otherwise out of order. Note the general condition of machinery as to cleanliness, lubrication and adjustment.

ACKNOWLEDGMENT.

The foregoing instructions were abstracted from the report of a committee of the American Railway Bridge and Building Association, presented at the annual meeting of the association in Detroit, Oct. 19-21, 1915.

Rapid Assembling of Dredge.—The assembling of the new 15-yd. dipper dredge Cascadas was completed October 30, and the dredge has been placed at the bases of the Culebra slides.

The rapidity of assembling the Cascadas establishes a new record for such work. The assembling of the dredge Gamboa required 30 days, and the dredge Paraiso was completed in 14 days, and notwithstanding the fact that special arrangements had to be made for assembling the Cascadas, on account of not being able to bring the dredge to the dock at Paraiso, the work was completed in a little over seven working days. The forces of the Dredging Division began work on the Cascadas on her arrival at Gamboa about 4 p. m., Friday, October 22. No work was done on Sunday, October 24. The exceptionally fast work is accounted for by the fact that the senior dredge men were taken off of the dredges Gamboa and Paraiso and placed on the Cascadas; and also by the fact that the Dredging Division rigging gang has become expert in handling the heavy parts. Work was also facilitated by the ability of the 250-ton crane Ajax to handle the heavy parts quickly, and by rush work performed by the Paraiso shop men on the job, in view of the urgent need of the dredge in the Cut.

The Cascadas is of the same type as the Gamboa and Paraiso, but several feet broader in the beam and has some improvements over the earlier dredges, notably in the case of gantry for handling the spuds and the addition of the third boiler, eliminating the 48 or 56 hours necessary for cleaning boilers.

GENERAL

Construction Plant and Methods Employed in Concrete Lining a Double Track Railway Tunnel Under Traffic.

Contributed by Rodman Meacham, Vice President and General Manager, Meacham Contracting Co., Hopkinsville, Ky.

The Diana Tunnel of the Louisville & Nashville Railroad is located about 68 miles south of Nashville, Tenn., on the new double track, low grade, main line to Birmingham on which work was started in 1912. The tunnel is 1,520 ft. in length. It was excavated through a limestone and shale formation, and required temporary roof timbering throughout. This timber had to be removed in the north end for the concrete section, but was left in place in the south 1,200 ft. of the tunnel where, after it was demonstrated timbering would be necessary, the excavated section was enlarged.

It was at first the intention to pour the side walls, using an incline and hoist to haul the cars of mixed concrete up to the spring line where they could be dumped directly into the side walls. Under this original plan the arch section of the concrete would have been dumped on a platform and shoveled and packed into the arch by hand.

After investigating the pneumatic method of placing concrete, however, the estimate of cost indicated the economy of blowing concrete through an 8-in. pipe directly into place, using a steel tunnel form built to the full section of the tunnel. This method had the advantages of permitting trains to pass through the tunnel, without interfering with concreting work, and made it possible to pour the full section of tunnel in a single operation. It also eliminated a cumbersome incline and hoist which probably would have caused some delays to the regular traffic of the road.

The pneumatic method was therefore adopted for the work to be used with two 35 ft. sections of steel forms of the Blaw type, built on travelers. The work was started Jan. 19, and completed Oct. 22, 1915, making a total of nine months, during which there was an average of 20 trains per day through the tunnel, with a total delay to traffic of less than two hours. This is considered remarkable, as some delays were fully expected. Speed of all trains through the tunnel while work was in progress was restricted to six miles an hour for safety.

FORMS.

A drawing of the traveling forms is shown in Fig. 1. They consisted of steel plate side walls to the spring line and 2½-in. by 5½-in. yellow pine lagging over the arch section. The side walls were stiffened with vertical I-beams and two waling pieces of two 4x8-in. timbers placed horizontally against these I-beams through which anchors passed. These anchors were fastened to the rock side walls using split point anchor bolts, set into the rock about 10 ins., to afford a rigid support for the side wall forms. There were also two diagonal tie rods and one horizontal tie rod near the bottom of the forms which were used to hold the form rigid while being moved, but these rods were found to be unnecessary after the first move and were discarded, thereby removing all obstructions to traffic. It was necessary to build the footing course of concrete ahead of the forms so that the bottom steel plate would fit up against the concrete footing as shown in Fig. 1. The forms were moved by opening the doors M-7 at the haunch of the arch. When the doors were opened the 16-in. jacks were lowered about 2 ins., bringing the arch section away from the concrete. After this, the diagonal stay braces B-1, were unbolted and the turn buckles M-1 were pulled in to move the side walls away from the concrete at the spring of the arch. The wall forms were pulled away from the concrete at the base simply by inserting a crow-bar between the rails on which the forms traveled, and the steel frame which carried the wheels, and prying the forms away. This was possible as there was enough play in the wheel axles to allow for the side movement.

The forms were first set up at the south end of the tunnel, one at the portal and the other about 350 ft. from the portal. As lining was placed they were moved north 35 ft. at a time until form No. 2, reached the center of the tunnel, and form No. 1, reached the starting point of form No. 2. During this part of the work the mixer plant was located at the south end of the tunnel about 75 ft. from the portal, but for the balance of the work it was moved to the north end of the tunnel. After form No. 2 reached the center of the tunnel it was moved ahead to the next position for concreting to a point about 350 ft. from the north end, and form No. 1 was moved ahead to the center of the tunnel to continue the work where the other form had left off. The forms were then moved ahead until form No. 2 reached the north portal and form No. 1 reached the starting point of form No. 2. Figure 2 is a view showing an engine passing under the forms—concreting was going on while this view was taken.

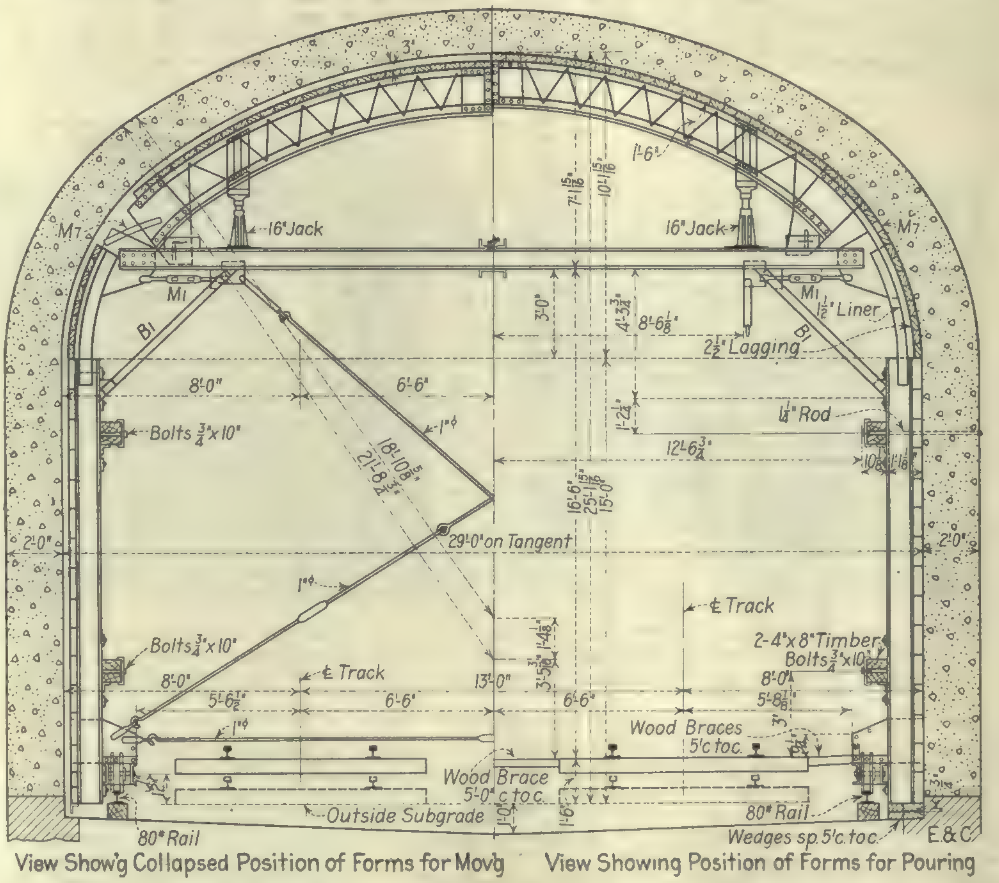


Fig. 1. End Elevation of Forms and Traveler Used in Concrete Lining the Double Track Diana Tunnel, of the Louisville and Nashville Railroad, Under Traffic, by the Compressed Air System.

THE PNEUMATIC MIXER PLANT.

The pneumatic mixer during the first half of the work was located about 75 ft. outside the portal of the tunnel. At this point the mixer was in the deep approach cut and the top of the cement house and stone and sand bins erected above the mixer was some 30 ft. below the top of the rock sides of the cut. A large pile of spoil rock excavated from the tunnel had been deposited on the east side of the cut above the mixer plant. This rock was crushed on the site, screened and dropped through a gravity chute into the bin below within the cut. Sand was brought in cars from Jacksons Lake, Ala., and unloaded into the bins by means of a derrick set at the top of the cut, which handled a large bottom dump bucket.

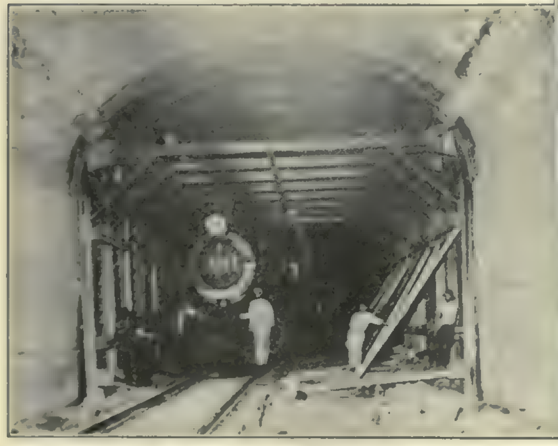
When the bins were built, the mixer was placed beneath with a measuring hopper directly above it for measuring 10 cu. ft. batches. A working platform was built at a convenient level for the measuring hopper and this platform was extended to the full area underneath the bins and occupied for cement storage. The bins for stone and sand above contained space for about 140 cu. yds. each. The cement storage capacity was about four cars.

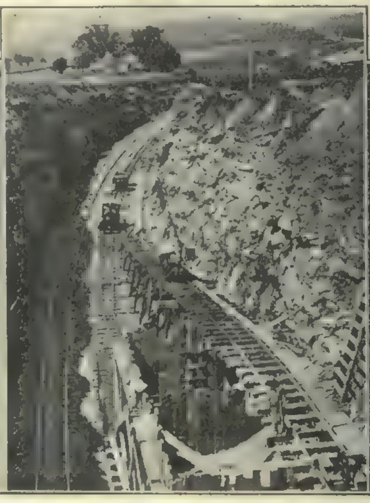
METHOD OF HANDLING.

From the pneumatic mixer an 8-in. standard steel pipe was carried to the forms. The pipe was laid along the ground and at the forms it turned vertically with a long radius 90° elbow and at the top just before turning horizontally through the bulk-head over the crown of the arch the pipe was divided by means of a "Y" connection into two 8-in. lines which passed over the crown of the arch. The "Y" connection is particularly useful in a double track tunnel where the width of the crown is so great that it is difficult to change the pipe rapidly in directing the concrete from one side wall to the other. The "Y" connection is shown in Fig. 3. It consists of a casting with Y branches at about 22½° deflection. The concrete passes through one of the branches and is obstructed in the other branch by means of a sliding plate. To switch the flow of concrete from one branch to the other, it is necessary only to slide the plate from one side to the other. This is done by a couple of blows from a sledge and requires but a second's time so that it may be accomplished after a batch has passed and before another batch is blown through, without the necessity of holding up or even notifying the operator of the pneumatic mixer.

The two 8-in. pipes passing over the crown of the arch reach about 20 ft. or midway into the forms and at that point turn through a 90° elbow to each side wall, and at the end of the elbow a 9 ft. length of 8-in. hose is suspended. While the concreting is going on two men with ropes attached to the end of this hose, station themselves at the ends of the form so that they can pull the hose forward and back and deposit the concrete evenly along the side wall. After sufficient concrete has been poured to bring the side wall up from 2 to 6 ft., depending on thickness, the concrete is diverted through the other side of the "Y" and deposited in the opposite side wall to balance the weight against the forms.

When the concrete reaches a point too high for the use of the hose, this is detached while concreting is going on at the other side, then concrete is discharged directly from the elbow until the space is filled up close to the end of the elbow and the concrete during this period of the pouring is distributed by means of hoes and concrete rakes. This brings the level of the concrete up to a point nearly level with the top of the barrel of the arch form, and leaves a space remaining to be filled approximately 10 ft. wide from zero at the sides to 18 ins. in height over the crown. The 90° elbows are then removed from the ends of the pipe and a short hose is attached to one of the 8-in. pipes, the other pipe being removed. Concrete is then shot against the rear and built up to the end of the hose after which this hose is removed and the concrete is shot straight ahead from the end of the pipe until the key is completed.





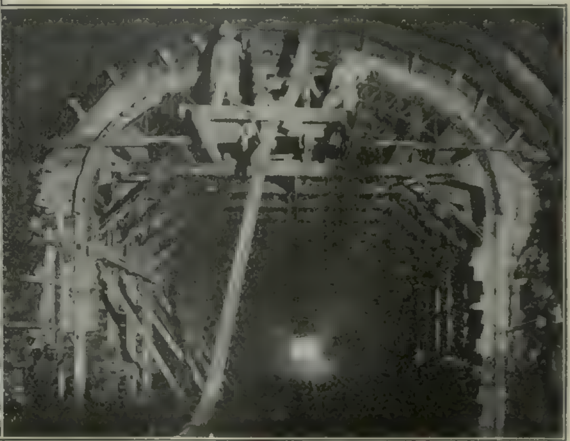


Fig. 2. View Showing a Locomotive Passing Under Steel Concrete Forms Used in Concrete Lining the Diana Tunnel Under Traffic. —Fig. 3. View of North Approach to Diana Tunnel Showing Bins, Incline and 4 cu. yd. Car of Crushed Rock. Dinky Engine and Crusher Plant in the Distance.—Fig. 4. View Showing the Y in the Concrete Delivery Pipe, Forms and Roof Timbering.

PACKING.

At the north end of the tunnel the temporary timbering was removed as concreting progressed and considerable breakage in the roof left cavities of various depths which it was necessary to fill up either with concrete or some variety of packing. Where packing was used it was placed with the pneumatic machine. The material consisted of a mixture of 75 per cent limestone screenings and 25 per cent sand. This was blown in, filling the cavity completely and packing it tightly so that the weight or any pressure from rock settlement was evenly distributed over the barrel of the arch through the packing.

COMPRESSOR PLANT.

The compressor plant consisted of two Ingersoll-Rand steam driven compressors, which delivered at the mixing plant about 1,000 ft. of free air per minute. The same steam plant and a Cameron duplex pump furnished water for construction purposes and camps.

GENERAL.

After the mixer plant was moved from the south portal to the north portal the crusher plant was located about 2,000 ft. north of the mixer and this required the handling of the crushed material in 4-yd. narrow gage dump cars hauled by dinky locomotives. These cars were hauled from the crusher plant to the base of an incline at the bins and were pulled up the incline by means of a cable from a Munday hoisting engine, located under the bins. A view of this plant as located at the north portal is shown in Fig. 4.

It was found that the 8-in. pipe used wore out first at the joints as the pipe was thinnest there on account of the threads. One thousand feet of standard pipe was purchased at the beginning of the work, and after the work was half completed 300 ft. of well casing with Van Stone joints was purchased. This well casing was found to be well adapted and did not give trouble through wearing at the joints as did the standard pipe. Another advantage of the Van Stone joints was their flexibility, as about 5° deflection could be obtained in this joint without a strain on the flange. Of the entire amount of pipe purchased, which was bought second hand, about half of it was still in very good condition at the close of the work after having some 11,000 cu. yds. of concrete blown through it. The elbows used consisted of cast manganese steel and also of bent pipe. The manganese steel elbows were purchased at the beginning of the work and were still in good shape at the end, having shown very little wear. The manganese steel elbows were, however, very heavy, weighing about 400 lbs. for a 90° bend and for this reason the pipe bends were used over the crown of the arch where handling pipe was difficult. The pipe bends weighed about 125 lbs. each and were worn through on the outside of the curve, and when worn through a "half sole" or patch was clamped over the worn part which usually lasted for another 500 cu. yds.

At the beginning of the work, the engineers permitted the moving of the forms after six days, but after a time this period was reduced to four days. In all there were 41 form sections, each approximately 35 ft. long and containing about 250 cu. yds. in each section. The longest distance which concrete was transported was 925 ft. and the average distance was about 400 ft. The average time to concrete one 35-ft. section was approximately 24 hours, although some forms were filled in 15 hours. The number of men required to mix and place the concrete was 13, including 3 men in the bins, 1 operating the gate levers, 1 to level off the measuring hopper containing the batch, 1 man on cement, 1 mixer operator, 1 man on the conveyor pipe, 1 attending to the bulk-heads and 1 foreman and 4 men helping in the forms. A gang of 10 men was employed constructing footings and to move and set the forms.

The work was done by the Meacham Contracting Co., of Hopkinsville, Ky., sub-contractors for Walton & Co., of Falls Mills, Va., who excavated the tunnel. Mr. C. B. Fritchie was superintendent in charge of the work for the Meacham Contracting Co.

The forms were furnished by the Blaw Co., of Pittsburgh, and the pneumatic mixer and conveyor was furnished by the Concrete Mixing & Placing Co., 123 W. Madison St., Chicago. The work was done under the supervision of Mr. H. C. Williams, chief engineer of construction for the Louisville & Nashville R. R., and Mr. Geo. B. Bryson, resident engineer, in direct charge for the railroad company.

Some Data on the Preservation of Ties.

(Staff Abstract.)

In 1904 the cost of ties on the Baltimore & Ohio was $121 per mile of track maintained. By 1912 this cost had increased 70 per cent, and in 1913 the increase was 109 per cent. The amount of money involved is large, for, next to fuel, ties constitute the largest single item of material cost on the railroad. In 1913 the Baltimore & Ohio spent over $2,200,000 for ties. This cost does not include ties for construction work, or the labor of putting the ties in the track.

In the campaign for the conservation of the nation's resources the railroads can materially assist, as the cheaper, inferior and more plentiful woods, such as red oak, beech, elm, etc., can be so protected by treatment that they will last as long, or longer in some locations, as the best white oak. This makes it feasible to use woods not otherwise easily marketable, and thus prolongs the existence of white oak timber, a species which, if there were no tie-treating plants, would soon cease to exist.

The wood-preserving industry in the United States has been built up largely on crossties and other railroad material. Out of a total of approximately 150,000,000 cu. ft. of wood treated in 1913 nearly 80 per cent were railroad ties, and probably 10 per cent other railroad material.

Although nearly 30 per cent of all crossties used annually received a preservative treatment less than 0.5 per cent of the total consumption of manufactured lumber is treated. If the crossties and the ten billion feet of lumber which fail from decay annually were properly treated it would effect a saving of at least $100,000,000 per year.

Chemical treatment of timber in this country, on what might be considered an extensive scale, was first undertaken by the Atchison, Topeka & Santa Fe in 1885. Up to that time there were only 3 pressure plants in existence; at the close of 1890 there were 8 plants; in 1900, 15 plants; in 1905, 34 plants; in 1910, 74 plants, and in 1914, 96 plants.

The first recorded use of treated crossties was in Maryland in 1838, and the first treating plant, which was in the form of open wooden tanks, was built in Lowell, Mass., in 1848. The preservative used at this and several of the other earlier plants was bichloride of mercury. The first permanent railroad plant using creosote was built by the Louisville & Nashville at West Pascagoula, Miss., in 1876.

The total number of ties treated in the year 1885 was about 120,000, which was approximately 0.25 per cent of the estimated number of ties used during that year by all the railroads in the United States. The number treated annually increased amazingly, and in the year 1913, 40,260,000 ties received preservative treatment, being about 28 per cent of the entire number purchased by the steam and electric railroads during that year.

The number of ties treated in 1914 exceeded the total of 1913 by over 3,000,000. The hewed ties treated comprised about 70 per cent of the total, or about 30,000,000, while approximately 14,000,000 were sawed. Ties of the red oak family lead in the number treated, followed by southern yellow pine, then in order of importance come Douglas fir, western pine, beech, gum, tamarack, maple, birch and elm.

When we consider wood preservation in its broadest aspect we include the prevention of loss by reason of using an expensive wood, or special costly sizes, where cheaper kinds would serve equally well. W. H. Clifton, lumber agent, in a paper read at the railway storekeepers' convention this year brought this out very clearly. He said: "As in other lines of industry, there are certain practices which are followed in the use of lumber in railroad shop and building work today, which have been unchanged for many years, regardless of the decrease in the supply and increase in the cost of the lumber used, or in fact that other kinds of lumber, equally well adapted to the purpose, are more easily and cheaply obtained."

After citing various incidents showing the prevalence of such practices, he concludes: "A remedy is not hard to find or difficult to administer. Usually a little educating of the consuming forces in the possibilities of substituting, with a view of economy, brings the desired result, for the average mechanic on a railroad is not averse to saving money for the company if some one will show him how to do it and co-operate with him in accomplishing the desired result."

Ties are purchased by the purchasing department. They are inspected by the timber preservation department and put in track by the maintenance of way department. Ties for treatment are shipped direct to the treating plant, and those to be used without treatment are distributed along the right-of-way and used in track as required. Ties received at the treating plants are cribbed in piles seven and one for seasoning. The seasoning period varies from four to twelve months, depending on the kind of wood.

White oak is rapidly increasing in price, and within a few years will doubtless be as little used for crossties as black walnut or other expensive woods. Chestnut and cedar are too soft for crossties, except under comparatively light traffic. The alternative is to utilize the inferior woods, such as the red oak family, beech, elm, etc. These woods decay rapidly when in contact with the ground. Preservative treatment makes them as good as or even better than the more costly woods.

One natrually wants to know what is really saved by going to all of this expense and trouble to treat crossties. A number of tables have been prepared and as many different estimates made to show the enormous saving in treating timber. There are so many factors to be taken into consideration that it is difficult to show what the average saving will be on a large railroad like the Baltimore & Ohio, which has upwards of 8,000 miles of track.

Mr. Emerson has kindly submitted the following, showing the total and annual cost of treated ties compared with untreated white oak ties:

	Treated, each.	Untreated, each.
(a)		
Purchase price	$0.547	$0.717
Inspection	.015	.015
Treatment	.23	......
Freight	.112	.067
Unload and pile	.02	.02
	$0.924	$0.819
(b)		
Truck to point of use	.01	.01
Install in track	.28	.28
Truck and burn old tie	.01	.01
Two tie plates	.24	.08*
Four spikes	.05	.05
Interest on (a) (6 months on untreated, 12 months on treated.)	.056	.025
	$1.570	$1.274
Supervision on (b) 5½ per cent	.086	.070
	$1.656	$1.344
Credit salvage, one-third value tie plates and spikes	.097	.043
	$1,559	$1,301

*Cost of one-third of two tie plates, assuming that one-third of the untreated ties are tie plated.

Annual cost per year, including 6 per cent interest with assumed life of 14 years, treated, each $0.20; of eight years, untreated, each $0.24; a difference of $0.04.

If we assume the production of treated ties to continue at its present rate, viz., 1,000,000 per annum from Green Spring, and 200,000 per annum from commercial plants, a total of 1,200,000 per annum, the saving would be as follows:

Saving the first year, 1,200,000, at $0.04	$ 48,000
Saving the second year, 1,200,000, at $0.04 continues and there are also introduced another lot of 1,200,000, the total annual saving then being, at $0.04	96,000
Third year	144,000
Fourth year	192,000
Fifth year	240,000
Sixth year	288 000
Seventh year	336,000
Eighth year	384,000
Ninth year	432,000
Tenth year	480,000
Eleventh year	528,000
Twelfth year	576,000
Thirteenth year	624,000
Fourteenth year	672,000
From fourteenth year on, this annual saving is continuous at	672,000

The Baltimore & Ohio uses more than 2,000,000 ties annually for renewals. It would not be proper to treat all of our ties because many are destroyed by mechanical abrasion, and for some years to come more or less white oak, cedar and chestnut ties will be purchased, which we use untreated. If we estimate the number of treated ties that could be used to advantage on the Baltimore & Ohio at 1,700,000 a year, and if the saving on this number is placed at the lowest estimate, viz., 4 cts. per tie, the total net saving would be $68,000 for the first year, increasing a like amount each year until all ties put in track are treated ties.

As there are approximately 25,000,000 ties in track, and if we estimate 21,000,000 are treated, the net annual saving would be $840,000.

To centralize the tie business this department has been instructed not only to treat ties, but also inspect them before purchase, and when proper methods have been devised, it will also distribute the ties in accordance with orders from the maintenance of way department. As a further safeguard to insure the full life of ties after they are put in track this department will have inspectors travel over the road to note the condition of the ties taken out of track and determine whether or not they have been removed before their full life has been attained.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by F. W. Angier, superintendent timber preservation, Baltimore & Ohio R. R., presented before the Baltimore and Ohio Operating Officers' Association, in June, 1915.

There is considerable waterworks construction in Southern India at present owing to new enterprises and also to the fact that municipalities or the Government have found it necessary to replace existing plants. In at least one town it is said that the council has decided to endeavor to obtain American pipe.

Experience with Cement Guns in Levee Revetment.

(Staff Abstract.)

Some 500 miles of Mississippi River levee, it is stated, must eventually be protected against wave action by revetment. Concrete revetment costs generally about as much as the original levee. In experiments made on the Fairfield levee Major Sherrill sought, among other things, to reduce the cost of revetment. A layer of gravel was placed on the levee. Into this mortar was blown with a cement gun to form concrete in situ. Penetrations of 4 ins. were readily obtained. The resulting revetment, when 2 ins. thick, proved about as strong as a 4-in. layer of 1:4:7 concrete and cost only two-thirds as much.

The experiments were so thorough and promising that Maj. W. G. Caples, U. S. Engineer Corps, purchased a cement-gun plant (Chicago type) and has used it for the past season (1915) on levee revetments. The plant has done generally what was expected of it, but in its operation a good many experiences were had, the relation of which may be helpful to other beginners in the use of this machine.

The cement gun was supplied with air through a 2-in. pipe from a 500-ft. straight-line single-stage compressor and with a 125-ft. receiver set in the line. The consumption of free air at 50 lbs. pressure was 300 cu. ft. per minute. Five cubic yards of dry materials were handled per hour. The output was limited by difficulties met in field operation. Water was supplied from the river through a ¾-in. pipe.

The principal trouble encountered was clogging of the machine, which was found to be due to three causes—large particles, wet sand, and wet air. The gun is not intended to handle particles retained on a ½-in. screen. Larger particles clog the feed wheel and cause about fifteen minutes delay for their removal. The best sand obtainable would occasionally have some large particles. In the moist atmosphere of this locality, cement stored for any length of time would become lumpy. Wet sand forms lumps with the cement before the mixture can pass through the gun. Uniformity of product requires that the sand and cement be mixed before placing in the gun. All these conditions were met by mixing the sand and cement, screening the mixture through a ½-in. screen, and then feeding the mixture to the gun.

Wet sand causes the cement to set in the gun, destroys gaskets, clogs the feed wheel and delivery hose, and is the most prolific source of trouble. On building construction and coating of metal structures it is possible to protect the sand supply and even to use sand driers, but on an exposed paving job such measures are impracticable. The best remedy found was to keep the sand in small conical piles that would drain easily. A single day's supply can be protected from the weather, but protracted rains cause a lay-up of the plant and add materially to the expense of the work.

Wet air was the result of a climate having 60 ins. of annual rainfall, well distributed, and almost daily fogs during a large share of the working season. The effect of wet air is to cause the cement to set in the air passages, partially closing them and making their cleaning difficult.

The successful manufacture of concrete in situ during the Fairfield experiments was found to be due to having accidentally obtained a gravel with just the right amount of voids. A gravel containing a large share of small particles can be penetrated only about three-quarters of an inch. Experiments with graded aggregate indicate that the gravel should be all retained on a ¾-in. screen and all passed by a 2-in. screen if concrete is to be made in situ. The local price of such gravel made its use out of the question. The small saving in mortar given by a ¾-in. penetration would not pay for handling the gravel. Thus it became economically impossible to make concrete in situ, and work was confined during the latter part of the season to placing a straight 2-in. gunite coating on the levee.

As mortar only was used for the coating, it became necessary to determine the economical mixture. When gunite is applied, from 10 to 25 per cent of the sand rebounds, depending upon nozzle velocity and angle of impact, the sand loss being least at normal impact. The cement all remains, giving a somewhat richer mixture in place than is fed to the gun. Experiments indicated that a 1:4 mortar fed to the gun would give a gunite of the proper strength. Briquettes were taken of this gunite blown into the molds and allowed to cure under water. Tensile tests on these briquettes give the following results:

Age (days).	Number of briquettes.	Pounds per square inch. Max.	Min.	Average.
7	3	194	133	162
28	8	394	321	359

The sand used affects the working of the gun. Very fine sand causes the gun to clog. Coarse sand having many particles just passing a ⅛-in. screen gives the best results. The coarser grains keep the machine and passages scoured clean.

The proper width of panel had to be determined by experiment. The first work was laid in alternate 10-ft. panels with elastite joints, each 50 ft. The frequent moves of the gun were expensive and the joints between alternate panels were not satisfactory. The second work was laid continuously with elastite joints spaced 50 ft. Expansion cracks developed generally at 15 to 17 ft. each side of each joint, although some panels showed expansion cracks only in the middle. Wire reinforced work showed no advantage over unreinforced. The last work was done by setting elastite joints each 20 ft. and blowing on the gunite continuously. The joints were floated to remove gunite extending across them. The rest of the surface was left as laid without floating. This method appears to be satisfactory.

In addition to the foregoing, certain other information was obtained, to-wit:

A 1:4 gunite is denser and stronger than hand-mixed mortar of the same or considerably richer mixture. For levee paving, reinforcement in gunite is uneconomical and unnecessary if care is taken in placing expansion joints.

Expansion joints should be set in place with wire nails, as wooden pegs swell and cause cracking. The replacement of 20 per cent of the cement with hydrated lime reduces cracking, but is difficult to accomplish if the mixing is exposed to high winds.

Gunite bonds almost perfectly with old work. Gunite can be successfully shot through 200 ft. of flexible pipe of uniform diameter if the materials are dry and 70 pounds air pressure is used. The delivery pipe will clog at any point where its diameter changes.

The ability to blow the gunite 200 ft. explains why a pure mortar coat can be used instead of concrete. The batture is generally from 75 to 200 ft. wide. Between the water's edge and the levee is generally a fresh pit full of water. All material has to be moved by hand under exceptionally difficult conditions. Two dollars worth of materials becomes seven dollars worth of revetment largely through excessive cost of handling. The cost of handling the gunite is much less.

For repair work, the cement gun easily is superior to any mixer, because the gun can be kept on a barge, reducing installation and moving costs to a minimum, and the gunite has a bond iwth old work superior to any obtainable with ordinary concrete.

Since the work has been in place, too little time has elapsed to tell what will be the ultimate result. Thus far, the 2-in. gunite coating has answered every purpose of a 4-in. concrete coating and has cost only two-thirds as much.

The margin furnished by the cost of handling concrete materials is so great that it seems probable that a concrete plant will be designed especially for levee work and able to do work cheaper than is done by the cement gun. The latter is, however, so excellently fitted for repair work and small jobs that it will have probably no competitor for many years to come.

Extract from an article by Major Caples in "Professional Memoirs," September-October, 1915.

Timber Flume for Water Power in British Columbia.

The power development of the Vancouver Island Power Co., whose hydraulic power dam at Bear Creek was described in our issue of May 21, 1913, required 5.3 miles of timber flume along a steep and broken side hill. Figure 1 shows the plans of this structure built, and gives all essential dimensions and details except as noted in the statements following. The T-bent shown was used only for "intermediate bents" under 12 ft. high between two standard bents. Generally the trestle was low, averaging not over 7 ft. high, but at a few gulch crossings it had two or more decks. The alinements, following this natural contour, was a series of curves, some as sharp as 90°; no serious retardation of the water resulted. Wier measurements indicated for this flume a value of 122 for *c* in Chezy's formula $V = C\sqrt{rs}$. In locating the flume each bent finding was decided and the bent dimensions were computed. From these notes the saw mill at the lower end of this flume cut to lengths all bent members with daps and gains complete. A service railway along the flume line delivered the sawed material. About 5,000M ft. B. M. of lumber were required, or a little less than 1,000M ft. B. M. per mile of flume. Not including hauling or clearing, the cost of lumber in flume was $17.41 per M. ft. B. M., and all lumber was cut at the company's mill and logged from the company's land. The total cost of the flume, excluding again hauling and clearing, was $419.27 per 100 lin. ft., or, say, $4.20 per lineal foot. The preceding data are taken from a paper presented to the Canadian Society of Civil Engineers by Charles A. Lee, engineer in charge of construction.

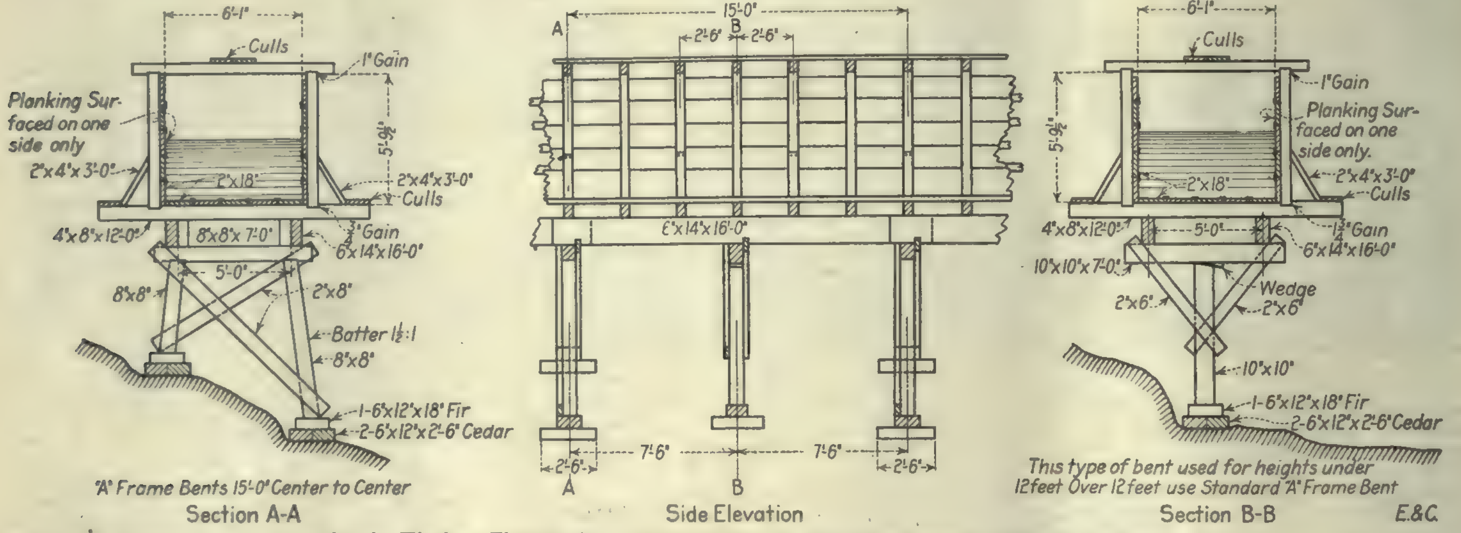


Fig. 1. Timber Flumes for Jordan River Power Development, British Columbia.

Calculations Showing Economy of Constructing the Rogers Pass Tunnel.

(Staff Abstract.)

The calculations showing the economy to be attained over the present alignment by constructing the Rogers Pass Tunnel of the Canadian Pacific Railway are here given.

The data to be taken into account are as follows: Present location, total distance 23.1 miles, revised location 18.68 miles, as shown in Fig. 1; grades are as shown in Fig. 2 and consist, on the present location of 16.65 miles up hill for westbound traffic on maximum grade of 2.2 per cent, 6.45 miles down grade same maximum with a total rise of 1,726 ft. and a drop of 602.1 ft. with 1,860° of curvature on the up-hill and 1,288° on the down-hill portion of the line. The revised location consists of 16.77 miles up hill with about 5 miles of 2.2 per cent pusher grade, the balance 1 per cent and a down-hill run of 1.91 miles with a maximum of 2.2 per cent grade; a total rise of 1,178.2 ft. and a drop of 144.3 ft., with 635° of curvature on the up-hill grade and 66° on the down-hill. The average traffic for the years 1912 and 1913, which is made the basis of calculation, was 1,342½ passenger trains in each direction; the average weight of the passenger trains, exclusive of locomotives, was 443 tons; 980 of the passenger trains required pusher engines; the weight of the passenger and pusher engines for passenger trains was 175 tons each; there were 1,738½ freight trains in each direction per year; the average weight of the freight trains eastbound, exclusive of locomotives, was 950 tons; the average weight of freight trains westbound was 898 tons; all freight trains had to be pushed in both directions; weight of freight locomotives and pushers, 181 tons each. The tonnage eastbound and westbound was as follows:

Eastbound.

		Tons.
1,342½	trains @ 443 tons each	594,727.5
2,322	locomotives @ 175 tons each	406.350.0
1,738½	freight trains @ 950 tons each	1,651,575.0
3,477	locomotives @ 181 tons each	629.237.0
	Total	3,281,889.5

Westbound.

		Tons.
1,342½	trains @ 443 tons each	594,727.5
2,322	locomotives @ 175 tons each	406,350.0
1,738½	freight trains @ 898 tons each	1,561,173.0
3,477	locomotives @ 181 tons each	629,237.0
	Total	3,191,487.5

COMPARISON OF COMPARABLE FACTORS AFFECTING THE COST OF OPERATING OVER ROGERS PASS, VIA PRESENT LINE AND VIA TUNNEL LINE, NOW UNDER CONSTRUCTION, AVERAGE TRAFFIC FOR THE YEARS 1912 AND 1913.

E. B. Tonnage Per Year, Including Weight of Engines, 3,281,890 Tons.

Resistance to Overcome, on Present Line.

	Ft.	Ft.
Actual rise, 692.1 ft.	692.1	
Curve resistance, 1,288° × .04 ft.	51.5	
Friction resistance, 6.45 mls. × 15 ft.	96.7	
Total		840.3

Resistance to Overcome, Tunnel Line.

	Ft.	Ft.
Actual rise, 144.3 ft.	144.3	
Curve resistance, 66° × .04 ft.	2.6	
Friction resistance, 1.91 mls. × 15 ft.	28.6	
Total		175.5
Difference		664.8

3,281,890 tons × 664.8 ft. equals 2,181,800,472 foot-tons.

W. B. Tonnage Per Year, Including Weight of Engines, 3,191,488 Tons.

Resistance to Overcome, Present Line.

	Ft.	Ft.
Actual rise, 1,726 ft.	1,726.0	
Curve resistance, 1,860° × .04 ft.	74.4	
Friction resistance, 16.65 mls. × 15 ft.	249.7	
Total		2,050.1

Resistance to Overcome, Tunnel Line.

	Ft.	Ft.
Actual rise, 1,178.2 ft.	1,178.2	
Curve resistance, 635° × .04 ft.	25.4	
Friction resistance, 16.77 mls. × 15 ft.	251.5	
Total		1,455.1
Difference		595.0

3,191,488 tons × 595 ft. equals 1,898,935,360 foot-tons.

	Foot-tons.
Total work done (extra)	2,181,800,472
	1,898,935,360
Total	4,080,735,832

One thousand foot-tons equals approximately 1 horsepower hour. Assuming that 5 lbs. of coal is consumed in doing 1 horsepower hour's work and that coal on locomotive costs $4.60 per ton, the saving in fuel will amount to:

$$\frac{4{,}080{,}736 \times 5 \text{ lbs.} \times \$4.60}{2{,}000 \text{ lbs. (one ton)}} = \$46{,}928.46$$

Extra Wages Train and Engine Crews.

Present Line.

6,162 trains for 23.1 miles	142,342.2 train miles.
5,437 push. engs. for 23.1 miles	125,594.7 push. eng. miles.

Tunnel Line.

6,162 trains for 18.68 miles	115,106.2 train miles.
5,437 push. engs. for 13 miles	70,681.0 push. eng. miles
Amount saved	27,236.0 train miles. 54,913.7 push. eng. miles.

27,236 train miles at 22 cts.	$ 5,991.92
54,913.7 pusher miles at 25 cts.	13,728.40

Note.—25 cts. to cover engine crew wages, cost of repairs to pusher locomotives and extra cost of maintenance account of running pushers.

Extra cost maintenance of way, 4.42 miles at $200 plus 27,236 train miles at 20 cts.	$ 6,331.20
Extra cost, maintenance of way, account of extra number of degrees of curvature, assuming that 400° of curvature per mile would increase rate at 20 cts. per train mile for maintenance by 30 per cent— 6,162 trains × 2,447° × 1/40 ct.	3,769.60
Special maintenance, account 4½ miles snow sheds	85,000.00
Extra cost, maintenance of equipment, 27,236 train miles at 21 cts.	5,719.56
Extra cost, maintenance of equipment, account of extra number of degrees of curvature, assuming that 400° of curvature per mile would increase rate of 21 cts. per train mile by 40 per cent— 6,162 trains × 2,447° × 21/1,000 ct.	3,166.47
Total annual saving in cost of operation	$170,635.61

The rate at which traffic has been increasing would indicate that shortly after the work of constructing the tunnel was completed the traffic would have doubled. In this case, if no further economies were made in methods of operating this section of track, the annual saving on account of operating over tunnel line would be—

$$\$85{,}635.61 \times 2 + \$85{,}000.00 = \$256{,}271.22.$$

In arriving at the above figure no account is taken of whether line was single or double track and for comparative figures it was assumed that methods of operation would be the same. Now, as a matter of fact, the present single track line with double the present traffic would make the business too congested for economical single-track operation. Therefore, it was apparent that it was time to study the question of double tracking the present line or seeking a new line for double track. It was decided to double track on the 5-mile tunnel location as shown in Fig. 1, with grades as shown in Fig. 2. Now to operate successfully a 5-mile tunnel we will require the installation of an electric plant and the purchase of electric locomotives. All the details of the proposed electrification have not as yet been worked out, but even if they were, the reader is not interested in the details of cost. He can see at once that the problem was to find out if the cost of operating and maintaining the tunnel line, taking into account the extra costs of operating on account of having a short section of electric operation and extra cost of maintaining tracks in the tunnel, plus the interest on the cost of building the new double track line, including the cost of electrifying the tunnel, would be less than the cost of operating and maintaining a double track line on the present location plus the interest on the cost of building the second track. The figures would not have been very decisive one way or the other if not for the fact that there is now 4½ miles of wooden snow sheds on the present location which will be all done away with on the new location. The maintenance and cost of renewals of these sheds cost between $85,000 and $100,000 per year. To maintain and renew a double-track wooden shed would probably cost at least 50 per cent more than the above, so that with a saving of about $125,000 per year in maintenance and renewals of snow sheds and a calculated saving in operation and maintenance of $171,271.22 on a traffic that surely will be reached in the near future, there was no doubt as to the proper course to pursue.

As to the details of figuring economics of railway location, the writer is well aware that it is impossible to devise any method that will show absolutely the saving in cost of operating one line over another, but he believes that the method herein followed, namely, that of comparing cost of fuel on the basis of work done rather than on a train-mile or any other unit, is much more logical and will give more reliable results than other methods that have been followed. The train mile is possibly the best unit for comparison in cost of wages and for cost of maintenance of equipment. In figuring maintenance of way a fixed sum should be taken plus a rate per daily train rather than a fixed rate alone per train mile, for the reason that a certain amount of expense must be incurred regardless of whether trains are run or not. The fixed sum of $200 per mile taken in this problem is probably about one-half the actual sum that would be assumed if the entire cost of maintenance was to be included in this fixed sum per mile plus the rate per train mile for the reason that cost of maintenance of terminals and other items are not affected by the details of location between fixed terminals.

Frictional resistance, normal conditions, warm weather, modern freight equipment, speed between 7 and 35 miles an hour,

$$R = 2.2T + 121.6\ C.$$

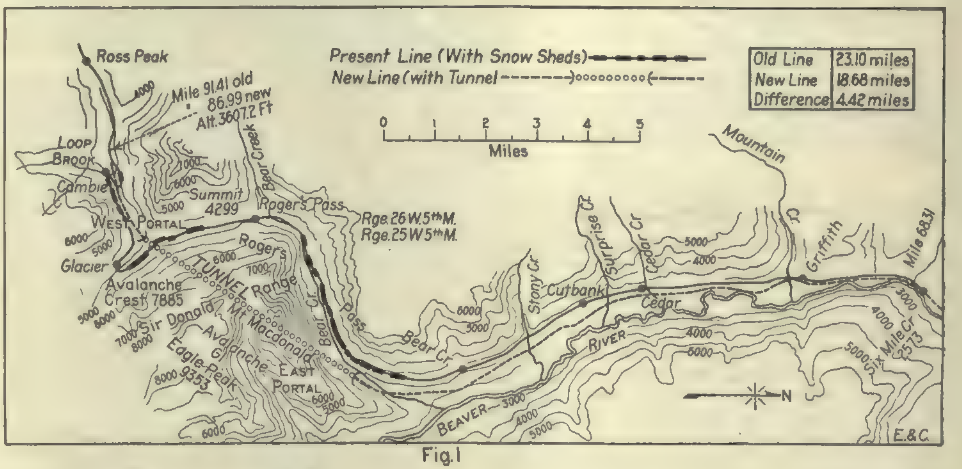
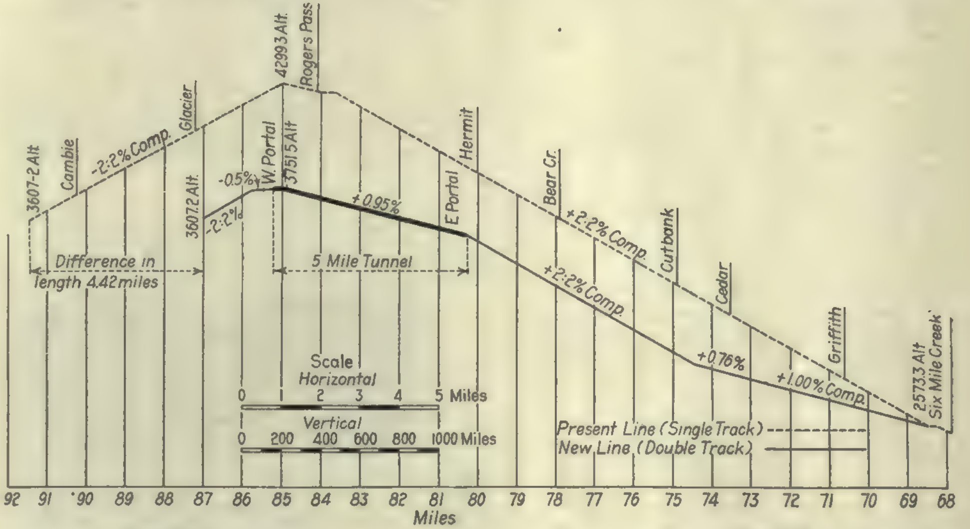


Fig. 1



West Side

	Old	New	Difference
Curvature	1288°	66°	1222°
Rise	692.1'	145.3'	547.8'
Distance	6.45 mi	1.91 mi.	4.42 mi.

East Side

	Old	New	Difference
Curvature	1860°	635°	1225°
Rise	1726'	1178.2'	547.8'.
Distance	16.65 mi.	16.77 mi.	.0.12 mi.

Fig. 2

Fig. 1. Map Showing Old and New Alignment of Canadian Pacific Railway at Rogers Pass Tunnel. Fig. 2. Profile of Old and New Lines of Canadian Pacific Railway at Rogers Pass Tunnel.

R = total resistance on level tangent.
T = total weight cars and contents in tons.
C = total number of cars in train.

This amounts to 4 lbs. per ton to 8 lbs. per ton, depending on whether cars are fully loaded or empty. This is equivalent to a rise of from 10 ft. to 20 ft. per mile. For mixed traffic a conservative estimate is train resistance equals rise of 15 ft. per mile.

It may appear that the rate of 25 cts. per actual pusher mile covering the cost of repairs and engine crew wages and extra cost of maintenance is too high, but as a matter of fact it is very conservative for the repairs, maintenance and renewals of the locomotives alone will run somewhere between 7 cts. and 10 cts. per mile and we have had cases where the engine crew wages alone averaged 25 cts. per mile for the actual mileage run, on account of delays to the pusher.

ACKNOWLEDGMENT.

This article is reprinted from the Cornell Civil Engineer for December, 1914. It was written by Mr. J. G. Sullivan, Chief Engineer of the Western Lines of the Canadian Pacific Railway.

Minimum Slope for Concrete Chutes.

To the Editors: In all the articles published in your valuable magazine, Engineering and Contracting, on concrete construction by chuting and spouting methods, nothing appears in regard to minimum slope of chutes necessary for successful operation with concrete of varying aggregates and degrees of wetness and I believe information on those points would be appreciated by many engineers who are located in out of the way places and who have not been able to observe the progress, at first hand, made in this method of construction but who are called upon to design and erect concrete structures.

Manufacturers of concreting appliances also might publish, to their advantage, information of this character in their catalogues; but the writer has never seen such data in any of the catalogues he has received.

I shall continue to look for this information in Engineering and Contracting and hope to be rewarded eventually.

Yours very truly, Arthur S. Hobby.
Guayquil, Ecuador, Sept. 19, 1915.

(The best records of practice in the matter mentioned by our correspondent are those of the manufacturers of concrete chuting appliances. At our request there has therefore been prepared the following answer by the engineers of the Insley Mfg. Co., Indianapolis, Ind. The catalog statement referred to in this answer adds nothing to the written information and we do not publish it.—Editors.)

To the Editors: We have your letter of the 22nd inst. with enclosure from Mr. Arthur S. Hobby with request for information as to the minimum slope of chutes and note Mr. Hobby's statement that this information is not referred to in manufacturers' catalogs. Mr. Hobby evidently has not received our catalog. On page 17 of our Catalog No. 40, we make a statement covering this point.

It is our custom in our Engineering Department to allow a slope of one to three, that is, 4 ins. of drop to 1 ft. of run in making the layout for a concrete gravity plant. Some contractors will carry concrete successfully in a chute much flatter than this, using a slope as flat as 3 ins. of rise to 1 ft. of run. Whether or not this can be done is a question of the experience of the crew in mixing the concrete and also involves the character of the aggregates. Concrete of broken stone requires a greater slope than concrete made of round gravel. Also gravel that has a very slight percentage of clay or hydrated lime will carry on a flatter grade than gravel that is thoroughly washed, and concrete that has a larger percentage of cement will flow on a flatter grade than concrete which is lean in cement. The grade on a line of considerable extent, say 200 or 300 ft., should not be uniform but should leave the hopper at a perceptibly slower grade, the grade of the chute gradually increasing toward the end, but the average grade will be about one to four.

Concrete is properly mixed for gravity distribution when all of the aggregates are held in suspension. If there is more water in the mixture than required to hold all of the aggregates in suspension, the concrete will be sloppy and the heavier aggregates will settle toward the bottom, tending to drag on the bottom of the chute, allowing the grout to move faster than these heavier particles and also tending to clog the chutes.

If concrete does not have water enough to hold the particles in suspension the whole mass will be sluggish and will not move properly. Concrete for a concrete gravity plant should be thoroughly mixed. There is only one condition in which the concrete is in proper and best condition to travel in the chute, that is as just stated. When the concrete is properly mixed the grade of the spout will depend on the aggregates as also stated above.

To recapitulate, it is good general practice to lay out a plant with a grade of 1 to 3 from the hopper gate to the end of the chute which will be the highest point of spill. A contractor will find by experience whether or not he can vary from this grade with the operating crew that he has available and the materials which he has to use. In figuring the height of the tower he will require an average of 20 ft. above the hopper gate for the height of the hopper and the dumping head room of the hoisting bucket.

Yours very truly, W. H. Insley.
Indianapolis Ind., Oct. 25, 1915.

Three 60-Ton Gas-Electric Locomotives for "Dan Patch" Electric Lines.

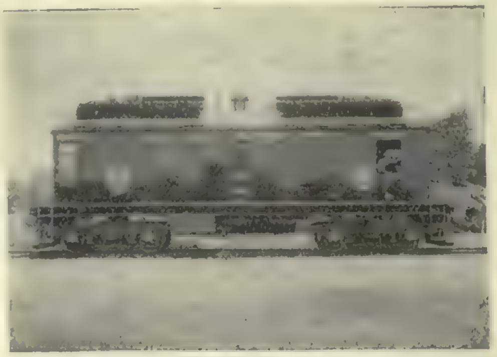


Fig 1. Sixty-ton Gas Electric Locomotive.

The Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Co., operating what is popularly known as the "Dan Patch" Electric Lines, has recently placed in commission three 60-ton gas-electric locomotives, Fig. 1, for freight, passenger and terminal service. These are somewhat similar in design although heavier than the 57-ton gas-electric locomotive which has been in successful operation daily on the company's lines for the past year or more from Minneapolis to Mankato, Minn. The four gas-electric locomotives, as well as 13 gas-electric motor cars which the railway company has purchased to date, were designed and built by the General Electric Co. It is interesting to note that this is said to be the first railroad in the world operated entirely with gas-electric service.

The new 60-ton locomotives are double ended. They are built with the box type of cab extending nearly the entire length of the underframe and have all the weight on drivers. Each locomotive is equipped with four GE-205-D motors. The truck clearances allow for 100 ft. minimum radius curvature. The power plant consists of two generating sets similar to the one used in the gas-electric motor cars. Only an engineer is required to operate the locomotive. The principal data and dimensions applying to the locomotives are as follows:

Total net weight equipped on rail	120,000 lbs.
Weight per axle	30,000 lbs.
Maximum tractive effort	32,200 lbs.
Length between knuckle faces of couplers	41 ft. 4 ins.
Length over cab	34 ft.
Height overall	14 ft. 10¾ ins.
Width overall	10 ft. 2 ins.
Total wheel base	24 ft
Rigid wheel base	6 ft. 10 ins.
Track gauge	4 ft. 8½ ins.

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The Third Pennsylvania Welfare, Efficiency and Engineering Conference will be held at Harrisburg, Pa., November 16, 17 and 18. This convention is called by the governor for the purpose of familiarizing the public and the various departments of the state government with the work of the separate departments which have to do in a responsible manner with state engineering projects, natural resources and industries. Talks will be given by the various department heads descriptive of such work, and addresses by others qualified to speak on these subjects will be heard.

4-19-23.

The Lighter Side of Engineering and Contracting

Hitting the High Places.

WHEN the present revolution broke out in Old Mexico there was a heavy exodus of contractors towards the United State boundary line. A large contractor handling grading contracts had several subcontractors working for him who fled along with him. One sub., named Billy McCann, however, was delayed in getting away. Several weeks passed and when he failed to put in his appearance at the border, he was given up as lost. Finally he appeared and was approached by the "boys," who inquired if he ran when the Yaqui Indians chased them. McCann replied, "Nope, I didn't run, but I passed some of the other 'boys' who were running."—C. A. E., Los Angeles, Cal.

God Was on His Side.

THE late John Blair, the Pennsylvania railroad magnate and coal operator, was a very pious man. His views of God, however, were somewhat similar to those of European nations, who believe the Lord has abandoned His neutrality in favor of their armies. One time Blair had a little scrimmage with William Van Horne, of the Canadian Pacific Ry. When the smoke of battle was over Blair was minus one small railroad. A short time afterward a flood washed away a good part of the roadbed; whereupon Blair exclaimed piously: "There is a God! There is a God!"

Who Said Baron Munchausen was Dead?

PAUL BUNYAN, that mighty superboss of the north woods, once carelessly allowed his supply of grub to run low and was only saved from having to lay off all hands right in the rush season by getting hold of a carload of beans that had been mis-shipped from Milwaukee. When these beans arrived at Hayward, Wis., Paul had wagon boxes with double sideboards mounted on eight logging bobs and to this string of empties he hitched his famous blue ox and drove in after the lifesavers. The journey to town was safely accomplished, but on the return trip, almost in sight of camp, the whole caravan broke through the rotten ice on a small lake and it was with great difficulty that Bunyan finally saved his own life and that of the blue ox. Undaunted by the misshap that would have crushed a less resourceful being, the intrepid leader rushed to camp and summoned all hands to the lake, which was surrounded by a rim of large boulders, among which stood hundreds of dead tamaracks interspersed with much downtimber. The crew was set to work at once felling and piling standing trunks, and when this task was finished the ring of firewood upon the boulders was fired at forty places at once. After the fire had burned down the ice had all melted from the lake and the men were set to prying the superheated boulders into the water with freshly cut sapling poles 20 ft. long. Soon the water reached the boiling point and the entire lake was transformed into a seething cauldron of bean soup. After that all was well. Warmer weather set in and the lake did not cool down entirely till long after the last log was hauled. Whenever mealtime came round the cook would send a couple of flunkies to hitch the blue ox to the tank-sled and go get a load of fresh bean soup from the lake. Nourished with this sustaining diet the entire crew toiled long hours cheerfully and tirelessly, and the season that had so narrowly escaped disaster yielded the company a handsome profit.—A. G. B., Madison, Wis.

In Hades.

ONE bitter cold night in 1892, the night shift in the Last Chance Mine at Avoca, Pa., found a very intoxicated man lying in the road beside the engine house. Not wishing him to freeze they took him down the shaft and laid him alongside a huge iron basket, in which was burning a fire of large lumps of coal, and went in to their work. When they came back to go out, they found the inebriate sitting up and running his fingers through his hair, and the following colloquy took place: "What are you doing here?" "I don't know." "How did you get here?" "I don't know." "Well, what are you going to do?" "I don't know, I was a teamster before I died." P. S.—This incident actually took place while I was making surveys in this mine.—T. L. W., Wilkes-Barre, Pa.

No Material Damage.

THIS happened long before there were such things as workmen's compensation laws. A big negro came into a lawyer's office and, exhibiting a scalp wound about 3 in. long, wanted to know if he could "git anything for dis heah." The attorney asked him how it had happened. "Well, you see, boss," replied the prospective client, "it wuz lak dis: Ah wuz workin' down by dis heah new buildin' an' a fo'-poun' brick fell off'n de sixteenth story an' hit me smash on top de haid." The lawyer took the case. The contractor readily admitted the facts and his liability but refused to pay more than $10 on the ground that the evidence failed to disclose any material damage.

Too Much of a Good Thing.

THIS happened some years ago when I was superintendent of construction on state highway work in Pennsylvania. All concrete work on a certain highway contract had been sublet to a local contractor, and I, being in charge of the job, was responsible for the fulfilling of all specifications on the concrete as well as on our own work. The inspector also was a local man. And he seemed to have some personal matters to settle with the concrete foreman. One day he came to me with a knockout indictment against his foe. Said he: "That concrete fellow is doing bum work again and I'm going to refuse to accept the job unless he tears out that culvert and builds it according to specifications." "What's wrong this time?" I asked for the dozenth time that week. "He's putting in inferior material. His concrete won't be strong enough to hold its own weight." "Well, I've seen nothing wrong." "Nothing wrong, eh? You said that the specifications meant that he was to mix up two sacks of cement with four wheel barrows of gravel. He's sneaking around when he thinks I'm not looking, and is not living up to his contract." "Now, just where is he going wrong?" "He's putting in too dad blamed much cement."—L. C. J., Brooklyn, N. Y.

He Wasn't Responsible.

TWO trains, each going about 40 miles an hour, tried to pass on a single track. A shyster lawyer hurried to the scene of the accident. He noticed an old negro, sadly in need of repairs, and ran up to him. "How about damages, Uncle?" he exclaimed breathlessly. The colored man waved him off. "G'way, boss, g'way," he said, "I never touched the train. I never done such a thing in all mah life, so help me Gawd! Yo' can't git no damages outen me."

Sanitary Expectoration.

IN a northwestern lumber camp it so happened that the owner's son had some very up-to-date ideas about the proper sanitary appliances for a camp. His suggestions at various times when he had visited the camp were received with good natured tolerance by Dennis Mulvey the camp boss. The climax came, however, when he suggested that a lot of sanitary drinking cups be ordered for use of the men. "Good idee," said Dennis, "we'll git some o' thim kind o' cups right away, and while we're about it we'll git a gross o' medicin droppers so's the men kin use 'em to spit on their hands."—E. N. L., Chicago, Ill.

Skinner Mulvey says: City engineer down home resigned last week. Local paper ran the notice of it under the head of "Municipal Improvements." A horse shoe for luck, a mule shoe for—well it depends on where you find it. If it's above your wishbone it's ten to one a season ticket for the happy hunting ground, and no return coupon.

CURRENT NEWS

The Doings of the Week.

Business, finance and industry continued their upward progress during the past week. Bank clearings showed a 20 per cent increase over those for the corresponding weeks of 1914 and 1913. Demands for iron and steel were heavy and railroad buying was up to the average of previous weeks. There was a greater commercial demand for money. Car surpluses were reduced and some railroads handled the greatest freight traffic in their histories. Country wide building statistics for October showed a gain of 37.1 per cent. In the construction field, despite the approach of the winter months, some improvement was shown. Several big contracts were placed and a considerable amount of new work was advertised for bids. In the Metropolitan District of New York much activity in the building field has developed. Steady gains in plan fillings have been made. Those for August were greater than for any single month since July, 1912. September showed an increase of 22.9 per cent over August and October continued the improvement. Material prices also have shown a steady advance. Portland cement in this district is now around $1.67. Municipal construction, as is to be expected, is quiet just at present. An unusual amount of street paving, water works and sewerage plans, however, are being developed for the coming year. The steel industry now has the biggest demands in its history. The October report of the U. S. Steel Corporation showed an increase of 847,000 tons of unfilled orders in that month. It is estimated that the unfilled orders of all steel companies were increased over 1,500,000 tons during the last month. Domestic orders now are playing a large part in the demand for steel products. Rail orders for the week include 20,000 tons for the Illinois Central, 12,000 tons for the Norfolk & Western, 6,000 tons for the Chicago, Milwaukee & St. Paul, and 30,000 tons in miscellaneous orders. Additional contracts for 4,000 cars and 50 locomotives were placed. France closes bids Nov. 20 on 100,000 tons of rail. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Nov. 10 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Nov. 10. Cts.	Nov. 3. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.709	1.659
Iron bars, Pittsburgh.........	1.50	1.50
Iron bars, Chicago............	1.45	1.45
Steel bars, Pittsburgh........	1.60	1.50
Steel bars, New York.........	1.769	1.669
Tank plates, Pittsburgh.......	1.60	1.50
Tank plates, New York.......	1.769	1.769
Beams, etc., Pittsburgh.......	1.60	1.50
Beams, etc., New York.......	1.669	1.669
Skelp, grooved steel, P'gh....	1.60	1.45
Skelp, sheared steel, P'gh...	1.70	1.50
Steel hoops, Pittsburgh.......	1.75	1.75
Sheets, Nails tand Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.20	2.15
Galv. sheets, No. 28, P'gh...	3.70	3.60
Wire nails, Pittsburgh.......	1.85	1.85
Cut nails, Pittsburgh.........	1.80	1.80
Fence wire, base, P'gh.......	1.70	1.70
Barb wire, galv., P'gh.........	2.70	2.70

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over 1.50 cts.

Railways.—No developments looking to the immediate undertaking of any great amount of construction by the railways have occurred during the past week. There has been some activity, however, and there is good reason to believe that a few contracts may be let in the near future. The Richmond, Rappahannoch & Northern R. R., a new short line in Virginia, is reported to have taken bids for its construction work. The Union Depot Co., of Chicago, is understood to have awarded the contract for the superstructure of its new freight station to Geo. A. Fuller Co., Chicago. The Gulf, Colorado & Santa Fe Ry. (Santa Fe System) has conditionally let contract for rebuilding the washed out 27 miles of its Gulf & Interstate division. Cincinnati, Hamilton & Dayton Ry. has awarded contract for second track between Miamisburg and South Dayton, O., to Ferguson & Edmonston, Pittsburgh, Pa. Public Service Commission of New York City is calling for bids on two important sections of the Dual System of rapid transit. One of these comprises the tunnel section under the East River from 14th st., Manhattan, to North 7th st., Brooklyn, for which bids are to be opened Dec. 7; the other calls for the elevated extension of the Southern Blvd. and Westchester ave. branch of the Lexington Ave. subway, bids to be opened Nov. 30. The Boston Transit Commission has awarded Sec. G of Dorchester Tunnel to Coleman Bros., Boston, Mass., at $382,394.

Roads and Streets.—Most of the highway work reaching the call for bids stage the past week is in the south. Highway commissions in northern states are not advertising much construction at present. Maryland is taking bids on one small road job and on two small bridge contracts. New York opened bids on 8 contracts, the largest calling for an expenditure of about $120,000. County Commissioners at Camden, Ala., open proposals Dec. 6 on 12 miles of sand-clay or clay-gravel roads. Fiscal Court at Albany, Ky., is asking bids on 22 miles of waterbound macadam; Mercer County, Ky., will receive proposals until Dec. 6 on 6½ miles of waterbound macadam. Street improvements to cost $306,000 are being advertised by Philadelphia, Pa. Berrien County, Michigan, opened bids on road work to cost about $380,000; County Commissioners at Bryson City, N. C., let contracts for grading 16.2 miles of road; Ontario, Cal., let a $57,088 street paving contract; Arcadia, Cal., awarded $118,000 worth of street paving; County Freeholders, Trenton, N. J., let a $52,574 road job and Sussex County Freeholders awarded a $57,103 job.

Bridges.—No particularly large bridge undertakings were advertised the past week. Contract for $38,350 bridge at Johnstown, Pa., was let by County Commissioners. Bids are being asked on several small steel structures by counties in southern states. Dallas County, Alabama, opens bids Dec. 13 for steel for 9 bridges, 12 to 200 ft. in length.

Drainage and Irrigation.—No new big jobs in either the drainage or irrigation fields appear to have reached the call for bids stage during the past week. Several small jobs in Indiana, Minnesota and Iowa are being advertised but the larger undertakings are yet to come up. Reynolds-Ely & Co., Springville, Utah, at about $40,000 were low bidders on a U. S. Reclamation job in the Grand Valley Project. County Commissioners at Marshall, Minn., awarded three county ditches at $7,100, $10,254 and $16,400. Young's Coulee Drainage District of Abbeville, La., let a 225,000 cu. yd. dredging contract.

Water Works.—The University of Idaho is calling for bids on 60,000-gal. steel tank on 79-ft. tower; Philadelphia, Miss., is asking proposals on water works and sewerage; Wesson, Miss., opens bids Dec. 7 on water works and electric light plant; East Youngstown, O., is calling for bids for 1,000,000-gal. filter plant, pumping station, etc. Salt Lake City, Utah, opens bids Nov. 24 on the Parleys Canyon storage dam, estimated to cost $125,000. Greater Winnipeg Water District, Winnipeg, Man., has awarded contract for 200,000 bbls. cement for use during 1916; Board of Water Supply of New York City has let a $94,400 contract for buildings at Hill View Reservoir.

Sewerage.—Henderson, Tenn., opens bids Dec. 3 on 5 miles 8-in. to 12-in. sewers and 5 miles of 4-in. to 8-in. water mains. Ocean Grove, N. J., is asking bids on about 2 miles of 6-in. to 10-in. sewer.

Rivers and Harbors.—Directors of Port of Boston, Boston, Mass., are advertising two contracts. One of these calls for 1,500,000 cu. yds. dredging and filling; the other provides for 2,200 ft. of bulkhead and 170,000 cu. yds. of filling behind it. The U. S. Engineer at Cleveland, O., opens bids Nov. 26 for dredging in Cleveland Harbor; bids will be opened Dec. 14 by U. S. Engineer, New York City, for dredging in Newark Bay and Passaic River, N. J.; Bureau Yards and Docks, Washington, D. C., is asking bids for dredging at Navy Yard, New York.

Increased Steel Plant Capacity.

The present unparalleled demand for steel products is resulting in the undertaking of an unusual amount of construction by steel producers. In one day last week improvements calling for an expenditure of over $10,000,000 were announced by three concerns. The Philip Sheet & Tin Plate Co. of Steubenville, O., with plants at Steubenville, Clarksburg and Weirton will build an addition to its strip steel plant in Weirton to cost about $1,000,000, and in the near future will start work on four new mills to cost almost $800,000. It also is reported that a steel mill to cost $6,000,000 will be erected in Weirton. The Carnegie Steel Co. has authorized an appropriation for improvements to its Ohio works in Youngstown, O., to cost $800,000. Three new 75-ton open hearth furnaces and two four-hole soaking pits are to be built. Official statement has been made by Elbert H. Gary, chairman of the board of directors of the U. S. Steel Corporation, that the Gary, Ind., plant of the Indiana Steel Co. will be enlarged at a cost of $7,500,000. The new installation will include two blast furnaces, several open hearth furnaces, blooming mills, a duplexing plant, etc. The great amount of new plant construction announced in the last few weeks by steel manufacturers is an excellent indication of the complete recovery of the industry from the worst depression in a generation. And this upturn has taken place in less than a year's time.

Idle Plant.

The present season has not been an especially prosperous one for many contractors. Heavy construction has not been so abundant as in previous seasons and what has been let has gone in numerous instances at prices that allowed small margins for profit. The railways have undertaken very little work this year and until recently there has been practically no construction started by private irrigation projects or power companies. As a consequence contractors specializing in these kinds of works have had to turn to other lines of construction or let their plants lie idle. And an idle plant, representing an investment of many thousands of dollars is a somewhat serious proposition to the owner. One big construction company that heretofore has engaged mostly in railroad building is now working only 13 of its 31 steam shovel plants. It thus has a good sized fortune tied up in idle equipment. There are many indications that the dullness in the field of heavy private construction is about over. In the last month or two several fair sized hydro-electric developments have been placed under contract, and in the far west contracts have been let or negotiations to that end are under way for beginning work on a number of long dormant irrigation projects. The railways, too, are enjoying a period of prosperity that may lead them to take up their long defered construction programs.

A 26-MILE ROAD IMPROVEMENT IN ONTARIO.

Construction of Highway from Toronto to Oshawa.

To Be Macadamized at Estimated Cost of $310,000.

A plan is under consideration for the improvement of the 26-mile section of the Kingston Road between Toronto and Oshawa, Ont. The estimated cost of the undertaking for macadam construction, which is favored by the committee in charge, is $310,000. A petition is now being circulated for signatures among the municipalities interested, asking that a commission be appointed to take charge of the improvement in accordance with the Ontario 1915 act respecting main highways. It is possible that the proposed improvement will be undertaken in the near future.

A report on the project was submitted in May by W. A. McLean, Engineer of Highways, Department of Public Works of Ontario. Because of the unsettled financial conditions in Canada and the evident disinclination of representatives along the route to undertake a large expenditure at the present time, the engineer suggested that the method of dealing with the improvement should be a matter of gradual development and the construction of a more permanent surface might be left in abeyance. Another report was submitted in October and in this the cost of improving the road by macadamizing was estimated to be as follows:

Grading to 6%, drainage, bridges and culverts	$128,000
Surface widening, 6.5 miles at $4,000	26,000
Macadamizing, 19.5 miles at $8,000	156,000
Total	$310,000

This estimate is for waterbound macadam, the surface of which would be painted or sprayed with oil or tar and then covered with stone chips.

The Kingston Road was one of the first highways constructed in Canada. It traverses a very prosperous farming and fruit-growing country, interspersed with towns and villages. It is closely paralleled by several steam and electric railways which will facilitate the assembly of material for construction purposes. The Grand Trunk Ry. runs from ¼ mile to 1½ mile south; the Canadian Pacific Ry. from within ½ mile to 3 miles north and the Canadian Northern Ry. ½ mile to 4 miles north. The Toronto & York Radial Ry. runs at the side of the road from the Toronto city limits to West Hill, 8 miles. The road passes through Birchcliffe, Scarboro, West Hill, Dunbarton, Pickering, Whitby and Oshawa.

Generally speaking, the subsoil along the route is a clay loam between Toronto and Pickering and a stiffer clay from there on to Oshawa. The present road from Toronto to mile 6.5 is of good waterbound macadam construction, laid down during the last 3 years, and having a good crown and alignment. From mile 6.5 to Oshawa the road has scarcely any crown. It has a gravel surface, but is in a very bad state of repair, there being many deep ruts and holes.

Kingston Road and the surrounding country from the Toronto city boundary to Oshawa is rolling in character and it is, therefore, necessary to do considerable excavating and filling to reduce the grades, which at present are steep. The grades on the hills either side of Highland Creek are at present over 10 per cent, and in order to reduce them a diversion to the north of the existing road is proposed, giving 4 per cent and 5 per cent grades.

The bridges and culverts on the present roads are in very poor condition, except in Whitby Township, where several concrete bridges and culverts have lately been constructed. Most of the culverts are timber and will last only a very short time. From mile 0 to mile 6.5 the drainage of the roads appears to be adequate except between the road and the electric railway. This, perhaps, should be underdrained. From mile 6.5 to Oshawa the ditches are not sufficient to deal with the water in many parts of the roads, and consequently a good ditch should be constructed on both sides of the road for practically the whole distance. A certain amount of gravel and field stone is available along the route for road material.

A 67-MILE RAILWAY.

Bids Asked for Building Railway for San Francisco.

To Be Used in Conveying Material to Site of Hetch Hetchy Dam.

The Board of Public Works of San Francisco, Cal., is now calling for bids for the construction of a 67-mile railway. The line will be built for the purpose of hauling materials to the site of the proposed Hetch Hetchy dam, which will be part of the new $40,000,000 water supply development of the city.

The new line starts from the Sierra R. R., and its route in a general way will follow the course of the Tuolumne Ricer for most of the distance to the site. The location, however is on an elevated bench some distance from the river. The line will run through a rough and broken country but its construction will not involve a great amount of excavation. The estimated quantity of this is about 1,000,000 cu. yds., over half of which is rock. Of the latter about 160,000 cu. yds. is classed as Sierra granite.

The specifications cover four classes of excavation: granite, solid rock, soft rock and earth. The first mentioned material is harder to break up than the slate, sandstone and other solid rock along the line. Alternate bids also will be received on the entire excavation.

The plans call for a 16-ft. roadbed at subgrade with embankment slopes of 1½ to 1.

Rails will be 60 lb. Bessemer steel, conforming to specifications of American Society of Testing Materials as revised in 1914. Ties will be redwood or cedar, 6x8 in. by 8 ft.; and will be laid on 6 in. of ballast. The latter will be broken stone, gravel or acceptable material from the excavation. Tie plates will be used on all ties.

One long bridge will be required. This will be erected over the Tuolumne River near Jacksonville. It will have a 220 ft. span and three plate girder approach spans and will require about 300 tons of steel. Culvert construction will be galvanized metal pipe or concrete pipe. For the former bids will be on pure iron and on copper bearing steel. The trestles will require about 500 sq. ft. of lumber. The specifications cover both ballast deck and open deck trestles.

Some of the principal items are as follows:

Excavation, 1,000,000 cu. yds.
Track laying, 69 miles.
Corrugated metal culverts, 6,700 lin. ft.
Fencing, 40 miles.
Water tanks, 100,000 gals. each, redwood, 8.
Fuel oil tanks, steel, 2.

The railway is to be completed ready for operation in 300 days contract time. A penalty of $750 per day is provided for delay beyond this time.

Bids for the construction of the railway will be received by the Board of Public Works of San Francisco. M. M. O'Shaughnessy, City Engineer, is in charge of the work.

County Tax Levies for Ohio Road Construction.

A considerable amount of road construction will be undertaken in Ohio as a result of the special tar road levies authorized at the election Nov. 2. In all 11 counties took action in these levies and in 10 of them the electors voted in favor of the proposition. As a result probably $1,000,000 will be provided for road improvements. In Muskingum county the special 2-mill road levy carried by a vote of almost two to one. The levy will extend over a period of 5 years and will aggregate about $675,000. It is expected the state will add $125,000 to the amount. The success of these special tax levies at the elections probably will lead to the submission of a like proposition next year in 30 counties.

Drainage and Road Construction in St. Francis Basin, Arkansas.

A large amount of construction work is proposed or under way in the St. Francis Basin of Eastern Arkansas and Southwestern Missouri. Some of the largest drainage and land reclamation projects in the country are now being carried out in this locality. In Crittenden County, Arkansas, it is estimated that nearly $2,500,000 worth of drainage canal construction is now being carried out by various districts. The county, also, proposes the expenditure of $1,500,000 for building improved roads.

In Mississippi County, Arkansas, numerous drainage districts have been organized and a great deal of this work has been placed under contract or is to come up for letting in the near future. Drainage District No. 16 of this county opened bids Nov. 15 on ditch work requiring 2,749,000 cu. yds. of excavation and levees containing 620,000 cu. yds. Steps are being taken for the formation of the Keystone Drainage District, which will improve portions of Mississippi and Craighead Counties. This, with the possible exception of the Little River Drainage Project of Cape Girardeau, Mo., now under construction, will be one of the largest single district undertakings in the Basin. The cost of the reclamation work will be in the neighborhood of $2,500,000.

Mississippi County, Arkansas, of which Osceola is the county seat, also proposes the building of many miles of improved highway under the new Alexander Road Law. Three districts already have been formed and petitions for the organization of a fourth will be presented shortly to the County Judge for his approval. The districts already formed are the Osceola-Little River, the Luxora-Little River and the Big Lake District. The first two each propose an expenditure of about $300,000. The bonds of Osceola District have been sold. Plans for the other two districts are now being perfected. The fourth district will be in the southern part of the county, the improved roads radiating from Wilson. It is expected that this district will construct about 26 miles of concrete road and 42 miles of macadam, and that the total expenditure will be about $428,000.

The main feature of the highway improvement will be a concrete road extending from the north boundary to the southern limit of the county. This will pass through Yarbora, Blytheville, Burdett, Osceola, Wilson and Bassett. Concrete roads also will be extended east and west from the main highway. In all about 100 miles of this type of road is proposed. The less important roads of the system will be graded earth, gravel or macadam.

A $555,000 Water Tunnel Extension for Milwaukee, Wis.

The City Council of Milwaukee, Wis., is considering a proposition for an extension of the Linwood Ave. intake water tunnel under Lake Michigan. A special commission, consisting of George H. Benzenberg, H. B. Ferguson and T. C. Hatton, has reported to F. G. Simmons, Commissioner of Public Works, recommending that the tunnel be extended to a point 2,500 ft. from its present terminus. The tunnel now extends out 4,000 ft. from shore and is 40 ft. under the lake.

The estimated cost of the 2,500-ft. extension for a 12-ft. diameter tunnel is given as follows in the report:

Floating crib, resetting same about 2,500 ft. eastward, refloating and scrapping same, and building and placing submerged timber crib with screens complete	$120,000
2,500 ft. 12-ft. tunnel, at $140	350,000
70-ft. intake shaft, at $500	35,000
Engineering and contingencies, 10%	50,500
Total approximate cost	$555,500

North and South Railroad for Idaho.

A much needed development for the state of Idaho is the connection by rail of the north and south sections of the state. The construction of a north and south railroad from New Meadows to Lewiston has been proposed by Governor Alexander, and a commission was appointed by him to investigate the project. In its report submitted recently the commission states that such a railroad is entirely practicable as far as the work of construction is concerned and that the cost per mile would not be excessive.

The distance from New Meadows to Grangeville on the proposed route is about 90 miles. The first 10 miles—from New Meadows to Little Salmon Falls—would require very little grading. From Little Salmon Falls to Riggins the route runs along the west bank of the Little Salmon, and in the neighborhood of Little Salmon Falls some expensive rock work would be required for a distance of 2 or 3 miles. The valley then becomes wider and railroad construction would be less difficult. All the way from Little Salmon Falls to Riggins there is an abundance of timber for ties, bridges, etc.

A short distance below Riggins the route crosses to the east branch of the Salmon River. From Riggins to Whitebird, a distance of 33 miles, about 5 or 6 miles of heavy rock work would be required. The average fall of the river from Meadows to Whitebird is about 16 ft. per mile. The route traversed by the railway leaves the Salmon River at Whitebird and crosses over the divide to Grangeville. To reach the top of the divide from Whitebird a rise of 3,000 ft. must be made and then a descent of about 1,000 ft. into Grangeville. The distance by wagon road is about 20 miles.

A route up Whitebird Creek also was investigated. It was stated that by keeping on a level or slight upgrade from the mouth of Eli Creek down the river until Rocky Canyon is reached, an easy grade up the canyon to Fenn would be found. Fenn is on the Northern Pacific R. R., about 8 miles west of Grangeville, and 650 ft. lower. The Commission recommended that this route be carefully investigated before making a final location.

The North and South Railroad Commission consists of Jerome J. Day, Moscow, Ida., Aaron Parker, Grangeville, and E. A. Paddock, Weiser.

Road Work for Multnomah County, Oregon, in 1916.

Multnomah County, Oregon, which is just completing a $1,200,000 road improvement, will expend $231,000 for new highway construction in 1916 if the estimates submitted to the County Commissioners are carried out. The total proposed expenditure in the 1916 estimate is $588,222, but the greater part of this will be for maintenance and minor improvements. The principal new work proposed under the budget includes the following:

Regrading St. Helens Road, 3 miles	$35,000
Relocating, grading and macadamizing Germantown Road, 2½ miles	15,000
Hard surfacing Capitol Highway, ½ mile	10,000
Extending Baseline Road	50,000
Grade crossing elimination at Fairview	8,500
Grade crossing elimination at Multnomah Station	6,500
Macadamizing Sky Line blvd.	20,000
Grading Sky Line Blvd., 3 miles	10,000
Macadamizing Fairmount Blvd., 3 miles	26,000
Grading Breyman Ave.	15,000
Grading Sandy Road	10,000
Completing grading on Sandy Cutoff	10,000
Grading and macadamizing Cornelius Pass Road, 2½ miles	27,000
Macadamizing Powell Valley Road, 2½ miles	15,000

In addition to the above the County Commission will be asked by property owners to undertake new construction to cost about $297,000. One of the larger items calls for hard surfacing Columbia Blvd. from St. Johns to a connection with the Sandy Blvd., a distance of 9 miles, the estimated cost being $18,000 per mile. John B. Yeon, Portland, Ore., is County Roadmaster.

New York Barge Canal Construction.

At the election on Nov. 2 the citizens of New York State authorized the proposed issue of $27,000,000 additional Barge Canal bonds. Of this amount practically oneh-alf will be expended for the settlement of awards for damage calims. In addition $3,654,000 will be refunded to the State Treasury. This sum was appropriated by the Legislature of 1915 for the completion of contracts let prior to Jan. 1, 1915, and for which no funds were available. Deducting these two amounts from the $27,000,000 bond issue will leave about $9,846,000 for the work of construction and for attendant expenditures.

The work of constructing the barge canal is now about 90 per cent completed. The uncompleted portions, however, are so located that the usefulness of the enlarged waterway cannot be realized without their completion. On the stretch between the Hudson River and Lake Ontario one uncompleted contract forms the chief obstacle to the opening of navigation along the new route. Also on the Champlain Canal a single contract forms a similar obstacle.

The status in October of contract plans for the Barge Canal was as follows:

No.	Description, Erie Canal	Status.
21A	Completing work on Contract No. 21	50 per ct. completed.
23A	Completing work on Contract No. 23	Under way.
29A	Completing work from Sterling creek to Oneida county line	Completed.
46B	Completing lock and dam at May's Pt.	Under revision.
47A	Completing work on Contract No. 47	Under revision.
55B	Changes in gates, etc., at Delta dam	Before Canal Board.
59	Rochester harbor	Under way.
63A	Completing work on Contract No. 63	Under way.
73A	Completing dredging from Stillwater to Northumberland	Before Canal Board.
83	Constructing canal from Contract No. 19 to Niagara river	Under way.
84	Viaduct over canal and railway at Clyde	Under way.
122	Bridge at Little Falls	Under revision.
130	Dredging Albany canal entrance	Before Canal Board.

NEWS LETTERS

St. Louis Items.

The Bondurant Construction Co. of Hickman, Ky., have a lot of team work to sublet or will hire teams by the day.

The J. H. Flick Construction Co., Chicago, has 16,000 yds. of good machine work on the Great Western R. R. near Des Moines, Ia., to sublet. Any one interested in this communicate with R. E. Cotton, Kirkwood Hotel, Des Moines, Ia.

The Board of Directors of the Southern Illinois Evangelical Orphanage at Hoyleton, Ill., awarded to English Bros. of Champaign, Ill., a contract for constructing the new building to replace that burned on June 11. There were 11 bidders and the contract figure is $51,407. The new structure will be brick and will accommodate 150 persons.

Thos. Harman and Hickey Bros. have finished their big tunnel job in Memphis. In addition to this Hickey Bros. expect to complete their retaining wall contract on the levee in Indianapolis about the first of the year. They have a cracker-jack standard gauge steam shovel outfit idle that they can place on work immediately.

William J. Smith, builder of the old Troost Ave., Independence Ave. and Ninth St. cable lines and president of the old Kansas City Cable & Ry. Co., died on Nov. 8 at his home, 3000 Troost Ave., Kansas City, Mo. He was 77 years old, president and active head of the Smith & Sons' Manufacturing Co., makers of road machinery in the East Bottoms, Kansas City. Mr. Smith was born in the state of New York. He came to Kansas City in 1866 with George J. Keating, another native of New York. They formed the firm of Smith & Keating, hardware dealers. Kansas City then had a population of less than 10,000, and the public square was near where the city hall now stands. Their business grew, they became dealers in implements and wagons and later organized the Smith & Keating Manufacturing Co. and began to manufacture wagons and all kinds of farm implements. Mr. Smith acquired a fortune in this business.

The Tonkawa Construction Co., 3233 McGee St., Kansas City, Mo., can use a small drag line to excavate sewer trenches at Maywood, Ill. Will hire machine by the day or let work by yard or by the foot. Sewer will be 63 in. wide and 17 ft. deep with some smaller trenches. They expect work to last about four months.

There are almost 700 men employed in the construction of the new state house. Approximately 60 per cent of the work is done and 35 per cent of the material is in place. Two hundred of the men are engaged in the real work of construction in Jefferson City. Two hundred and fifty are employed in the Gill Co. quarry and dressing sheds at Carthage preparing the stone, and the remainder are working under sub-contractors in various parts of the country. Seventy-five men are employed by a marble company at Peoria, Ill., where the interior stone finishings are being made. A sash and door company of St. Louis has about fifty men engaged in turning out the woodwork for the building. Another company of St. Louis is employing seventy men in putting in the mechanical equipment and fittings. The work has been going forward more rapidly the last few weeks than at any other period since the building was started.

Z. C. Mitchell, who has been on the L. J Smith Construction Co. work on the Santa Fe R. R. in New Mexico, Arizona and California for the past five years, has returned to Kansas City and will be located in their office in the Commerce Bldg. until spring. During his stay in the west Mitchell got married and is the proud daddy of a 2-year-old boy which he says is going to be one of the big contractors of the future. We think he is right, as the boy looks like dad and beginning to build railroad grades for his toy locomotives.

J. F. Murphy, former general superintendent of the Eastern District of the Missouri Pacific-Iron Mountain System, who has just been made general manager of the railroad, has taken with him his chief clerk, J. H. Emerick. M. Marlatt, who previously served as chief clerk in the office of the general manager, will occupy a similar position with John Cannon, who succeeds Mr. Murphy as general superintendent.

The List & Gifford Construction Co., Kansas City, Mo., received the contract from the Kansas City Southern R. R. for widening and deepening ditches on their entire line. Also 60 miles of bank widening, and are placing a steam shovel at Joplin, Mo., on this line, taking out a cut north of town. They expect to finish the track laying at Garden City, Kan., by the 20th of November.

The Kansas City & Tiffany Springs Ry. Co., which was organized for the construction of a line 15 miles in length to connect Kansas City and Tiffany Springs, was chartered on Nov. 2 by the Secretary of State. The capital stock is $500,000. The incorporators are: T. N. Smith, Charles J. Smith, Bayless Steele, C. W. Chandler and J. N. Baird of Kansas City, H. G. Post of Kansas City, Kan., and Robert Engleman of Parkville.

J. G. Grommett has returned to St. Louis. He has been down in Texas selling automobiles for several years. He expects to break into the contracting business again right away.

Bids will be received by the city of St. Louis, Room 315, New City Hall, until 12 m., Nov. 19, for the erection of the first section of a children's building for the city of St. Louis. Plans, specifications, form of contract and other information can be had at the office of the president of the Board of Public Service.

Surveyors for the Illinois Central are surveying for a cutoff starting at Creal Springs, Ill., which is intended to eliminate the high grade at Ozark Hill. A short tunnel will pass under the range of hills in the neighborhood of McCormick, Pope County. The route will result in the road diverting many trains that now go over the bridge at Cairo to the new bridge at Metropolis.

A. L. Cook of Ottawa, Kan., can use several 8 or 10 team outfits on bank widening work on the M., K. & T. R. R. in Oklahoma. Will hire teams by the day or by the yard.

J. E. Lyman is around daily getting information on new work opening up.

Contractors when in want of labor or work for their outfits, write Koenig's Labor Agencies, 612 Walnut St., St. Louis, Mo., or 503 W. 5th St., Kansas City, Mo.

A condemnation suit, filed in the County Court at Edwardsville, Ill., indicates that the Illinois Terminal R. R. Co., with headquarters in Alton, is planning a belt of terminal facilities from Alton to East Carondelet, which will connect with every railroad entering St. Louis from the east. The lower half of the arc is to be completed by a line running south from Edwardsville to O'Fallon and thence to East Carondelet. The suit was brought by the Terminal Co. against Henry J. Stahlhut to condemn a right of way for three miles between Hartford and Cotte's Station. At present the Terminal is using Wabash tracks between those two points. Mallory Borrughs, Edwardsville, attorney of the Terminal Co., admitted that plans were on foot for a belt line to tap the entire district traversed by east side lines into St. Louis, but said he could not give the details. H. H. Ferguson, president of the company, is in the east and at his office in Alton it was said he was the only person who could explain the whole plan. The Illinois Terminal R. R. Co. is at present operating lines between Alton and Edwardsville and intermediate points, but has no line running south from Edwardsville.

The East St. Louis City Council passed an ordinance providing for a Bowman Ave. sewer district, the improvement to cost $43,500. The main line of the system on Bowman Ave. will extend from First St. to Seventh St. The southern boundary is St. Clair Ave. and the northern Lynch Ave. The district will empty into the outlet sewer at 17th St. and Bowman Ave. The Bowman Ave. sewer will be of 42 in. pipe with lateral pipes from 8 to 30 ins. in diameter. It will relieve pressure on the St. Clair Ave. sewer, which collapsed recently. The Board of Local Improvements is considering a large sewer district to be known as the Winstanley and to cost $340,000. An ordinance covering such a district was once passed by the Council, but the project was given up.

A. B. Koenig.

Buildings at Naval Radio Station, Cavite, P. I.

Bids are now being asked by the U. S. Navy Department for the construction of five buildings at the Naval Radio Station, Cavite, P. I. The structures comprise one power house, one operating building, one quarters for commanding officers, one double quarters for married operators and one quarters for bachelor operators.

The power house and operating building will be of concrete construction on concrete foundations, with steel and concrete roof construction, covered with tar and gravel. The quarters will be of frame construction on concrete piers, with roofs covered with an approved prepared roofing. All walls and ceilings of quarters will be sheathed.

The general dimensions of the buildings are approximately as follows, excluding porches: Power house, 37 ft. 8 ins. wide, 82 ft. 8 ins. long, two stories, with an extension 18 ft. 8 ins. wide, 82 ft. 8 ins. long, one story high; quarters for commanding officers, 45 ft. 10 ins. wide, 51 ft. 10 ins. long, one story; quarters for married operators, 27 ft. 2 ins. wide, 65 ft. 8 ins, long, two story; quarters for bachelor operators, 19 ft. 6 ins. wide, 66 ft. 6 ins. long, one story, with kitchen extension 35 ft. 6 in. wide, 37 ft. long, one story.

Bids for the construction of the buildings will be received until 11 a. m., Jan. 4, by Bureau Yards and Docks, Navy Department, Washington, D. C.

PERSONALS

Dr. Miller Reese Hutchinson, chief engineer for Thomas A. Edison, has been appointed to a membership on the naval advisory board.

Mr. R. L. Baldwin has resigned as appraisal engineer for the State Utility Commission of Missouri, a position which he has held for two years, and has associated himself with the firm of Burns & McDonnell, consulting engineers of Kansas City, Mo., where he will have charge of electrical work and appraisal of electrical and other utilities for the firm. Mr. Baldwin is a graduate of the Missouri State University and was formerly associated with Burns & McDonnell before taking the position with the State Utility Commission.

Mr. W. V. Cruse, who has been resident engineer with the Illinois State Highway Commission during the past year, is now assistant engineer on surveys and construction of drainage districts with Edwards & Chamberlain, consulting engineers, Eldora, Iowa. Mr. Cruse was a rodman on the Missouri Pacific in 1910 and in 1911 was employed by the Stone & Webster Engineering Corporation as transitman on work at Keokuk, Iowa. From 1913 to 1914 he was engineer with the Cedar Rapids Manufacturing & Power Co. at Cedar Rapids, resigning that position to enter the service of the Illinois Highway Commission.

Mr. Louis K. Rourke, formerly assistant division engineer of the Central Division of the Panama Canal, and recently commissioner of public works of the city of Boston, and Mr. Edward C. Sherman, formerly division engineer on the Charles River dam and lock at Boston, later designing engineer on the Panama Canal, and for the past four years in private consulting practice, have associated themselves under the firm name of Rourke & Sherman, to conduct a general consulting engineering practice, occupying offices at 6 Beacon St., Boston, Mass. They will give special attention to organization, to the design, construction and operation of public works, including river and harbor improvements, refuse disposal, water supply, sewerage and pavements, to railroad work and to Spanish-American projects.

Mr. John Laylin, civil engineer of Norwalk, Ohio, has resigned as division engineer of the Ohio State Highway Department to take a position as engineer with the Ohio Paving Brick Manufacturers' Association, 311 Hartman Bldg., Columbus, Ohio. Mr. Laylin will have charge of construction in Ashtabula, Cuyahoga, Erie, Geauga, Huron, Lake, Lorain, Medina, Portage, Ottawa, Sandusky, Seneca, Summit, Trumbull and Wood counties, Ohio. Mr. Laylin was city engineer of Norwalk, Ohio, for 20 years, and was also county surveyor of Huron county for part of that time. Since January, 1914, he has been division engineer for the State Highway Department. He is an associate member of the American Society of Civil Engineers, and is secretary-treasurer of the Ohio Engineering Society.

Mr. William Gray Kirchoffer, sanitary and hydraulic engineer of Madison, Wis., has been appointed consulting engineer to the Department of Engineering of the State of Wisconsin. Mr. Kirchoffer is a graduate of the University of Wisconsin, class of 1897. He taught sanitary and hydraulic engineering at that institution in 1902 and 1903. From 1904 to 1915 he was sanitary engineer for the State Board of Health and the State Board of Control. Since 1913 he has also been a member of the Examining Board for Plumbers of the State of Wisconsin. Mr. Kirchoffer will be recognized by our readers as a frequent contributor to Engineering and Contracting. Two recent articles under his name were "The Design Features and Cost of Gravity Water Works at Mellen, Wis.," in the September 1 issue, and "A Handy Method of Estimating the Cost of Constructing Pipe Sewers," in the issue of October 13.

CIVIL SERVICE NEWS

The New York State Civil Service Commission announces examinations to be held on Dec. 11 for the following positions:

Junior assistant, engineering departments, $901 to $1,200 per annum.

Junior engineer, Grade 7, $1,201 to $1,500 per annum.

Junior draftsman, $901 to $1,200 per annum.

Structural draftsman, $1,201 to $1,500 per annum.

These examinations are open to non-residents of the state. Application must be made before Dec. 1. Application blanks will not be sent out by the Commission after Nov. 29.

NEW CATALOGUES

Reels for Chains and Tapes.—Paper, 6x9 ins.; 4 pp. Keuffel & Esser Co., New York City.

Shows two new reels for band chains and flat wire tapes, one of which is a folding type for ¼-in. tape which can be carried in the pocket.

Concrete Silos.—Paper, 3½x6¼ ins.; 6 pp. United States Portland Cement Co., Denver, Colo.

Folder containing useful data for the instruction of those interested in silo construction. Gives rules for building and for estimating quantities of materials, with example, sectional diagrams, and tables of quantities of materials, dimensions of reinforcing bars, and dimensions of silo, and quantities of silage in proportion to size of herds.

CATALOGUE REVIEWS

Lakewood Cars.—Paper, 6x9 ins.; 152 pp. The Lakewood Engineering Co., Cleveland, O.

A handsome catalogue with the title "Lakewood Cars, Book No. 16," has been recently published by the Lakewood Engineering Co., in which a few of the many types of Lakewood factory and industrial cars and trucks are shown.

The first section is devoted to Lakewood "V" dump cars used for many purposes. Pages 18 to 26 show a few standard types of these cars, while beginning on page 28 there appear a number of installation pictures showing the cars in different classes of service and handling a variety of materials. Beginning with page 37, the book takes up quarry cars, mine cars and a variety of miscellaneous cars adapted to many services, including side, bottom, end and all around dump cars, rack cars, removable side, gate dump, scale, incline and platform cars.

In the last part of the book are shown and described some of the accompanying equipment, such as industrial railways, portable track, switches, turntables, etc., locomotives, clam-shell buckets, mixers and distributing plant.

INDUSTRIAL NOTES

The Bucyrus Co., of South Milwaukee, Wis., has shipped recently to Sweden on orders four No. 100 C. electric shovels and one 35 B. electric revolving shovels. There are now operating in Sweden and Norway, in addition to the above, 20 Bucyrus shovels.

The Lehigh Portland Cement Co., Allentown, Pa., announces with regret the retirement of Mr. Edward S. Larned from the position of Manager of Sales for the New England States. Mr. Larned has not yet made known his plans for the future, and maintains his address at the City Club, Boston, Mass.

The Cleveland Galvanizing Works Co., Cleveland, O., has acquired an entire city block adjacent to its present location at Cleveland. This will permit the company, who manufacture a line of weldless wire chain, sash chain, and chain of all kinds, to greatly enlarge its present plant and output, as soon as some leases expire.

MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York, has been awarded contracts covering concrete pile foundations for the following: Grain Elevator, Standard Tilton Milling Co., Alton, Illinois; Mill Building, Paterson Parchment Paper Co., Passaic, N. J.; Factory Building, Electric Auto-Lite Co., Toledo, Ohio.—Mills, Rhines, Bellman & Nordoff, Architects, Toledo.

RAILWAYS

BIDS ASKED.

New York:

New York, N. Y.—Until Nov. 30, by Public Service Commission for First District, for Section 2, Routes 19 and 22, being elevated extension of South Blvd. and West Chester Ave. branch of Lexington Ave. subway, extending northerly over West Chester Ave.

New York, N. Y.—Until Dec. 7, by Public Service Commission, First District, 154 Nassau St., for Section 3 of Route No. 8 of the dual system of rapid transit, comprising tunnel section under East River from 14th St. to North 7th St., Brooklyn.

PROSPECTIVE WORK.

Alabama:

Gadsden, Ala.—Louisville-Nashville R. R. may build a 3-mile spur from Altoona to Walnut Grove, where new iron ore mines are being developed.

Alaska:

Seward, Alaska.—Surveys for the Government Alaska R. R. are reported to be practically completed. On Nov. 1, about 80 miles of steel had been laid and 30 miles of additional roadbed were ready for rails.

California:

Trinidad, Cal.—Northwestern Pacific R. R. is reported contemplating early construction of extension northward from Trinidad.

Florida:

Jacksonville, Fla.—The right-of-way for the municipal railroad from the new dock to connect with the main line of the Florida & East Coast R. R., has been secured.

Georgia:

Macon, Ga.—Southern Ry. will expend about $100,000 for construction of approaches for its line to new union passenger station in this city.

Illinois:

Harrisburg, Ill.—It is reported that construction may be started in the spring on the proposed electric railway to connect Marion, Johnson City and Herrin with Benton and Harrisburg. W. H. Schott, 1813 Harris Trust Bldg., Chicago, Ill., is interested.

Creal Springs, Ill.—Illinois Central Ry. is reported to have surveys under way for cutoff, starting at this point, for eliminating high grade at Ozark Hill. Improvement would involve construction of short tunnel in the neighborhood of McCormick.

Kansas:

Coldwater, Kan.—Greensburg, Coldwater & Northwestern R. R. Co. is to be incorporated and proposed construction of a 210-mile railroad from Coldwater, in almost a straight line across the state of Kansas to Almena on the Nebraska line. P. Z. Wardall, Greensburg, Kans., is interested.

Topeka, Kans.—Chicago, Rock Island & Pacific Ry. is reported contemplating double tracking its line next spring between Topeka and McFarland, 38 miles.

Maine:

Bangor, Me.—Financial arrangements are reported to have been completed for construction of Mattawankeat & Northern railway, proposing 28 miles electric railway from Mattawankeat on Maine Central R. R. to Millinnocket, and to Bangor and Aroosook. Stone & Webster Engineering Corp., Boston, Mass., has been making surveys. Chas. W. Mullen, Bangor, Me., is promoter.

Missouri:

Kansas City, Mo.—Kansas City & Tiffany Springs Ry. Co. has been chartered with a capital stock of $500,000, and proposes a railroad from Kansas City to Tiffany Springs, 15 miles. T. H. Smith, Kansas City; J. H. Baird, Kansas City, Kans., and Robert Engleman of Parkville, Mo., are interested.

Mexico, Mo.—Mexico & Santa Fe R. R. Co. has been chartered with a capital stock of $160,000, and proposes an electric railway from a connection with the Chicago & Alton at Mexico to a point 16 miles northeast. Incorporators include J. A. Botts, W. W. Munday and N. W. Beamer.

New Jersey:

Morristown, N. J.—The new owners of the New Jersey & Pennsylvania R. R. are reported to plan improvements for the line at once; also laying of track on graded extension from Watnong.

Trenton, N. J.—New Jersey & Pennsylvania Traction Corp. proposes to double track West Hanover St. from Greens Pl. to Calhoun St.

New York:

Cooperstown, N. Y.—It is reported Otsego & Herkimer R. R. Co. propose an expenditure of $250,000 for betterment.

North Carolina:

Sanford, N. C.—Surveys have been completed for proposed extension of Central of Carolina R. R., from Lillington to Mt. Olive.

Ohio:

Ironton, O.—Chesapeake & Ohio R. R. is reported to be planning to begin work early next year on the improvement and enlargement of its Russell yards.

Tiffin, O.—The Baltimore & Ohio R. R. is reported to be considering extending Findlay, Fort Wayne & Western Ry. from Findlay to Tiffin.

Oklahoma:

Bartlesville, Okla.—Project is under consideration for construction of interurban line through this place connecting Nowata and Pawhuska. Geo. C. Priestly, Bartlesville, is reported to be interested.

Altus, Okla.—It is reported that construction will be resumed shortly on the Altus & Pacific R. R., and that the division between Memphis and Lubbock, 100 miles, will be built first. T. C. Nobles, Houston, is interested.

Oregon:

Falls City, Ore.—Falls City Lumber Co. has completed survey for an 8-mile extension of its railroad into the Siletz basin.

Pennsylvania:

Lock Haven, Pa.—New York Central & Hudson River R. R. is understood to be planning construction early next year of branch from Keating to Avis.

Texas:

Denton, Tex.—Proposition has been submitted to the citizens of Krum and Denton for the construction of a railroad between the two places. E. P. Turner, Dallas, Tex., is interested.

Washington:

Mount Vernon, Wash.—The Puget Sound & Cascade Ry. Co. proposes an 8-mile extension of its line west from Clear Lake to Mount Vernon.

North Yakima, Wash.—Cascade Lumber Co. has organized the Teanaway Logging Ry. Co. for the purpose of constructing 12 miles of main line and 7 or 8 miles of spurs for logging purposes. It is stated that surveys have been completed, right-of-way purchased, and that the construction will be started in Spring.

Nicaragua:

Bluefields, Nicaragua.—J. A. Anderson, Winnipeg, Canada, has applied for franchise for constructing a railroad from Bluefields, on the Caribbean coast, to Leon, on the Pacific slope.

BIDS OPENED: CONTRACTS LET

Georgia:

Macon, Ga.—J. Henry Miller, Inc., Baltimore, Md., has been awarded contract by Macon Terminal Co., for erection of its terminal station. Virginia Bridge & Iron Co., Roanoke, Va., was awarded contract for 2,000-tons of steel. Estimated cost of the development including building of platform and approaches, is about $650,000.

Massachusetts:

Boston, Mass.—Coleman Bros., 166 Devonshire St., city, have been awarded contract at $382,394, for the construction of Section G of the Dorchester Tunnel for the Boston Transit Commission. The contract called for 1,280 ft. of two-tracked subway for electric passenger trains.

Mississippi:

Leakesville, Miss.—H. J. Bonnabel, Lucedale, has been awarded contract for 13-mile extension of Alabama-Mississippi railway from Leakesville to Evanston.

Missouri:

Kansas City, Mo.—List & Gifford Construction Co., Kansas City, Mo., has been awarded contract by Kansas City Southern R. R. for widening and deepening ditches on its entire line. List & Gifford also secured contract for 60 miles of bank widening for this railroad.

New York:

New York, N. Y.—A. L. Guigone & Son, Inc., New York City, awarded contract at $513,656, for construction of station finish on Section 2 of Route No. 39, New Uprecht Ave. elevated railroad in Brooklyn.

New York, N. Y.—Geo. S. Bennett, 36 Northern Ave., New York City, at $204,000, was low bidder for installation of tracks on Queens Borough Subway Extension, Astoria Elevated Line and Corona Elevated Line for Public Service Commission.

Ohio:

Miamisburg, O.—Ferguson & Edmondson, Keystone Bldg., Pittsburgh, Pa., have been awarded contract for grading, etc., for second track between Miamisburg and South Dayton for the Cincinnati, Hamilton & Dayton Ry.

Oklahoma:

Muskogee, Okla.—A. L. Cook, Ottawa, Kans., has been awarded contract for bank widening work for Missouri, Kansas & Texas R. R. in Oklahoma.

ROADS
STREETS

BIDS ASKED.

Alabama:

Camden, Ala.—Until Dec. 6, by Blair Hughes, County Road Supervisor, for constructing about 17 miles of sand clay or clay and gravel roads.

California:

Santa Barbara, Cal.—Until 10 a. m., Nov. 22, by County Clerk, for two contracts for fencing for state highway.

Florida:

West Palm Beach, Fla.—Until Dec. 23, by Geo. O. Butler, Clerk, County Commissioners, for hard surfacing military trail from Okeechopee Road west of West Palm Beach to Palm Beach canal.

Fellsmere, Fla.—Until Nov. 20, by Wallace Sherwood, Secretary Commissioners, for about 26,000 sq. ft. of concrete sidewalks.

Indiana:

Madison, Ind.—Until 1 p. m., Dec. 7, by C. S. Bibler, County Auditor, for ten-ton traction road roller, new or second-hand, with or without scarifier.

Muncie, Ind.—Until 10 a. m., Dec. 8, by F. M. Williams, County Auditor, for 4 gravel roads in Perry and Mt. Pleasant Townships.

Kokomo, Ind.—Until 10 a. m., Dec. 7, by Wm. L. Benson, County Auditor, for ⅛ mile of gravel road in Honey Creek Township.

Vincennes, Ind.—Until 2 p. m., Dec. 7, by Joseph I. Muentzer, County Auditor, for 11,450 ft. of gravel road in Washington Township and 12,560 ft. of gravel road in Decker Township.

Knox, Ind.—Until noon Dec. 7, by Chas. Weninger, County Auditor, for roads in Center and California Townships.

Franklin, Ind.—Until 2 p. m., Dec. 6, by H. L. Knox, County Auditor, for gravel road in Franklin and Union Townships.

Greencastle, Ind.—Until 2 p. m., Dec. 6, by C. L. Airhart, County Auditor, for about 2 miles of macadam road in Jackson and Floyd Townships, ½ mile in Franklin and Monroe

Engineering and Contracting

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and to Methods and Cost of Construction**

EDITORS

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A "Census" of Electrical Engineering Students and Graduates.

For the last nine years the *Electrical World* has annually published its census of electrical engineering students. Statements for the college year ending in June, 1915, secured from 117 colleges, show that there were 10,231 students enrolled and that 1,532 graduated. About 18 per cent of those enrolled were taking special, short courses in electricity. These 117 colleges had graduated a total of 22,475 men, of whom about 15 per cent had taken only short courses.

The following is the census by years:

Year ending June—	Students enrolled.	Graduated.
1907	8,929	1,358
1908	9,651	1,501
1909	8,670	1,473
1910	9,041	1,543
1911	9,515	1,641
1912	8,921	1,442
1913	9,143	1,366
1914	9,569	1,630
1915	10,231	1,532

Two facts are noteworthy: First, the relatively slow increase in the number of enrolled students. Second, that positive and negative annual departures from average registration have been less than 9 per cent.

We plan to publish soon a similar "census" that we are making of civil engineering students and graduates. It will then be interesting to compare numerical progress in these two large divisions of engineers.

A Novel and Effective Concrete Distributing System.

The contractors for the Field Museum of Natural History, now under construction in Chicago, are using a concrete mixing and placing plant which involves some original and effective features. The large area covered by this structure—its total width being about 438 ft. and its length 706 ft.—coupled with the fact that its concrete foundation is carried up from elevation—2.5 ft. to about elevation +33 ft., emphasized the need for a concreting plant which would be both flexible and economical in operation. The arrangement and facilities afforded by this plant are such that it is possible to spout all the concrete in either half of the structure from a single hoisting tower 180 ft. in height. The concrete in the west half of the foundation is being placed from the present position of the tower, while it is planned to move the mixing plant bodily to a central position in the east half for placing the concrete there. In the "Buildings" section of this issue we are publishing an article on the construction plant and methods in use on this work. As the dominant feature of the construction plant is the concrete distributing system a brief description of it is given herewith.

In the main, the concrete distributing system consists of a centrally located tower, four radiating lines of chutes leading to four derricks set on top of permanent concrete piers, and a system of counterweighted trusses suspended from the boom of each of the four derricks, one upper chord segment of each truss being constructed in the form of a chute. The operation of this distributing system, given somewhat in detail, is as follows:

The concrete is elevated 164 ft. in the hoisting tower, where it is automatically dumped into a distributing hopper equipped with a four-way gate. From this hopper the concrete is discharged into any one of the four 150-ft. permanent lines of chutes, in which it passes to a special form of distributing hopper attached to the 60-ft. mast of a derrick set on top of a tall concrete pier. From this hopper the concrete is discharged into a 40-ft. section of chute, the outer end of which is suspended from the 55-ft. boom of the derrick. The concrete then passes into the receiving hopper of another 40-ft. section of chute which forms one upper chord segment of a counterweighted truss, this truss being suspended at its apex from the end of the derrick boom. As the truss pivots at its point of support it is evident that concrete can be placed at any point in a circle, or, by attaching a 20-ft. section of chute to the end of the truss, concrete can be placed at any point within a circle, the radius of which is equal to the horizontal projection of the 40-ft. section of chute plus that of the auxiliary section used. The possible area covered may be further increased by shifting the position of the boom laterally. Provision is made for concreting at various levels by making each line of chute and also the special mast hopper adjustable as to height. This is accomplished by means of tag lines, which pass from the chutes upward through pulleys attached to the supporting cables and are continued to the ground, where they are anchored. By suspending a second counterweighted truss from the end of the first one, and attaching a short section of chute to it, the area over which concrete can be placed is still further increased. It will be noted that the arrangement outlined insures both flexibility and rapid operation, as it is possible—by means of the pivoted and counterweighted system—for one man to shift the end spout to any desired position.

This system of spouting has been in operation for a sufficient length of time to demonstrate its effectiveness and economy. The success attending its introduction on this work will undoubtedly lead to its widespread use in concrete construction.

Systematic Recording of Engineering Discovery by Engineering Societies.

Formerly when two nations made war on each other it was the habit of other nations to request and be granted the privilege to have army officers attached to the staffs of the opposing commanders as non-combattants. The duties of these attachees were to record and analyze the strategy and tactics employed with the purpose of applying the lessons learned to improving the military organization at home. War as it is now being waged has developed so many strange practices that this amiable custom may no longer be practiced. We are not particularly concerned in the fact of its persistence. However, it was a thoroughly practical custom and we have often speculated whether our associations of engineers could not advantageously adopt one somewhat similar.

Not to go abroad with our thought at first, we will consider the Panama Canal and the Catskill Aqueduct. It is always fair presumption and indeed all engineers know it as a fact, that great construction works like these are not prosecuted without bringing forth many lessons new and of value to the constructor and designer. Some of these lessons get to the engineering practitioners, in time perhaps they all do, but often the delay is so protracted that the lesson in the meantime has been learned from a subsequent source. Now then, could not, say the American Society of Civil Engineers, when these two great construction tasks were being waged, have delegated attachees to record, analyze and report the lessons discovered. This would not necessarily entail the appointment and compensation of special expert observers. On both works there were many members of the National society named engaged as engineers. Certain of these would have been willing without doubt to serve as recorders and reporters for a stipend of comparatively small size. Indeed we imagine that if the Society should have planned a comprehensive schedule of subjects to be reported upon and the reports to be published collectively it could have secured the authors without gift or recompense.

The assertions advanced in the preceding paragraph are: Every great engineering work brings forth new lessons in construction and design, the recording of which should be guaranteed and not left to chance, and, the engineering association can make recording certain with little trouble if it bestirs itself to that purpose. Two illustrations may be offered to demonstrate the truth of these assertions.

Vertical shafts connect the pressure tunnel or dry rock siphon sections of the Catskill aqueduct with the intervening sections of hydraulic grade aqueduct. The means at hand do not permit a precise count of these and other waterway shafts but as our recollection serves there are between 30 and 35. A circular section shaft afforded the best waterway but at the time of beginning construction (1908) the circular shaft was shunned in American practice. It was considered difficult and slow to construct. Now with the shaft work of the aqueduct substantially completed it is known that, using proper methods, these fears are groundless. Again when the first of the aqueduct's circular shafts was planned, timbering following excavation was regarded as a matter of course. The first shaft was excavated and carefully timbered and then it was lined, removing the timbering as the concreting advanced. The timbering, as will be seen, was virtually a temporary work and, since segmental timbering was necessary, it was rather expensive work. To avoid this expense trial was made of concreting directly following excavation. A small depth of shaft was excavated without timbering and immediately lined; then another depth was excavated and lined and so on to the full shaft depth. As experience was obtained, processes were speeded up and methods improved until the latest shafts built were excavated and concrete lined as rapidly as they could have been excavated and timbered.

The experience recorded establishes a distinctive advance in shaft construction. To discover the fact one must piece together fragmentary statements and data from many partial descriptions of the aqueduct shaft work. In no one place is there set down all the contributing factors, all the data of progress and costs, and an analysis of these which establish full proof. It is not to be presumed that the lesson indicated here is the only one of importance or even the most important one taught and only partially and by chance recorded in places available to the average reader. The instance is merely an example.

The ready ability of the engineering society to place on record with brief delay the lessons taught in prosecuting large engineering enterprises stands proved. A few years ago, soon after the completion of the great tunneling operations in New York City of the Pennsylvania R. R., the American Society of Civil Engineers in two volumes of size published a most complete account of all the important design and construction features. A somewhat similar task, involving the Panama canal work, was set for itself by the Pan-American Engineering Congress held in San Francisco this fall. To pass on the success of this effort we must await the published volume of papers. But whatever this success may be, the action indicates a practice which requires only proper planning and direction to be a success.

Obviously merely to mention these examples of special work by engineering associations has not been our final object. This is to demonstrate a means of service which every engineering society has within its power. Should it not, then, be a fundamental duty of every association of engineers to adopt a procedure which will guarantee that no advance of the first order in engineering design and construction shall fail to be recorded. It will be said that engineering societies do perform this task very largely. It is in a measure true that they do but it is by the happenchance of voluntary contribution by individual members. The contention is that they should perform the work as an integral part of their activities by thought-out plan and if occasion demands, with financial aid.

This idea that we have discussed and discussed, we must confess, in a somewhat idle mood, has possibilities of wide extension. Not very long ago we recorded trenchant criticisms by a foreign engineer of a somewhat elaborate experimental study conducted in this country. His criticism was that much of the work was supererogatory; it had already been well performed abroad and instead of to repetition the investigator should have devoted his efforts to the advance of the foreign studies. Perhaps the American investigator knew these foreign studies, but for reasons of his own decided to ignore them. The chances are, however, that he knew of them not at all or only in a vague manner. Here then is an instance in which an established plan by an American engineering society of recording foreign engineering studies would have served engineering progress? Or if this is not an instance to the point, one who follows foreign engineering activities can call to mind instances that are. Perhaps an M. Am. Soc. C. E. attachee to the Verein der Deutscher Ingenieure may not, after all, be an altogether absurd idea.

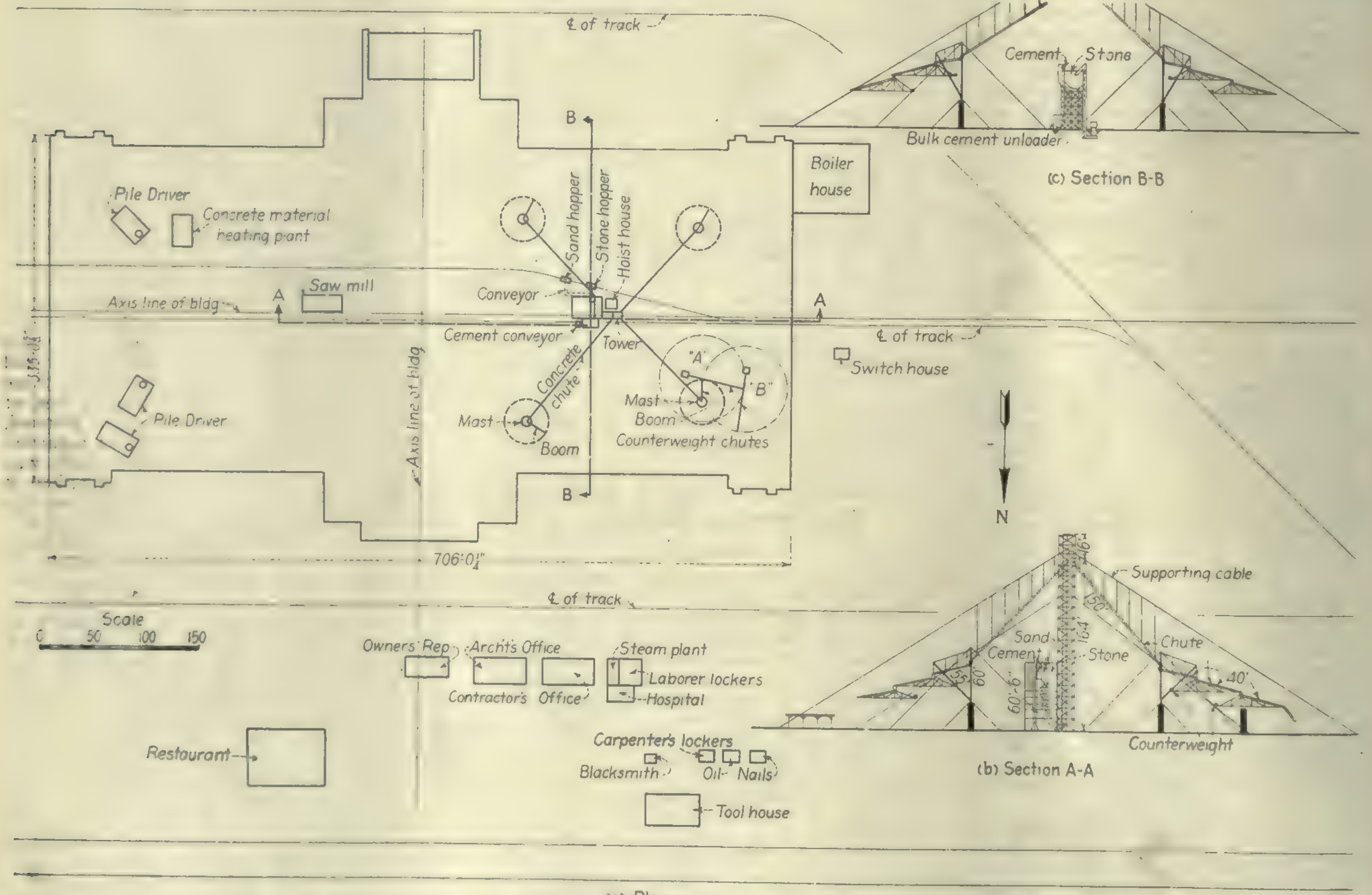
BUILDINGS

Methods and Plant Used in Constructing the Foundations for the Field Museum of Natural History, Chicago, Ill.

(Staff Article.)

The Field Museum of Natural History, now under construction in Grant Park, Chicago, will be one of the largest and most complete museums in the world. With a width of 438 ft. and a length of 706 ft., it will have a floor area of about 670,000 sq. ft., of which about 400,000 sq. ft. will be devoted to exhibition purposes. The plans for the museum call for a central portion, containing the main entrance, open from the first floor to the ceiling under the roof, a vertical distance of 77 ft. The main display spaces are located in the two symmetrical wings which flank the central portion. The outside and each alternate bay of these wings are three stories in height, while the intermediate bays are only one story high and are provided with skylight roofs, this arrangement giving excellent lighting facilities. The exterior of the building will be white Georgian marble, and the floor construction will consist of reinforced concrete on long-span steel beams, the ends of which rest on massive masonry piers, which take the place of columns. The arrangement of these piers is such as to give the effect of separate exhibition rooms, at the same time providing passageways from one room to another.

The structure will be supported on concrete piers, founded on clusters of wood piles, the pier bases being about 2 ft. 6 ins. below the lake level. The basement floor is at elevation + 34 ft., and the first floor at elevation + 50 ft., or 50 ft. above the lake level. The site of the museum was formerly a part of Lake Michigan, the original depth of water being about 15 ft. Before construction started the site had been filled in until all parts of it were above the lake level. The surface of the fill was very uneven, varying from about a foot above the level of the lake to a maximum of about 12 ft. above this level. To avoid unequal settlement all parts of the



(a) Plan

Fig. 1. Plan Showing Layout of Construction Plant for Field Museum of Natural History, Chicago, Ill., and Sections Through Concrete Mixing and Placing Plant.

structure, even the concrete basement and areaway walls, are supported on the piers, these walls being cantilevered from the piers by means of heavy girder constructions. At present, the pile foundations are practically completed, and concreting operations are being pushed on the piers and walls of the west half of the structure.

In the main, this article will treat of the construction plant and methods used in connection with the construction of the pile foundations, the piers, and the basement walls. The concrete plant is of special interest, as some original and effective devices have been installed. (The results of tests made to determine the character of the subsoil and the supporting power of the piles were given in our Aug. 25, 1915, issue; while the structural features of the museum were covered in an illustrated article in our issue of Sept. 22, 1915.)

LEVELING SITE AND DRIVING PILES.

Both on account of the size of the structure, and due to the fact that it is symmetrical about its north-and-south axis, it was decided first to construct the piers and basement walls of the west half of the building and then to use the same concreting plant for the east half, by moving it bodily to a central point in that half. The unevenness of the ground surface interfered seriously with construction operations, and it was therefore decided to level the surface, even though it would be necessary later to fill in the entire site from 20 to 30 ft. The high points were excavated with "Marion" steam shovels, this work being done at the same time that the foundation piles were being driven. Lines of spur tracks were laid from the main line of the Illinois Central R. R., which adjoins the site on the west. These tracks permitted the piles and other materials to be placed approximately in the positions needed. Up to Nov. 10, 1915, about 26,000 cu. yds. of clay fill had been moved with the steam shovels.

As has been noted, the tall concrete piers are supported on clusters of wood piles. These piles are 60 ft. long, of Georgia pine, and are almost perfectly straight. They are 9 ins. in diameter at the tip, and vary from 15 to 22 ins. in diameter at the butt, averaging about 18 ins. The total number of piles required is 9,320. Pile driving was begun July 29, 1915, and 8,100 piles had been driven up to Nov. 10. Three steam drivers, equipped with 70-ft. leads, are being used for this work. As the piles are cut off at elevation—1 ft. 9 ins. (the elevation of the pier bases being—2 ft. 6 ins.) it is necessary to use followers in all cases. The piles are driven through from about 16 to 25 ft. of clay fill, through a thin stratum of wet sand, then through from 20 to 30 ft. of soft blue clay, into strata of stiff to hard blue clay and gravel. All piles are driven practically to refusal at these depths. With the exception of about two weeks, during which time it was impossible to secure delivery of piles on account of floods in the South, pile driving has continued without interruption.

Each driver has averaged from 30 to 35 piles per day of ten hours, the pile driving crew consisting of 7 men, in addition to those whose duty it is to prepare the piles for driving and to bring them to the driver.

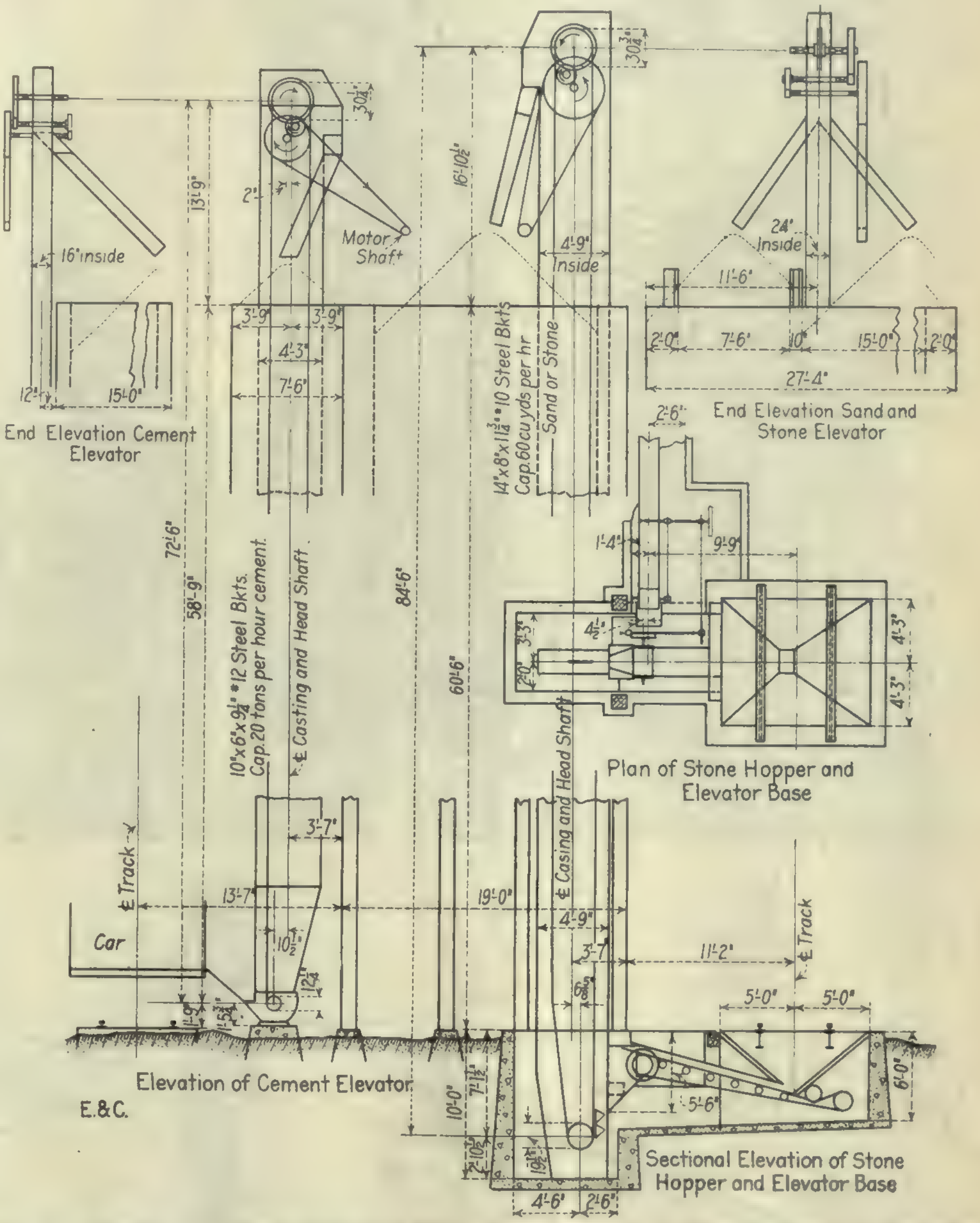


Fig. 2. **Details of Cement, Sand and Stone Elevators and of Stone Hopper of Concrete Mixing Plant for Field Museum of Natural History.**

CONSTRUCTION PLANT LAYOUT.

Figure 1 (a) shows the location of each unit of the construction plant, the concrete mixing and placing plant being shown in position for concreting the west half of the structure. It will be noted that materials are delivered to the site over three spur tracks, although access can also be had over a wagon road. One of these tracks is located south of the building site, another north, and a third is placed along the longitudinal axis of the museum; the latter branches, near the mixing plant, to permit sand and stone to be delivered along one side of it and cement along the other side. Separate offices are maintained for the owner's representatives, the architects, and the general contractor. The location of the restaurant, hospital, tool house, locker rooms, blacksmith shop, oil and nail sheds, sawmill, concrete materials' heating plant, and boiler house are shown in Fig. 1. It is of interest to note that the buildings are well constructed and are painted.

CONCRETE MIXING PLANT.

The concrete mixing and placing plant is centrally located on the west half of the building site. Its principal features are illustrated in the drawings of Figs. 1 and 2 and in the views of Figs. 3, 4 and 5. The mixing plant, which is of the "Hains" gravity type, has a capacity of 450 cu. yds. per 8-hour day.

As shown in Figs. 1 (a), 2 and 3, the sand and stone are discharged from bottom-dump cars into hoppers located under the tracks at the south side of the plant. On account of the short distance to the water level (about 7 ft. below the base of rail) it was necessary to make these hoppers quite shallow, the pits in which they are placed being only 6 ft. deep. Each hopper has a width, at the top, of 8 ft. 6 ins., a length of 10 ft., and a depth of 4 ft. 3 ins. The sand and stone are discharged from their respective hoppers onto belt conveyors, which convey them, alternately, to a common bucket elevator. One at a time, the aggregates are then hoisted by the bucket elevator into storage bins above the mixer, the tops of these bins being 60 ft. 6 ins. above the railroad tracks. The sand bin holds three cars (about 105 cu. yds.), and the stone bin four cars (about 180 cu. yds.). The elevator buckets, of No. 10 steel, 14x8x11¾ ins., are encased in a shaft, 2 ft. x 4 ft. 9 ins., inside dimensions. This shaft is constructed of 1x6-in. boards, with 2x4-in. braces and 6x6-in. uprights. It is divided into two compartments, to separate the ascending from the descending line of buckets. The elevator has a capacity of 60 cu. yds. of sand or stone per hour. Figure 2 shows details of the stone hopper and of the common stone and sand elevator; the sand hopper is similar to that shown in this drawing.

The bulk cement is taken from the cars by means of a "Clark" shovel, operating on a niggerhead, into a boot, where it is elevated by a separate bucket elevator into the cement storage bin, located adjacent to the sand and stone bins. This bin has a capacity of two cars (about 460 bbls. of cement). The buckets of this elevator, of No. 12 steel, 10x6x9¼ ins., are encased in a shaft 1 ft. 4 ins. x 4 ft. 3 ins., inside dimensions. The construction of this shaft is similar to that used for elevating the sand and stone. The cement elevator has a capacity of 20 tons per hour. Details of the cement elevator are given in Fig. 2.

The cement, sand and stone are discharged from their respective storage bins into a double measuring hopper, which permits one charge to be dumped while another is being measured. After passing through the gravity mixer the concrete discharges into a hopper located near the base of the tower. From this hopper it is discharged into a 36-cu. ft. elevating bucket, in which it is hoisted, by a

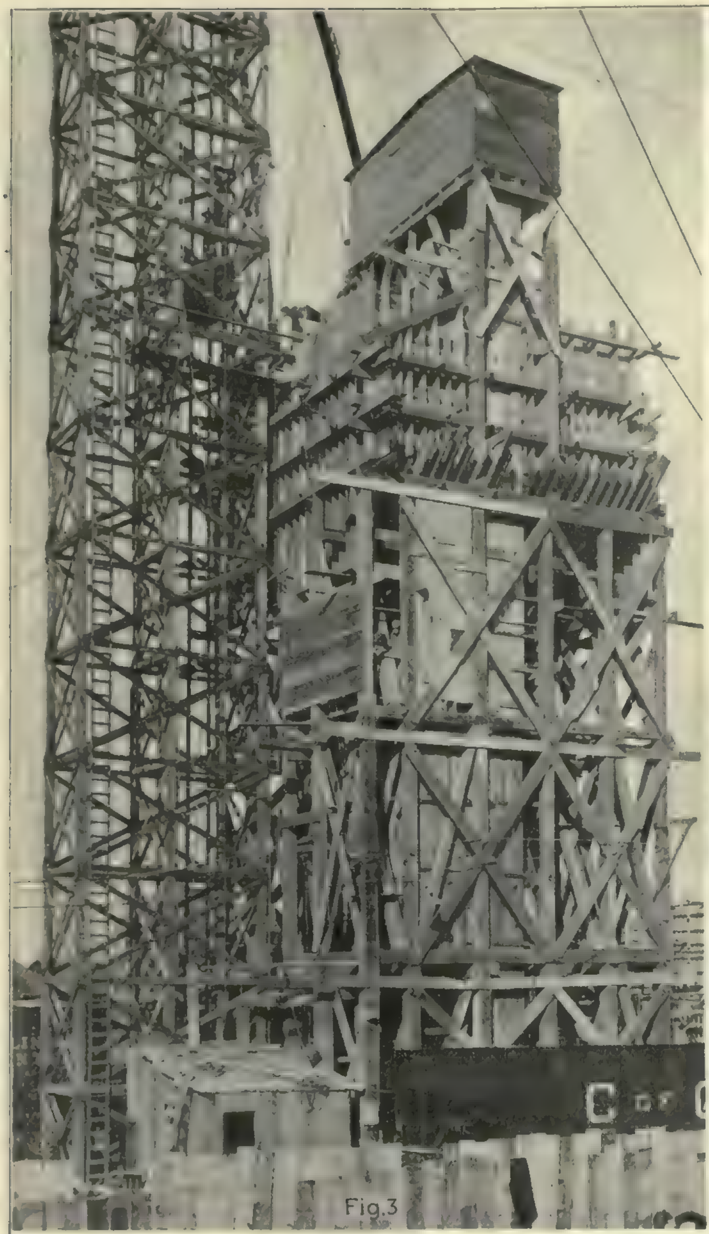


Fig.3

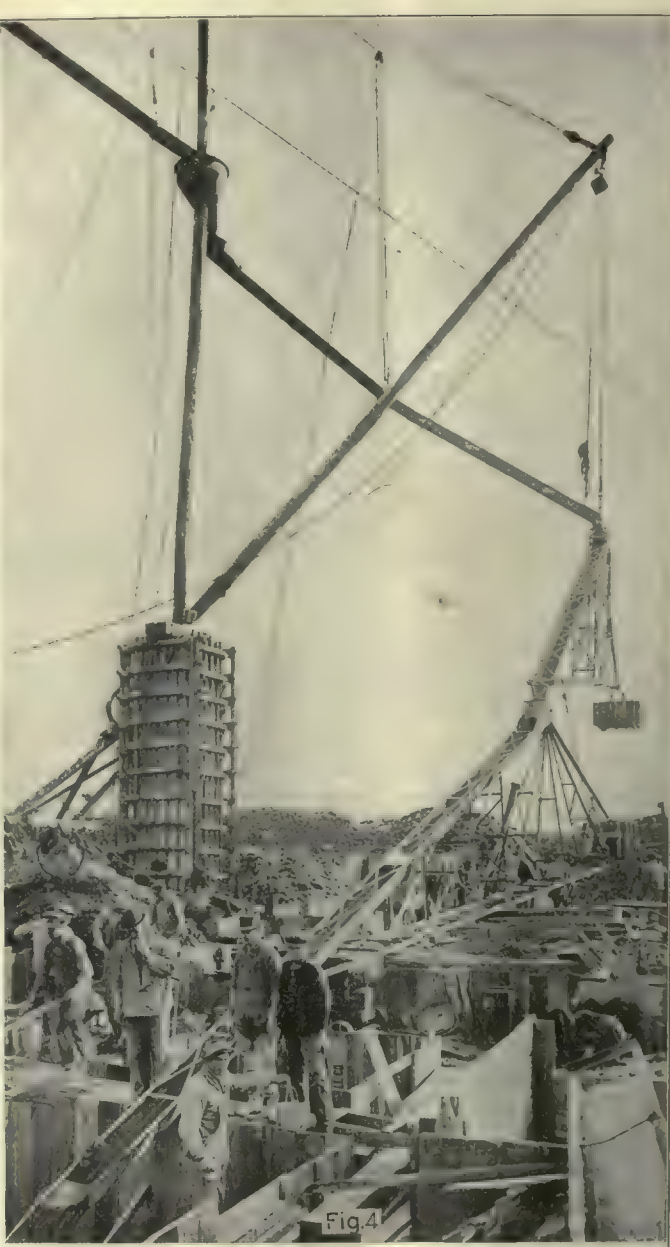


Fig.4

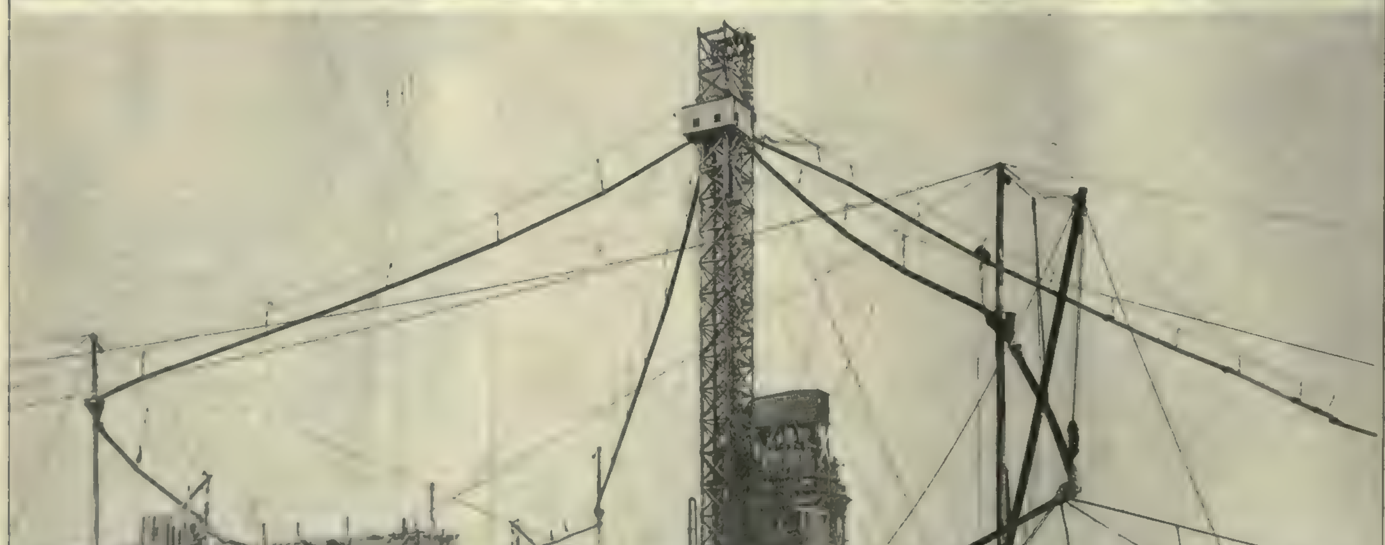


Fig.5

Fig. 3. Close View of Concrete Mixing Plant for Field Museum of Natural History. Fig. 4. Close View of One of Four Derrick-and-Counterweighted Truss Distributing Units. Fig 5. General View of Concrete Mixing and Distributing Plant.

"Thomas," double-drum, electric hoist, at a speed of 350 ft. per minute. The concrete is elevated 164 ft. and then automatically discharged into a 45-cu. ft. distributing hopper. This hopper is equipped with a four-way gate, to permit spouting in four directions. (Since its installation the capacity of the distributing hopper has been increased to 2 cu. yds. by building up its sides; this gives it a capacity of two batches.) The total height of the hoisting tower is 180 ft., its construction features being shown in Fig. 3.

CONCRETE DISTRIBUTING SYSTEM.

The dominant feature of the concrete plant is the distributing system, which permits the concrete to be placed rapidly and economically, without a change in the position of any of the four main lines of chutes.

As shown in Fig. 1 (a), there is a fixed line of chute, 150 ft. in length, leading from the distributing hopper at the top of the tower to a special form of hopper attached to the mast of each of four derricks, located in the positions shown. Each line of chute is supported, by hangers, from a cable anchored at a distance from the tower sufficient to bring the derrick end of the fixed line of chute about to the top of the derrick, when the chute is in its highest position. It is possible to vary the height of each 150-ft. line of chute, as the cable hangers pass through pulleys attached to the main supporting cable and are continued to the ground, where they are anchored (see Figs. 4 and 5.) It also is possible to raise or lower the mast hopper, as its special construction permits the mast to slide through its center. The capacity of this hopper is about 30 cu. ft.

The derricks are equipped with 60-ft. masts and 55-ft. booms. Each derrick is set on a concrete pier (the permanent piers of the building being here utilized), the elevation of the top of which is 33 ft. From the mast hopper a 40-ft. line of chute carries the concrete to a small hopper supported from the end of the boom. This hopper is located at the apex of a counterbalanced truss, one upper chord segment of which is a 40-ft. section of chute (see Fig. 4). Without changing the position of the boom it is possible to place all concrete within the dotted circle "A" (Fig. 1 a), or, by attaching a short section of chute to the end of the truss, this area may be increased somewhat. By changing the position of the boom it is evident that the possible area covered can be greatly increased. To increase still further the area served by the spouting equipment a second counterbalanced truss, similar to the first, is pivoted from the end of the upper truss. It is then possible to place all concrete within the circle "B" (Fig. 1 a), or, by attaching a short section of chute to the end of the lower truss, this area may be increased considerably (see Fig. 4). It is thus apparent that it is possible to place the concrete in the entire west half of the structure from the four derricks, without shifting the position of any of them. The trusses are so well counterbalanced that one man can easily swing the end of the chute to any desired position. This method of spouting was first used on this work, and it has proved highly successful.

The elevating bucket and chutes are of the "Insley" type. The chutes are constructed of No. 12 gage steel, and are reinforced with a No. 12 gage interliner, to give increased resistance to wear. It is estimated that these chutes are good for spouting 30,000 cu. yds. of concrete.

Although four fixed lines of chutes are provided, it is not planned to have more than three of them in operation at the same time, shifting operations being conducted on the fourth in the meantime. To date, only two lines have been in operation at the same time. The investment represented by the concrete mixing and placing plant is about $25,000, the cost of the tower alone being about $1,500. In concreting the east half of the structure it is planned to move the mixing plant bodily from its present location to a central position in the east half. The hoisting tower will be dismantled and re-erected in its new location.

CONCRETING FORCE.

To operate the concrete mixing and placing plant (using two lines of chutes) requires only 24 men, in addition to the two engineers who supervise the work. The division of work and the number of men required for each operation are as follows:

5 men at each chute, swinging the chutes and placing the concrete.
1 man at the measuring hopper, one hopper being filled while the other is emptied.
1 man to operate the levers of the concrete receiving hopper.
1 man to attend to transferring the concrete from the receiving hopper to the hoisting bucket.
1 to 2 men located at the distributing hopper at the top of the tower.
1 man to operate the tower hoist.
1 man to attend to the sand and stone elevating machinery, stationed under the housing.
1 signalman at the hoisting tower.
1 foreman in charge of loading bins, etc.
2 men unloading cement from the car.
2 to 3 helpers cleaning up sand and stone about the hoppers, etc.

To date, the concreting work has consisted of building the foundation piers and walls from elevation — 2.5 ft. to about elevation + 33 ft. The outside piers are provided with cantilever brackets, designed to support the wall and floor of the areaway (see Fig. 4).

EXCAVATING AND FORM WORK.

The excavating for the pier footings is done by hand, the pits being sheeted with 2x10-in. planks. About 17,000 cu. yds. of clay have been excavated to date in connection with the construction of the piers.

The pier forms are built of 1-in. lumber and 2x4-in. studs and girts. On account of the irregular shape of the piers the form work is quite complicated. The forms are constructed in sections, and are held in place with wire and "Gordon" clips. The sawmill equipment consists of a rip-saw, a band-saw, and a swinger-saw, the mill being operated by two men.

COST DATA.

The cost of driving piles has averaged about 7½ cts. per linear foot of pile.

The average cost of placing and stripping the forms has been about 8 cts. per square foot, of which about 2½ cts. are for material (with lumber at $23 per M) and 5½ cts. for labor.

Elevating the sand, stone and cement to their respective storage bins above the mixer has cost about 10 cts. per cubic yard of concrete.

The cost of mixing and hoisting the concrete has run about 15 cts. per cubic yard, and that of placing it about 50 cts. per cubic yard. These costs include both labor and investment charge on the plant.

GENERAL DATA.

The construction of the museum will require a total of 9,320 60-ft. piles, about 60,000 cu. yds. of concrete, 7,350 tons of structural steel, 500 tons of reinforcing steel, 650,000 sq. ft. of forms, and 400,000 cu. ft. of marble. The total cost of the museum will be about $8,000,000, and it will take about three years to build it. About 700 men are now employed on construction, in addition to the three piledriving crews and helpers. Of this number, there are 24 men and 2 engineers in the concrete gang, 75 carpenters and 2 foremen, and 52 carpenter helpers, of whom 14 are employed on the reinforcing. The remainder are employed principally in excavation work.

PERSONNEL.

The museum was designed by D. H. Burnham & Co. and their successors, Graham, Burnham & Co. Its construction is under the direct charge of Robert W. Grange, Jr., vice president and manager of Western business for the Thompson-Starrett Co.

Effect of Temperature on the Attainment of Strength of Concrete.

(Staff Abstract.)

The following data describe and give the results of some experiments made at the Illinois Engineering Experiment Station to determine the influence of temperature on the attainment of strength of concrete, the experiments being recorded in Bulletin No. 81 by A. B. McDaniel. Three sets of tests are described in this bulletin, but only the third set, in which the concrete was tested in the form of standard 8x16-in. cylinders, is treated in our abstract. (In the first set the concrete was molded in the form of 6x6-in. cylinders and in the second set, in the form of 6-in. cubes; in both of these sets the mixing conditions were not those met in practice.) The tests here considered cover sixty 8x16-in. cylinders.

MATERIALS.

The materials were of the same character and quality as those used for other concrete and reinforced concrete specimens made and tested by the Illinois Engineering Experiment Station during the past five years. The quality of the materials may be taken as representative of that used in first-class concrete work in the Middle West.

Cement.—Universal Portland cement was used in all specimens.

Sand.—The sand came from a deposit of glacial drift near the Wabash River at Attica, Ind. It was clean and well graded, its specific gravity was 2.65, its density was 1.79, and the sand contained 32 per cent of voids.

Stone.—The crushed limestone came from Kankakee, Ill. It was well graded and contained 49 per cent of voids. The stone had a specific gravity of 2.65 and a density of 1.35. It was carefully screened over a ¼-in. screen before use and contained 10 per cent of material smaller than ¼-in.

CONCRETE.

The concrete was composed of 1 part cement, 2 parts sand, and 4 parts broken stone, by weight; corresponding to 1 part cement, 2.2 parts sand, and 3.6 parts broken stone, by volume.

The cement and sand were first mixed dry to a uniform color and spread out on the concrete floor of the laboratory in a layer of uniform thickness. The stone was then added and the whole mass given four complete turnings. Water was then added, and the material turned until thoroughly mixed. The concrete was gathered together in a compact mass, to reduce evaporation to a minimum. The time of mixing each batch was kept as nearly uniform as possible.

MOLDING CONDITIONS.

The concrete was molded in sections of standard 8-in. wrought iron pipe, 16 ins. long, the forms being removed from the specimens after a storage of two days. The average air temperature during the molding was 68° F., and the average temperature of the concrete was 69° F. The concrete contained 9.3 per cent of water; it was wet and was very similar in consistency to that used in concrete building construction. The specimens were removed to their storage rooms after a set of six hours.

STORAGE CONDITIONS.

The temperature of the storage rooms was determined by daily readings of the maximum and minimum thermometers. The specimens will be referred to as sets *G*, *H*, *I* and *M*, each set containing 15 specimens.

Set *G* was stored in the ice storage room of an ice plant, at an average temperature of 26.5° F. Set *H* was stored in an ice chest of the dairy, at an average temperature of 34.7° F. Set *I* was stored in an interior heated room of a storage company, at an average temperature of 71.8° F. Set *M* was stored in a chamber of a heating conduit tunnel, at an average temperature of 95.6° F. While in storage all the specimens were covered with several layers of moist sacking, which was sprinkled daily.

TABLE I.—RESULTS OF TESTS OF SPECIMENS AT AGE OF 3 DAYS.

Set.	Weight, lbs.	Average diameter, ins	Crushing strength, lbs.	Strength, lbs. per sq. in.	Average strength, lbs. per sq. in.	Remarks.
G	67.75	7.94	8,880	180	190	Crumbled
	67.25	7.87	9,720	200		
	70.25	8.06	9,340	180		Crumbled badly
H	65.0	7.94	9,950	200	180	
	66.0	7.87	8,250	170		
	65.0	8.0	9,250	180		Plaster loose on one end
I	69.0	8.0	29,650	600	500	
	70.25	8.06	23,750	460		
	69.75	8.06	22,600	440		
M	64.0	8.0	24,000	480	500	
	65.0	7.94	30,850	620		
	65.0	7.94	20,000	400		

METHOD OF TESTING AND AGE.

The specimens were brought to the testing laboratory from their storage places, weighed, measured, their bearing surfaces plastered with plaster of paris, and tested within one hour.

Three specimens of each of the sets *G, H, I* and *M* were tested at the following ages: 3, 7, 10, 14 and 28 days.

RESULTS OF TESTS.

The results of testing three specimens each of sets *G, H, I* and *M*, at the age of 3, 7, 10, 14 and 28 days, are given in Tables I, II, III, IV and V, respectively.

The relation between the strength of the concrete and its age is shown graphically for the various sets in Figs. 1, 2, 3 and 4. It is noteworthy that under a temperature slightly below freezing the concrete gained strength continuously (see Fig. 1). It is also interesting to note that the curve for a mean temperature of 26.5° F. is substantially of the same character as that for a mean temperature of 71.2° F. (compare Figs. 1 and 3).

SUMMARY.

In Fig. 5 there is shown the relation between the strength of the concrete and its age for the several mean temperatures used in the tests.

In Fig. 6 there are given the interpolated results of the various tests, presented to show

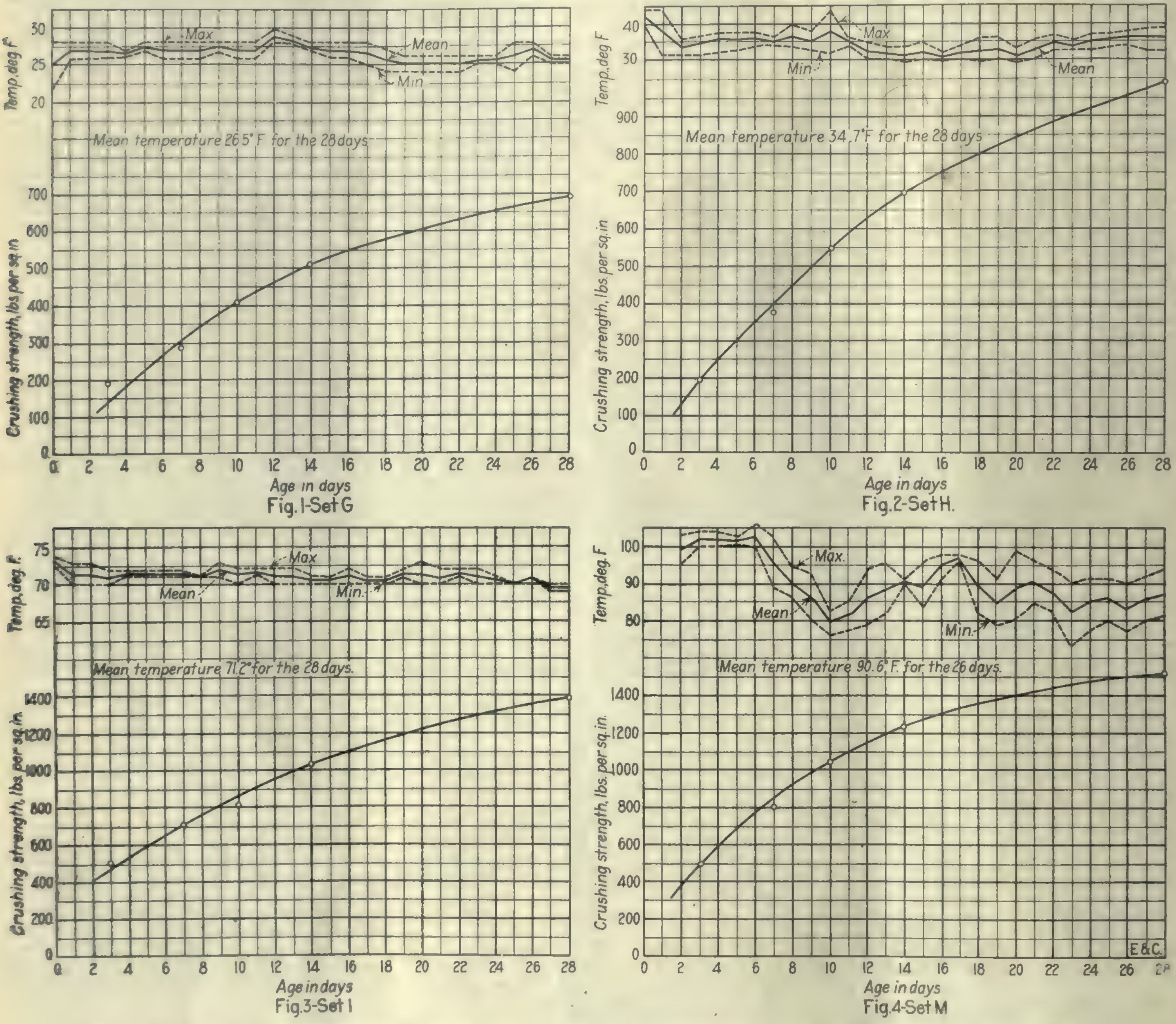


Fig. 1-Set G Fig. 2-Set H. Fig. 3-Set I Fig. 4-Set M

Figs. 1, 2, 3 and 4. Curves Showing Relation Between Strength of Concrete and Its Age for Test Sets, G, H, I and M.

TABLE II.—RESULTS OF TESTS OF SPECIMENS AT AGE OF 7 DAYS.

Set.	Weight, lbs.	Average diameter, ins.	Crushing strength, lbs.	Strength, lbs. per sq. in.	Average strength, lbs. per sq. in.	Remarks.
G	67.75	8.0	17,200	340	280	
	67.25	8.0	14,750	290		
	65.50	8.0	10,700	210		
H	66.0	7.87	14,450	300*	370	Skewed 1 in., horizontal crack
	69.5	8.06	18,920	370		
	65.5	7.94	18,530	370		
I	67.75	8.0	40,800	810	700	
	67.25	7.94	31,630	640		
	......	8.12	34,340	660		
M	68.0	8.0	44,500	890	790	
	69.0	8.06	40,250	790		
	69.0	8.06	35,150	690		

*Not used in calculating average strength.

TABLE III.—RESULTS OF TESTS OF SPECIMENS AT AGE OF 10 DAYS.

Set.	Weight, lbs.	Average diameter, ins.	Crushing strength, lbs.	Strength, lbs. per sq. in.	Average strength, lbs. per sq. in.	Remarks.
G	66.5	8.0	18,670	370	400	
	67.5	7.87	18,280	370		
	70.5	8.0	23,630	470		
H	68.0	8.0	25,000	500	540	2—8x8 forms
	68.5	8.12	30,680	600		
	69.0	8.06	26,830	530		
I	67.5	8.06	44,700	880	800	Top crumbled
	68.0	8.0	36,050	720		Skewed
						Fractur'd in transit
M	68.0	7.94	59,620	1,200	1030	
	69.0	8.06	46,700	920		
	69.5	8.06	49,540	970		2—8x8 forms

TABLE IV.—RESULTS OF TESTS OF SPECIMENS AT AGE OF 14 DAYS.

Set.	Weight, lbs.	Average diameter, ins.	Crushing strength, lbs.	Strength, lbs. per sq. in.	Average strength, lbs. per. sq. in.	Remarks.
G	70.0	8.0	26,430	520	510	
	68.5	7.94	25,330	510		
	69.5	8.06	25,420	500		
H	67.5	7.94	30,550	620	690	
	64.5	8.06	35,100	690		
	66.5	8.0	37,750	750		
I	66.0	7.94	51,000	1,030	1,040	Skewed slightly.
	69.5	8.0	63,230	1,260		Bearing faces not parallel.
	67.0	8.0	41,430	820		
M	67.5	8.0	58,000	1,150	1,220	Visible voids.
	66.5	7.94	40,650	820*		
	66.5	8.0	65,000	1,290		

*Not used in calculating average strength.

the relation between strength and temperature at different ages. This diagram may be used to determine: (1) the strength which the concrete attained at different ages under a constant temperature; (2) the ages at which a particular strength was gained under the different temperatures, and (3) the strength which may be expected at different ages under different temperatures. The relative strength attained by concrete at different temperatures during hardening and at different ages may be expected to vary somewhat with differences in cements, aggregates, and consistencies; but it is thought that the values in Fig. 6 may be taken to represent the effect upon the strength of the variation in the temperatures during hardening.

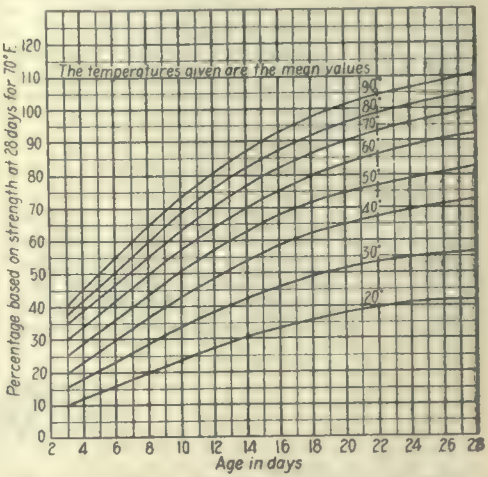


Fig. 7. Curves Showing Relation Between Strength at 28 Days for Temperature of 70° F. and That Obtained at Various Ages Under Varying Temperatures

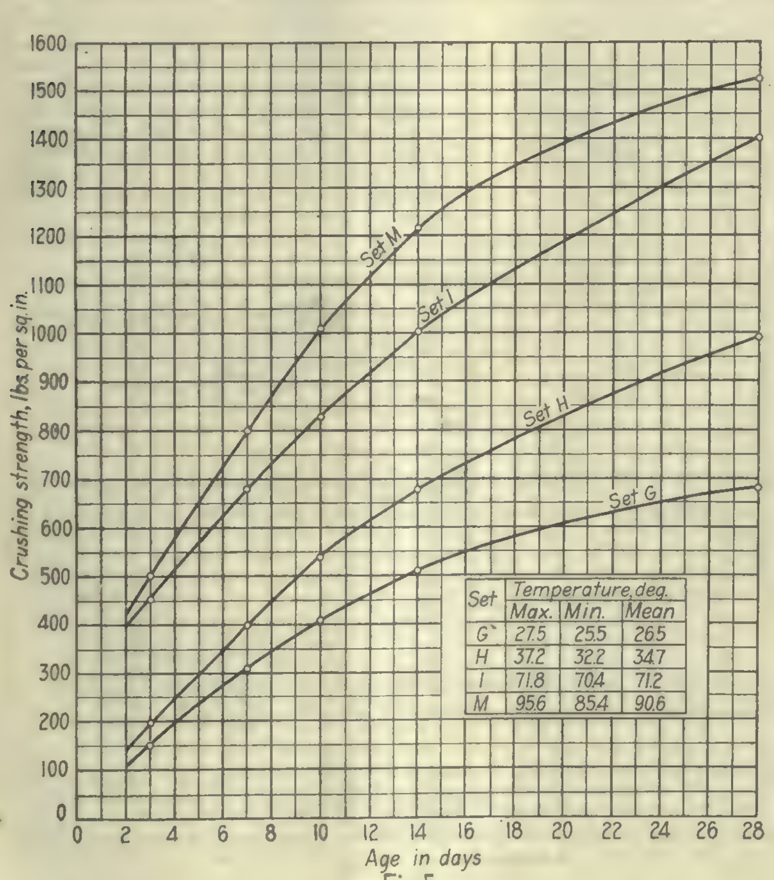


Fig.5

Fig. 5. Curves Showing Relation Between Strength of Concrete and Its Age for Mean Temperatures of Sets G, H, I and M.

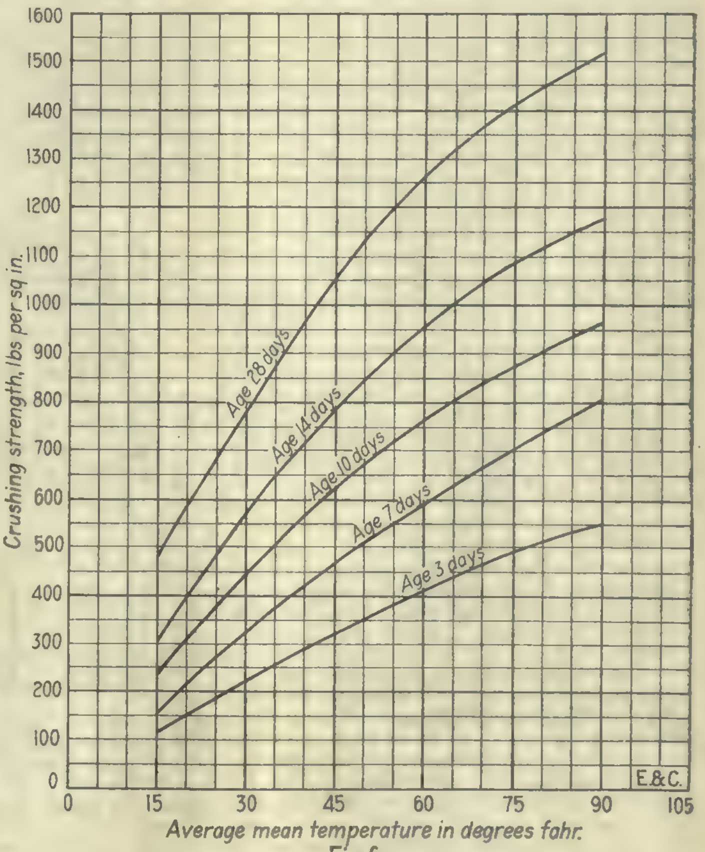


Fig.6

Fig. 6. Curves Showing Relation Between Strength of Concrete and Temperature at Different Ages.

TABLE V.—RESULTS OF TESTS OF SPECIMENS AT AGE OF 28 DAYS.

Set.	Weight, lbs.	Average diameter, ins.	Crushing strength, lbs.	Strength, lbs. per sq. in.	Average strength, lbs. per. sq. in.	Remarks.
G	68.0	8.0	32,100	630	680	
	67.5	7.94	35,900	730		
	65.0	7.94	34,100	690		
H	65.0	8.06	45,900	900	990	
	65.0	8.0	51,600	1,030		
	64.0	7.87	51,400	1,050		
I	68.5	8.0	83,950	1,670	1,380	Odd fracture.
	68.5	8.0	60,000	1,190		
	66.0	7.87	63,900	1,290		
M	66.0	8.0	63,500	1,260	1,530	
	66.0	8.12	101,900	1,960		
	66.0	8.0	68,200	1,360		

The curves of Fig. 7 have been drawn by taking values from those in Fig. 6. In a general way Fig. 7 shows the relation between the strength at 28 days under a temperature of 70° F., and that attained at various ages under varying temperatures. Figure 7 can be used in substantially the same way as Fig. 6.

The tests summarized in Figs. 6 and 7 cover a wide range of temperature conditions, the average temperature varying from 20.4° F. to 90.6° F., and are fairly consistent; hence it is believed these values are sufficiently accurate to furnish suggestive information which may be useful in determining the time when forms may be removed and loads applied.

CONCLUSIONS.

It is believed the following general conclusions are justifiable:

1. Under uniform temperature conditions there was an increase of strength with age within the limits of the tests. For any temperature the rate of increase decreases with the age of the specimen; and this rate of increase is less correspondingly at the lower temperature conditions. For the specimens tested, under normal hardening temperature conditions of from 60 to 70° F., the compressive strength of the concrete subjected to a uniform temperature at the ages of 7, 14 and 21 days may be taken as approximately 50 per cent, 75 per cent, and 90 per cent of the strength at 28 days, respectively. For lower temperatures the percentage values are less; and for higher temperatures the percentages are higher. The relation between the percentage values at the ages of 7, 14, 21 and 28 days is nearly the same for temperature conditions from 30° to 70° F. However, the values for the lower temperatures should be used with caution.

2. Concrete which is maintained at a temperature of 60° to 70° F. will at the age of one week have practically double the strength of the same material which is kept at a temperature of 32° to 40° F.

3. Figs. 6 and 7 may be used to determine the representative strength of concrete similar to that used in these tests, for various temperature conditions and for ages up to 28 days. These diagrams may be used with a fair degree of approximation to ascertain the relative strengths which concrete of ordinary practice may be expected to attain at the different temperatures. It should be noted that generally in this investigation the specimens were stored under temperatures which were nearly uniform during the whole storage period. In set *F* (not considered in this abstract) the variations in temperature include a number of alternations above and below the freezing point and the specimens were seriously injured. The results accord with the well-known effect of freezing and thawing upon green concrete.

WATER WORKS

Methods and Plant Employed in Constructing a Large Concrete-Lined Reservoir in California.

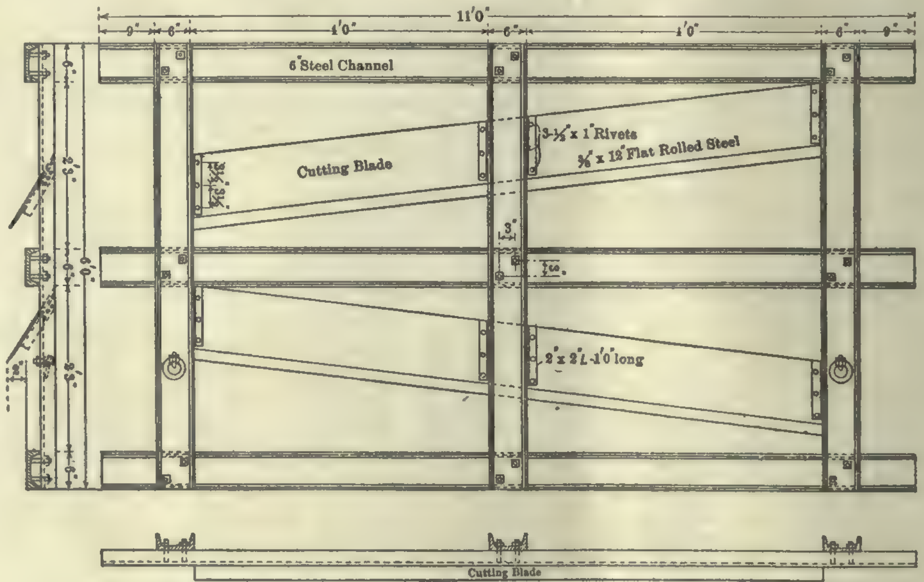
(Staff Abstract.)

A number of large earthen oil-storage reservoirs have been constructed in the oil fields of California. In general, these reservoirs are circular in plan, with earthen embankments built up from material excavated from within the reservoir, and range in capacity from 500,000 to 1,000,000 bbl. Some of the larger ones are oblong in plan, with circular ends connected by a rectangular section in the middle. In many cases dependence has been placed on the earth alone to prevent loss of oil by seepage, but it is now becoming general practice to line the inside slopes and bottom with a thin layer of reinforced concrete as an additional safeguard against leakage. The reservoirs are covered with a wooden roof supported, usually, by 6x6 in., or 8x8 in. posts resting on wooden footings or concrete piers. The present article describes the construction of one of two 750,000 bbl. reinforced concrete-lined reservoirs, built by the writer, for the Kern Trading and Oil Co., at Bakersfield, Calif., during the winter and spring of 1913-14. The general dimensions of the reservoir are as follows: inside diameter, bottom 462 ft., top 528 ft.; depth 22 ft.; width of top of embankment 11 ft.; inside slope 1½ to 1; outside slope 1½ to 1; thickness of concrete lining, bottom 3 ins., top 2½ ins.

Earthwork.—The formation at the site was a light sandy clay, and this was easily handled by the Fresno and wheel scrapers used throughout the work. After the site was cleared of all brush and grass, the foundation under the embankment was thoroughly plowed and wet down before the fill was started. Water for moistening the material was supplied through a 2-in. pipe line laid around the site, just outside the outer line of slope stakes, with hose connections approximately 100 ft. apart. A 2-in. line was also run to the center of the reservoir to supply water to the portion of the site which could not be reached from the outside line. To avoid being in the way of the scraper teams, this pipe line was laid through one of the three 12-in. outlet pipes that were placed in position under the fill at the beginning of the work. A narrow trench was dug from the inner end of this outlet-pipe to the center of the reservoir, and the 2-in. line was laid in it. This line was lowered from time to time as the work progressed, and was kept far enough below the surface of the excavation to be clear of the plow and scraper teams. Wetting down the excavation material was a help in several ways, as it not only made a more compact bank, but kept the dust down and made the earth ride better in the scrapers. This may seem inconsistent, inasmuch as the work was done during the rainy season, but can be readily understood on taking into consideration the fact that only 6 working days were lost during the winter on account of wet weather. The embankment was built up in thin layers, about 3 ins. thick, laid parallel to the floor of the reservoir, and well compacted. In addition to the tramping of the scraper teams, the fill was compacted by two petrolithic road tampers which were driven continually around the top of the embankment.

To insure a compact and uniform backing for the concrete lining, on the inner slope below the natural ground surface, the excavation was started 2 ft. (measured normal to the slope) inside the inner line of slope stakes. This necessarily increased the quantity of excavation, and left the embankment short on the inner slope by this quantity. After the completion of the main portion of the embankment, a lining of selected material, 3 ft. thick (measured normal to the slope), was built up against the inner slope, from subgrade (1 ft. below floor grade) to the top of the finished fill. This extra foot of material was put on to insure a compact surface at the grade line of the inner slope, but was afterward removed, as will be described later. The refill is an important part of the construction because it would cut off any layers of sand or loose material that might be encountered in that portion of the inner slope which lies below the ground surface. On some previous work it was found necessary to excavate and refill portions of the natural embankment, below the ground surface, after the fill had been completed and trimmed to grade; this work caused considerable delay and added expense. One concrete-lined reservoir in this field partly failed, due to neglect of this part of the work, necessitating heavy expense in emptying the reservoir, besides the loss of a considerable quantity of oil and the cost of patching the lining.

On the first reservoir, in which a refill was put in, the lining of selected material was started with Fresno scrapers, but these were soon abandoned in favor of wheel scrapers, on account of the difficulty in keeping them from sliding over the edge, and also because the wheel scrapers would build up a bench of the required width, and it was impossible to keep within the limits with the Fresnos. Apparently, the wheel scrapers build up a more compact lining.



Detail of Slope Trimming Machine Used on Embankment for Backing of Concrete Lining in a Reservoir.

Trimming Slopes.—On the completion of the main embankment and the refill, the excess material on the inner slope, which ranged in thickness from 1 ft. at the top to 2 ft. at the bottom, was trimmed off leaving the slope smooth and true to grade. For this work of trimming the slope, a novel and (the writer believes) original method was used. Grade stakes were set on radial lines, both at the top and inner toe of the slope, approximately every 10 ft. around the circumference of the reservoir. Men with mattocks and slope-level boards then dug narrow trenches, 1 ft. wide and true to grade, from the top grade stake to the stake at the toe of the slope. Then 2 by 4-in. timbers, 38 ft. long, each faced with a narrow strip of strap iron, were placed in the bottom of each trench to act as guides for a trimming machine which was used to finish that portion of the slope between the hand dug trenches. Before using the planer, however, all excess material above the top of the 2 by 4-in. timbers was scraped off the slope with a specially made Mormon or Buck scraper which was dragged up and down the slope, power being furnished by a double-drum hoisting engine at the center of the reservoir. The back-up line from the engine passed through a 12-in. snatch-block supported at the top of the slope on a portable wooden truss designed for that purpose. This wooden truss was anchored against overturning by two heavy chains fastened to iron stakes driven into the top of the embankment. As each succeeding section of the slope was finished, the wooden truss was moved along the top of the bank with a team of horses.

After the bulk of the material above the top of the 2x4 in. timbers had been removed, a slope trimming machine, designed and built by Mr. C. O. Zeller and the writer, was substituted for the Mormon scraper and used to plane off the remaining thin layer of earth and bring the slope to grade or flush with the bottom of the guides. The accompanying figure shows the trimming machine, which consists of a rectangular frame 11 ft. long and 6 ft. wide, built up of 6 in. steel channels bolted together and carrying two cutting blades. The cutting blades are of ⅜x12 in. flat rolled steel, and are set at an angle with the frame of 1 to 2½. The blades are also set at a slight angle longitudinally with each other, and the cutting edge projects down 2 ins. below the bottom of the frame. The planer is dragged back and forth on the slope until the ends of the frame ride on the top of the guides, and that particular section is shaved off flush with the bottom of the guides, or down to grade. In this way nearly nine-tenths of the slope were finished by machine and at one-half the cost of doing the work by hand. One might naturally suppose that there would be considerable difficulty in keeping the guides in place without staking them down, but very little trouble was experienced. Loose earth would fill in the trenches around the guides as the machine worked above them, and this served to hold them in place. The trenches being dug on radial lines necessarily made them closer at the bottom of the slope than at the top, but the blades of the planes were long enough to catch all the earth between trenches at the top of the slope and still have room at the bottom without binding between the guides. The crew on all the trimming work consisted of only seven men, including the engineer who ran the hoist.

Floor.—The floor of the reservoir was excavated to a depth of 1 ft. below grade, and the sub-grade was plowed and well rolled before commencing the refill upon it. It was then back-filled to grade, built up in thin layers, moistened and well rolled with petrolithic road tampers. Sand and gravel patches in the floor below sub-grade were excavated to a depth of 3 ft. below floor grade and then refilled with selected material. The floor was rolled smooth and hard to grade with a 5-ton road roller, a variation of only 0.05 ft. from true grade being allowed.

Pier Footings.—Excavations for the pier footings were made and the concrete piers for the roof supports were poured. Before pouring the concrete piers, however, and after the footings were dug, the floor reinforcing metal, which consisted of one layer of Clinton electrically welded fabric, made up of No. 6 wire in 6-in. square mesh, was laid out over the floor and tied together. The piers were poured through this metal, and later, when the floor was poured, this method left the reinforcing metal continuous throughout the floor and piers, without any patchwork.

Roof.—The roof was supported on 6 by 6-in. posts, approximately 18 ft. apart on centers, resting on concrete piers, and placed in concentric rings around the floor of the reservoir. The rafters were of 2 by 8-in. lumber, 20 ft. long, and were supported by 3 by 12-in. girders, 18 ft. long, which were notched into the tops of the posts. The rafters were laid on radial lines toward the center post, and 2 ft. from center to center at their inner ends. The roofing, or sheathing, was of 1 by 12-in. boards, surfaced on one side to give a uniform thickness, and these were of varying lengths to insure breaking of joints. The rafters that bridged the space from the top of the embankment to the first row of posts at the toe of the slope were of 2 by 14-in. lumber, 38 ft. long, and rested at their outer ends on 2 by 12-in. redwood mudsills on the top of the embankment. All posts and girders were cut to length before commencing the construction of the roof. Later, this lumber was hauled to the top of the embankment and skidded down to the bottom of the reservoir where it was loaded on hand-trucks and distributed.

Bents, consisting of two posts and a girder, were framed in the bottom and hoisted into position with a small hand derrick operating on the roof. This derrick consisted of a boom made up of two pieces of 2 by 8-in. lumber, 38 ft. long, supported in the middle on an ordinary two-wheeled lumber truck, and rigged with a 2-ton hand-operated hoisting crab. The hoisting line ran over a small sheave at the outer end of the boom, and consisted of ⅜-in. pliable steel cable. While raising a bent, the outer end of the boom was anchored to a rafter with a U-shaped bolt which could be quickly attached. Later, this system was changed somewhat, as the strain on the girder under the wheels of the derrick was considered too great for safety. The hoisting winch was transferred to the extreme end of the boom, which placed the men operating it over the second row of posts back from the edge of the roof, and only one post and a girder were raised at a time. This method worked very well, and good time was made. The best day's work consisted in raising 145 bents in 9 hours, or about one-fifth of the total number in the reservoir. In fact, good time was made throughout the job, as the roof, consisting of about 600,000 ft., b. m., was erected in 7 days with an average of 50 men.

In hoisting the bents the derrick worked on only one row at a time, starting at the outer row and working toward the center of the reservoir. The hoisting crew was followed by a crew which placed the rafters, and this one was followed by a crew laying the sheathing. Joints in the sheathing were made on top of the rafters, and, on account of the large quantity of sawing necessary, a special rig was devised for this purpose. A 2 H. P. electric motor, belt connected to a circular saw, was mounted on a small hand truck which could be wheeled around on the roof and used to cut off the ends of the sheathing. Pencil marks were made where boards were to be sawed, and this work was done by three men, including the saw filer. Power was supplied by a nearby power line, the transformers being mounted on a pole just outside the embankment. Wires were run to the center post and lead lines from there to the saw could be dragged to any part of the roof.

Concrete Lining.—The floor and slopes of the reservoir were covered with a lining of concrete reinforced with a continuous layer of Clinton electrically welded fabric made up of No. 6 wire in 6-in. square mesh. The thickness of the floor lining was 3 ins. and that of the slope 2½ ins. The concrete was mixed in a Ransome batch mixer of 1 cu. yd. capacity, placed at the outside toe of the slope, and was delivered into a hopper at the toe of the slope inside the reservoir by a hoisting tower and a 1-cu. yd. automatic dump bucket. From the hopper it was delivered into concrete buggies and wheeled to the spreading gang. In pouring the floor a 1½-in. layer of concrete was first spread over a small section, and the reinforcing metal was then raised up through the concrete before the second layer was poured. After pouring the slab the concrete was tamped with wide-faced wooden tampers and troweled smooth and even. The construction joint at the end of a day's work was beveled off, and, before placing concrete against it on the following day, was swept clean of loose material and thoroughly grouted with a mortar of neat cement.

The concrete for the slope was delivered from the hoisting tower into small hoppers set on wagons and hauled with teams around the top of the embankment. From the wagons it was poured directly on the slope. No forms of any kind were used, as the concrete was mixed so that it would not run any more than enough to facilitate spreading. The slope lining was also put on in two layers in order to insure that the reinforcing metal could be placed in the middle of the slab. No trouble was experienced in pouring the slope without the use of forms, as the concrete was mixed fairly "stiff" and was prevented from "sluffing" by the reinforcing metal. In fact the writer has just finished lining a reservoir with side slopes of 1 to 1 for the Union Oil Co. at San Luis Obispo, Cal., without the use of forms and with no appreciable difficulty. Each day's work was gone over on the following day and swept with a cement wash mixed in the proportion of 1 part of cement to 1⅓ parts of water. This wash of grout was applied to fill up any small checks which might appear while the concrete was taking its final set.

No expansion joints, either in the floor or slope, were put in, on account of the comparatively heavy reinforcement of the slab and the low range in temperature to which the concrete would be subjected.

The concrete for the floor lining was mixed in the following proportions, based on a mechanical analysis of the aggregates: 1 part cement, 3 parts sand, 1½ parts of ½-in. crushed rock, 2½ parts 1-in. crushed rock.

This mixture worked well on the floor, but was found too rocky for the slope, as it was very difficult to tamp the concrete and prevent it from sluffing to the bottom of the slope. For this reason the 1-in. rock was eliminated and the following mixture used: 1 part cement, 2 parts sand, 2 parts ½-in. crushed rock.

The concrete crew, consisting of a foreman and 30 men, poured an average of 20,000 sq. ft. of lining per 9-hour day.

Roofing.—After the completion of the concrete lining the roof was covered with a layer of Pioneer Paper Co.'s 1-ply roofing, and this was covered with a layer of asphaltum and gravel. For each 100 sq. ft. of roof area 30 lbs. of asphaltum and 1.35 cu. ft. of gravel were used.

Cost.—Concrete-lined reservoirs of this type cost, complete, from 9½ to 10 cts. per bbl. of capacity, depending on the location and other governing conditions. This cost may be distributed approximately as follows:

Cost of earthwork	$0.03 per bbl. of capacity
Cost of roof	0.03 per bbl. of capacity
Cost of concrete lining..	0.04 per bbl. of capacity

The work was done by Mahoney Bros., Allison & Cole of San Francisco, with the writer acting as superintendent of construction. Mr. Earl Derby was resident engineer for the Kern Trading & Oil Co.

ACKNOWLEDGMENT.

From a paper by E. D. Cole entitled "Concrete-Lined Oil Storage Reservoirs in California: Construction Methods and Cost Data," published in Vol. XL. Proc. Am. Soc. C. E., pp. 1327-1350.

Use of Riveted or Screw Jointed Pipe for Submerged Lines.

(Staff Abstract.)

When it is considered that any riveted or screw-jointed pipe line, of whatever diameter, has a certain radius to which it may be bent without causing leakage of the contents, it raises the question why this kind of pipe should not wholly replace hinge-jointed pipe lines.

If such a steel pipe line, though even of tunnel dimensions, be loaded on the exterior, or interior, or both, so as to give the combination a specific gravity slightly greater than 1, and the front end be then closed water-tight, the pipe may easily be hauled across on the natural, or on a prepared bottom of the river, to which it will fit itself by virtue of its inherent flexibility.

Weighing little or nothing in the water, it exerts little or no pressure on the bottom on which it slides; and, without material pressure, offers no material frictional resistance.

Heavy pipe, or pipe full of water, may also be hauled across on the bottom. Sixteen lines of 12 and 18-in. flexible-joint cast-iron pipes have been thus hauled across a 1,000-ft. channel at Vancouver, B. C., and quite recently about a mile of pipe was hauled out from a sand beach into deep water off Tampico, Mexico, to enable tank steamers to load with oil.

In 1895 the writer laid seven lines of 18-in. screw-jointed pipe (the largest size of welded pipe then made) by the method described in a trench dredged for the purpose across the Passaic River at Belleville, N. J., at a narrow crossing that was constantly impeded with passing vessels. Flexibly jointed pipe could not have been laid at this place from floats or scows.

A flagstaff set on the forward end indicated where that end was at any moment; and the rear end was added to and extended backward on a kind of launching way as the pipe passed into the water from that end.

During the passage of the forward end across on the bottom of the river, filling the pipe with compressed air furnished proof that there was no leakage, and for 19 years a Venturi water meter set in this line of pipes on each shore has proved that they do not now and never have leaked, though under some 350 ft. head. On the other hand, it is doubtful if any form of flexible-joint pipe ever laid will stand or would have stood such a test equally well, it being remembered that water under 350 ft. head will cut out lead very rapidly if a leak is once started.

A 6-ft. pipe was laid under the Hackensack River by this general method some years later. The fact that it broke apart at one point at the bottom of the pipe shortly after it was laid is no criticism of the general method of laying such pipe here described, but only of the special method of loading the pipe in this instance. The break was immediately repaired and the pipe is today doing good service.

The loading must be designed so that it will not affect the natural flexibility of the pipe, which is far greater than one would suppose. Speaking from memory, a riveted 4-ft. pipe can be made to assume a curvature of 1,000 or 1,200 ft. radius without causing the pipe to leak, and such a radius is easily attainable in a river cross-sectional profile; or the pipe may be built on a curve following the profile across the river selected, a special curved launching way being used when hauling the pipe across.

ACKNOWLEDGMENT.

From discussion of D. D. Clarke's paper on Submerged Pipe Work at Portland, Ore., by Clemens Herschel, Vol. XLI, Proceedings American Society of Civil Engineers.

Efficiency of the Liquid Chlorine Sterilization Plant at Wakefield, Mass.

(Staff Abstract.)

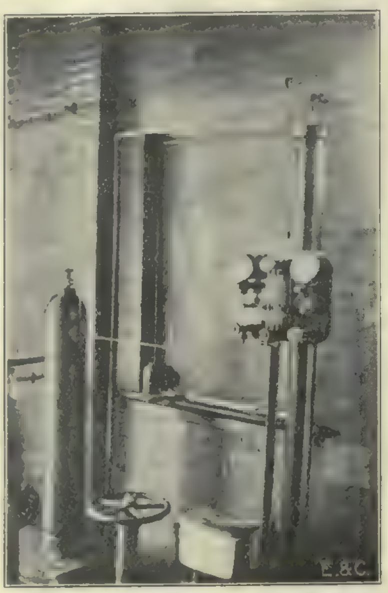
The only chlorine gas plant used for the sterilization of a municipal water supply in Massachusetts is the one at Wakefield, which has been in regular use since Sept. 1, 1914. Wakefield, with a population of some 13,000, has a surface water supply taken from Crystal Lake, in the outskirts of the town, and pumped directly into the mains, a standpipe serving to take the surplus and to afford a night supply, the pumps being run about 8 hours a day. A considerable part of the watershed is under cultivation and much of the resident population is without sewers, so that heavy rains wash a good deal of organic matter into the lake, raising the bacterial content very considerably and at times causing dangerous contamination.

The expense of installing filters was not considered by the Water Board to be justifiable, as they estimate that the growth of the town will make a new source of supply necessary in from 10 to 15 years. Indeed it is probable that the capacity of Crystal Lake would have been reached by now had not the introduction of meters on services resulted in checking the waste of water and in reducing the per capita consumption to about 48 gals. per day.

The Board asked the writer to recommend an inexpensive means by which the water could be kept safe for domestic use, though the physical characteristics remained unchanged. The use of chlorine gas sterilization was recommended on account of the simplicity of operating the apparatus and applying the chlorine to the water. The plant was purchased from the Electro-Bleaching Gas Co. of New York City and is here illustrated. The makeup and operation of this apparatus have been described in previous issues of ENGINEERING AND CONTRACTING.

During the first year of the operation of the plant, ending Sept. 1, 1915, 75 samples of raw water and 107 samples of treated water from taps in Wakefield were collected and examined. Samples were collected at intervals of from one day to one week, depending on the results of previous analysis and on the weather. The examinations, which are made in the laboratory of Mr. Robert Spurr Weston of Boston, indicated that the treated water was continuously safe.

The total number of bacteria in the lake water has varied from a minimum of only 30 per c. c. in August, 1915, to a maximum of 1,420 per c. c. in January, 1915, just after a hard, warm rain had removed a considerable accumulation of snow and ice from the watershed.



View of the Liquid Chlorine, Water Sterilization Plant at Wakefield, Mass.

The total number of bacteria in the treated water has seldom been above 30 per c. c., the maximum being 56 and the minimum 1 per c. c. In January, on the day when the lake was in its worst condition, we found only 16 bacteria per c. c. in the treated water. For the year the averages were, for Crystal Lake, 254 bacteria per c. c., and for the supply as delivered to the consumer, 18 bacteria per c. c., an average removal of bacteria of all kinds of 93 per cent.

B. coli were found in 17 per cent of the raw water samples and in none of the treated water samples, the counts being made on 10 c. c. samples.

To secure these results the amount of chlorine has varied from a minimum of 1 part to 2,000,000 parts of water in December, 1914, to a maximum of 1 part in about 800,000 parts of water for a very short time in January, 1915. The water at this time contained a large amount of organic matter, much of it of a harmless nature, but it made necessary an unusually large dose of disinfectant in order to get the desired effect on the bacteria. If the water could be clarified by rapid filtration prior to the sterilization it is probable that even better results could be secured and with less chlorine.

As it is becoming more difficult to secure adequate natural supplies of pure water, processes of artificial purification are absolutely necessary. Sterilization has a proper place as an adjunct to filtration, but it is especially valuable to small surface water supplies which do not justify the expense of filtration.

ACKNOWLEDGMENT.

Abstract of paper before November meeting of the New England Water Works Association by Mr. Edward C. Sherman of the firm of Rourke & Sherman, Consulting Engineers, 6 Beacon street, Boston.

The editors understand that the cost of the sterilizing plant here described, in place, was about $600. The present cost of operating it, including chlorine, analyses of water samples, supervision of operation and interest, is about $1.25 per 1,000,000 gals.

Comparative Merits of Sand Cushioning and Grouting Standpipe Bases, with an Example of the Latter Process.

The present article discusses the comparative merits of the sand cushion or grouted base for standpipes, and gives a detailed description of the grouting of a standpipe base at Needham, Mass.

Probably the most common method of transmitting the pressure from the bottom of a standpipe to the masonry or concrete foundation is by means of a sand cushion or in some cases a cushion of sand mixed with cement. Without such a supporting layer it is obvious that the empty tank would rest upon the rivet heads, and when filled the plates between the rivets would be bent in such a way that a considerable part of the plates would come in direct contact with the foundation.

As far as transmitting the loads from the plates to the foundation is concerned, there is no material criticism of the sand cushion. It is a fact, however, that even with the best of workmanship the bottom of the standpipe is not absolutely flat. Certain plates or parts of plates will bulge either up or down. Those parts which bulge up, or "dome," will not rest upon the sand cushion when the tank is empty, as the sand cannot be caused to flow enough to fill these empty spaces, and the confined air has no opportunity to escape. When the tank is filled with water the plate is bent down into contact with the sand, but when the tank is emptied the plate will spring back to its original position.

It is, of course, impossible to get at the under side of the bottom of the tank for cleaning and painting, and it is therefore of importance that the material with which the plate comes in contact should have a preservative action upon the metal. It is well known that hydraulic cement has such a preservative action. Probably for this reason it has been customary in many cases to mix dry cement with the sand cushion on the supposition that in the course of time slight leaks in the bottom plate, or water absorbed from the atmosphere, or by capillarity through foundation, may be sufficient to cause the cement to set. It is obvious, however, that if the cement should set, when the tank is empty the domed places in the bottom plate would again spring back to their original position, leaving voids between the metal and the cushion.

As an alternative method it has been attempted in some cases to grout the space between the bottom plate and the foundation by pouring cement grout through holes left in the bottom plate, these holes being afterward stopped by iron plugs. Although it is somewhat difficult to fill all the voids under the bottom plate by this method without forcing in the grout under so great a pressure as to lift the bottom plate itself, nevertheless it is possible, by careful work, substantially to fill the entire space. When the bottom is well grouted in this way the plate should be in intimate contact with the cement mortar through its entire extent, and accordingly should be subject to the preservative action of the cement.

GROUTING NEEDHAM STANDPIPE BASE.

This paper has been suggested by a recent experience in grouting the bottom of the new Bird's Hill standpipe for the town of Needham, Mass. This tank is 55 ft. in diameter and 44 ft. in height and rests on a foundation of cement concrete.

In this case the holes for grouting were arbitrarily spaced 10 ft. apart in both directions. This spacing was unfortunate, as it left a few plates without any grouting holes whatever in them, and in several cases brought the holes close to the seams between the plates. The holes were 2 in. in diameter and were fitted with 2-in. pipe 2 ft. in length and with threaded plugs.

The grout was made of a 1 to 1 mixture of cement and screened sand, using sufficient water to make it of the consistency of cream, and was poured from coalhods into tin funnels inserted in the tops of the 2-ft. lengths of 2-in. pipe. A stick about ¾ in. in diameter and somewhat uneven was worked up and down in the grouting pipe while the grout was being poured, thus assisting in keeping the grout well mixed and in causing it to flow freely through the pipe.

The experience in pouring the grout varied considerably. In some cases the grout would flow freely to a long distance from the hole through which it was poured; in others it could not be made to run more than a short distance. In one case, at least, the grout flowed to a distance of 7 ft. on one side and 8 ft. on the opposite side of a particular hole. In one case where the grouting hole was located close to a seam the grout apparently did not flow past the seam at all. In another similar case the grout not only passed the seam, but flowed freely for a distance of 3 or 4 ft. beyond it.

It was found practicable to determine closely the extent of the filling beneath the plate by pounding upon the bottom with a heavy stick. When the grout at last ceased to flow from any pipe it was apparently due to a stoppage at the bottom of the pipe itself, and there was no evidence that hydrostatic pressure was transmitted to any distance around the pipe in such a manner as to tend to lift the bottom plate.

As previously stated, the spacing of the grouting holes was somewhat unfortunate, and we were not successful in completely filling the space beneath the bottom plate from the holes originally drilled. We did, however, succeed in filling nearly all of the space and used 132 bags of cement in the grout poured through the original 27 holes. By pounding the bottom after this work was completed the points where additional grouting was required were determined and were marked. Additional holes are to be drilled at these points and the grouting continued, and we anticipate no difficulty in satisfactorily completing the job.

If the points for the grout pipes had been spotted upon the bottom in advance of drilling, instead of being arbitrarily located at a fixed distance apart, there would probably have been no difficulty in completing the job from the first set of holes. The holes should have been so located that there would be at least one in every plate. They should be located approximately axially upon the center line of the plate, and also in the high spots of the bottom if any exist.

GROUTING CONICAL-BOTTOM TANKS.

A different method of insuring that the bottom of a standpipe is in perfect contact with the foundation has been employed by Mr. William Wheeler of Boston in twelve or fourteen cases and with entire satisfaction. This method consists in constructing the bottom of the tank in the form of an inverted cone. In Mr. Wheeler's practice the altitude of this cone has been uniformly 2 ft., and this method has been used on tanks as large as 40 ft. in diameter.

It is obvious that the conical form possesses the advantage of being able to resist pressure from beneath without deformation, so that it is possible to put in grout under pressure without in any way lifting the bottom, and also that there is no opportunity for air pockets. In setting these tanks it has been Mr. Wheeler's practice to lower them into final position about 2 ins. above the previously constructed masonry foundation and to fill the 2-in. space with a 1 to 1 mortar mixed rather wet and forced into place by a long, thin rammer, working from the outside.

It is interesting to note that Mr. Wheeler had occasion a few years ago to raise one of the standpipes constructed in this manner from its original base, and found the under side of the bottom plates as clean and free from corrosion as when originally received from the mills.

ACKNOWLEDGMENT.

Paper before the November meeting of the New England Water Works Association by Mr. Charles W. Sherman, member of the firm of Metcalf & Eddy, Consulting Engineers, 14 Beacon street, Boston, Mass.

Simple Test for Ascertaining Whether Pipe Is of Wrought Iron or Steel.

(Staff Article.)

Four simple tests for identifying steel and wrought iron pipe were described in ENGINEERING AND CONTRACTING of Oct. 13, 1915. A fifth test, somewhat similar to one of those previously described, is here given. This information was brought to our attention by Mr. Dow R. Gwinn, president and manager of the Terre Haute Water Works Co. of Terre Haute, Ind. Mr. Gwinn states that for some time he has been using genuine wrought iron pipe in preference to what is known as the merchant or steel pipe. He states that the genuine wrought pipe costs more than the other pipe but is worth much more. He has had some difficulty in determining by its appearance whether a shipment was genuine wrought iron or the ordinary steel pipe. He has sent us some notes, here given, setting forth some fundamental differences between iron and steel pipe and giving the identification test previously mentioned. For these notes Mr. Gwinn acknowledges his indebtedness to Mr. H. S. Moulton of the Chicago Tube & Iron Co. The notes are here quoted:

DIFFERENCE BETWEEN IRON AND STEEL PIPE.

There are three prominent differences between iron and steel which ought to cause a difference in their rapidity of rusting:

(1) Blow holes; in steel, but not in iron. (2) Manganese; in steel in greater quantity than in iron. (3) Presence of cementite in the steel and of cinder in the iron.

Steel contains iron carbide, higher carbon, higher phosphorus, higher sulphur, all of which elements are friendly to corrosion.

Iron contains cinder, and, as corrosion proceeds and more and more of the metal which at first overlay the sheets of cinder is eaten away, the remaining cinder forms a larger and larger proportion of the outer surface, and therefore protects a constantly increasing proportion of the underlying metal from corrosion.

In short, the mechanical protection afforded by the cinder ought to increase as corrosion proceeds. On the other hand, as steel is gradually corroded away, more and more of its surface should come to be composed of cementite, and this fact should tend to retard corrosion of steel because cementite, too, should protect the underlying free iron or ferrite.

Cutting thread on steel pipe is more uncertain of perfect joint than with iron pipe on account of thread crumbling off.

TO ASCERTAIN WHETHER THE PIPE IS OF WROUGHT IRON OR STEEL.

Cut off a short piece of pipe and suspend it in a solution of 9 parts water, 3 parts sulphuric acid and 1 part muriatic acid.

First, place the water in a porcelain or glass dish, adding the sulphuric and the muriatic acid. Suspend the pipe in such a way that the end will not touch the bottom of the dish. After about two hours' immersion remove the pipe and wash off the acid. If the pipe is steel the end will present a bright, solid, unbroken surface. If the pipe is iron it will show faint ridges or rings, like the year rings in a tree, showing the different layers of iron and streaks of cinder.

The fact that steel has a smoother surface than iron furnishes a very obvious reason why galvanizing should adhere better to iron than to steel, and all galvanizers using the hot metal process will certify to the fact that it requires more zinc to galvanize iron pipe than steel pipe, so that galvanized iron pipe has more protection than has the galvanized steel pipe.

GENERAL

An Economic Comparison of European and American Methods of Driving Tunnel Heading.

Contributed by Eugene Lauchli, New York City.

In Bulletin 57, prepared by Messrs. David W. Brunton and John A. Davis, and published by the Bureau of Mines, the problem of drilling and blasting in connection with heading work is ably discussed by the authors, and several tables and sketches illustrate practice in various bores driven in this country. As the authors make frequent references to and comparisons with practice in driving headings of long tunnels abroad, the writer wishes to point out here that a comparison is impossible, because the methods used in, and the purpose of, the headings referred to aim at altogether different results.

In adits, mine and water-conveying tunnels of small cross section the chief aim, all things being equal, is to carry on the work at minimum cost, keeping the excavation as close as practicable within certain specified lines, thereby reducing the amount of excavation, and, in certain cases also, of the concrete or masonry lining.

In driving headings of long tunnels altogether different conditions prevail, and economy can be expressed only in terms of the enlargement and lining work, the cost of which depends to a large extent on the progress made in the heading. This accounts for giving first consideration to speed in driving. This is obvious, for, the type of timbering to be used in the enlargement work, the cross section of the bore, and the type of lining to be adopted and which must be known in advance, depend on the success in driving the heading. To this end the heading is driven practically regardless of shape or cross section, a minimum rather than maximum section being specified, for construction reasons. No special attempt is made to obtain an even floor, as the drainage canal is excavated later on, and the alinement of the heading in a horizontal plan is also of secondary consideration. On the other hand, care is exercised not to shatter the overlaying and adjacent strata, especially in folded mountains, the rock of which is usually subjected to latent stresses. In certain cases, this feature alone warrants the use of shallow holes for blasting purposes.

Proper Number of Holes.—In Table XIV (See ENGINEERING & CONTRACTING, July 8, 1914), prepared by the authors of paper 57, the square feet of heading per hole are given for various bores of small cross section, driven through various materials. The average area per hole for bores driven through igenous rocks is 3.65 sq. ft. and that of bores driven through sedimentary rocks is 4.87 sq. ft. Referring the column 3 of Table I, which represents very nearly the practice now followed in driving headings of long tunnels, the number of square feet of heading area for bores driven through igneous and sedimentary rocks are 4.85 and 4.8, respectively.

In Table II, data from Table XIV of paper 57, for headings of 50 to 70 sq. ft. area, have been tabulated, in order to offer a fair comparison with Table I. It will be noted very readily that for headings of nearly similar cross section the comparison is decidedly in favor of the method used in European tunnels, with 4.85 sq. ft. of heading area per hole, for igneous rocks, as against 3.1 sq. ft. only in American headings.

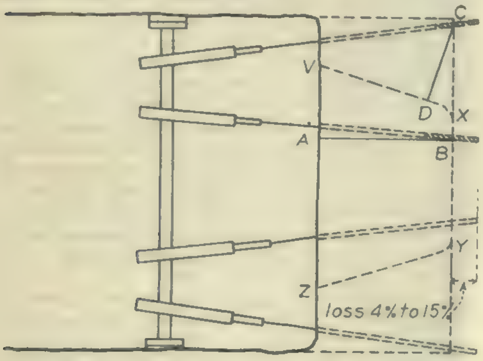


Fig. 1. Typical Arrangement of Heading Holes, European Practice.

Direction of Holes.—Figures 1 and 2 illustrate the practice commonly used in heading work abroad and in this country, respectively. The wedge and pyramidal cuts are used and advocated most usually in this country as offering a satisfactory solution towards economy and progress. In European headings the holes are drilled nearly straight, as shown by Fig. 1; the reason for following this mode of procedure lies in the fact that the drills, being mounted usually on a horizontal bar, are allowed little play in a horizontal plane; besides, it takes much time to locate deep holes so as to make the ends intersect, and, when the heading's face is uneven or rough, much preliminary work is required to start a hole at a specified point, especially with piston drills, thus consuming valuable time, which otherwise could be used to advantage for drilling.

It is the writer's experience that nearly nine out of ten times, excepting in shaly materials, soft sandstone or limestone, the material within the line *v-x-y-z*, and especially that near the face, between *v-z*, instead of being shattered in small fragments, is forced outwards in large chunks, a feature very objectionable in mucking.

TABLE I.

Materials penetrated.	Area of heading, sq. ft. 1	No. of bore holes. 2	Sq. ft. of heading area per bore hole. 3	Depth of hole, ft. 4	Progress per attack, feet. 5	Effic. col. 5-col. 4, per cent. 6	Dynamite consump. per cu. yd., lbs. 7	Bore hole per cu. yd., feet. 8
Limestone	71	14.24	5	5	4.82	96	5	5.65
Crystal schist	67	13.72	4.9	4.25	3.45	81	8.2	6.9
Quartz porphyry	67.2	12.77	5.26	4.36	3.7	85	7.8	6.1
Limestone	67	14.5	4.6	5.05	4.86	96	5.6	6.1
Granite	66.5	14	4.75	4.4	3.96	90	7.1	6.4
Granite	67.5	14.9	4.5	4.56	4.1	90	6.9	6.7

In Fig. 1 the line of least resistance, *A-B*, coincides very nearly with the bore-hole, and, in this respect, the line of least resistance, *A-B*, Fig. 2, is shorter than the bore-hole, but on the other hand the larger the angle alpha the longer will be the line of least resistance, *C-D* of the side holes, thereby causing the materials removed by the side holes to break also into large pieces and to be thrown against the sides of the heading instead of being thrown forward; thus, the muck pile will accumulate directly in front of the heading's face, as shown by Fig. 3, instead of piling, as shown by Fig. 4.

Depth of Holes.—In paper 57, under the above title, the following sentence is quoted:

> One of the chief advantages arising from the use of shallow rounds is (when the holes are properly directed) the increase efficiency obtainable from a given charge of explosive; for, as the width of the heading is for all practical purposes constant, the angle between the line of least resistance and the axis of the bore-hole becomes a function of the depth of round, the width of the angle increasing with shallow holes. This advantage obtains especially with the wedge-cut and with the pyramid-cut, and it should be a fundamental consideration with the bottom-cut method of drilling the holes.

TABLE II.

Materials penetrated.	Area of heading, sq. ft.	No. of bore holes.	Sq. ft. of head per hole.
Granite	57	15-19	3.3
Granite	60	24	2.5
Granite	70	21-26	3.0
Granite	65	25	2.6
Granite-gneiss	72	18-20	3.8
Gneiss	65	19	3.4
Granite	60	24-26	2.4
Diabase	65	16	4.0
Limestone	50	16-18	2.9
Limestone, sandstone and shale	50	18	2.8
Average for igneous rocks			3.1

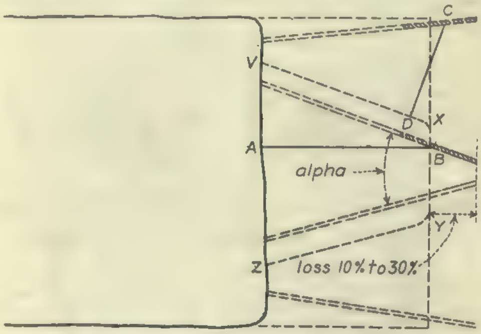


Fig. 2. Typical Arrangement of Heading Holes, American Practice.

> Strangely enough, however, in the Loetschberg and the Simplon tunnels, which are so often cited as examples of the "highly desirable" European practice of using shallow holes, this advantage was almost, if not entirely, thrown away because the holes were drilled in vertical rows and were nearly parallel to the bore of the tunnel. In such a case the line of least resistance and the axis of the bore are nearly coincident, a condition that results in the production of the least possible efficiency from the charge of explosive, and it cannot be gainsaid even by the advocates of this method that a much greater quantity of explosive was required to break the same amount of rock than is usual in American practice.

That from 2 to 2.5 lbs. more of explosive per cubic yard are used in European practice is true, but in countries like Germany, Austria and Switzerland, where research work is carried to almost an extreme, and where tunneling methods have reached a high degree of efficiency, it seems hardly possible that the engineers in direct charge of tunnel driving would overlook such an important item as economy in powder consumption, and efficiency in drilling and blasting methods. Elsewhere the writer has shown that the efficiency of bore-holes, that is, in the present case, Col. 6, see Table I, was far better by using shallow holes, and that the length of bore-holes lost, see Figs. 1 and 2, was from 10 to 30 per cent, as against 4 to 15 per cent only by using deep and shallow holes, respectively. This feature alone surely compensates for the surplus of powder required (especially where wages are high), as the saving affects both labor and power charges. Furthermore, less time is required to drill shallow holes, as the steel bits are changed more rapidly and less trouble is experienced due to the bits sticking, especially with piston drills.

Another advantage made possible by the adaptation of shallow holes lies in the possibility of using hammer air hand drills—i. e., a one-man drill, requiring no setting up, and which can be used effectively in soft rocks, such as limestone, sandstone, shale, molasses, etc. In the Hauenstein tunnel three such drills enabled monthly driving progress of 750 ft. to be made in a heading of 78 sq. ft. area.

TABLE III.

Name of tunnel.	Material penetrated.	Bore hole per cu. yd., feet.
Gallitzen	Shale	7.0
Sutro	Trachyte	8.7
Musconetgong	Gneiss	6.0
Melones mines	Diabase	7.6
Hodsback mines	Diabase	5.0
Walkill	Shale	5.8
Tequiquac	Sandstone	5.0
Average		6.45

Let it be pointed out here also that the length of bore-hole per cubic yard is equal or even less by using shallow holes, as will be seen by comparing column 8 of Table I with Table III. The amount of bore-hole per cubic yard being 6.45 and 6.3 ft. for deep and shallow holes, respectively.

In selecting the Loetschberg tunnel as an example the authors of paper 57 quote wrongly the influence on progress of the rock penetrated. It is true that, in general, greater progress was made on the north side of that bore, but this was due almost entirely to the organization, which was far superior to that on the south side. This was made evident when the north and south crews penetrated the center of the range, consisting of granite of like formation and hardness or toughness. The same conditions prevailed on both sides, as will be noted by the last two lines of Table I. The powder consumption and length of bore-hole per cubic yard being practically the same, yet the progress on the north side was 29 ft. per day, as against 17.2 ft. on the south side, there being 4½ rounds per day, as against 7 on the north side.

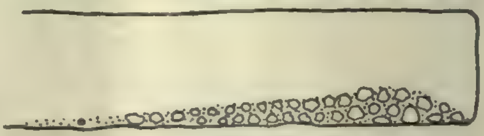


Fig. 3.

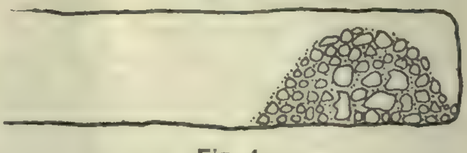


Fig. 4.

Diagrams of Muck Piling.

The progress made in the Loetschberg tunnel has been repeated and exceeded in driving two other tunnels, and it can be stated that the success leading to progress lies chiefly in the organization, and with a good organization and by using shallow holes in heading work there is no earthly reason why 6 rounds cannot be fired in 24 hours, thus making the daily progress 20 to 25 ft.

Taken as a whole, and including also the power consumption and mucking methods, the writer would not venture to say that, yard for yard, the European method of heading driving is more economical than the American method, but it is conducted on at least as practical, if not a more practical, basis.

As stated in the first part of this paper, the purpose of heading driving in connection with long tunnels being different from that of individual bores of small cross section driven for other purposes, no fair or absolute comparison of cost can be established.

Design and Construction of a Concrete Idler Stand.

(Staff Abstract.)

The accompanying data refer to the design and construction of a concrete idler stand at the Isabella Mine, Palmer, Mich. The stand described is the largest of three similar stands built at this mine. It is located on a solid rock bluff of Goodrich quartzite about 80 ft. from the steel idler on the shaft house. The plans, as drawn, were based on a circular "Concrete Poles," published by the Universal Portland Cement Co. The poles for the stand were given a greater span than is required to carry the two-skip rope idlers, and by adding a third pole the stand will serve for both skip and cage hoists.

THE DESIGN.

Computations were made on the run of the idler wheels at the stand, the ropes and axle elevations, and the size of posts required. Three inches were allowed for play between the posts and the outside position of the hub of the idler, which gave the distance between the centers of the posts and the co-ordinates of the centers.

Figure 1 shows side and end elevations of the idler stands, and give the general design features.

All rods were ribbed steel and were 1-in. square, with the exception of those at the corners, which were ⅞-in. square. The rods were tied at the collar of the beveled piers with No. 12 galvanized wire to an iron hoop 7 ins. square, made from a ⅛x1-in. bar. They were tied to similar squares at three other places above: the first at the top of the poles, the second at the top of the east and west center rods, and the third 9 ft. below the latter.

Starting from the top of the beveled pier all rods were bound horizontally with No. 12 galvanized wire, the intervals being gradually reduced from 20 ins. at the bottom to 10 ins. at the top of the pole. The wire was wound once around each rod and thence carried to the adjoining one until the circuit was made. At intervals the rods were bound with cross wiring to help reduce binds and kinks.

Four ¼-in. square rods were used as reinforcement in the 8x8-in. horizontal braces. These rods were held at three points with hoops 4 ins. square, made of ⅛x1-in. bars. At points 8 ins. back of the ends the four horizontal rods were bent down and bound with No. 12 wire to the vertical rods in the posts.

FORMS.

The base forms were built of 2-in. hemlock, and the pier and pole forms of 1-in. hemlock. The pole forms were made in three sections: 12 ft. at the bottom, 10 ft. in the middle, and 8½ ft. at the top. The side of each form consisted of one board braced every 2 ft. with a short 2x4-in. piece (see Fig. 2). Three sides were nailed together on the ground, and this part was then placed around the reinforcing rods and the fourth side nailed on. The form was then lined in with a transit and spragged securely. To keep the forms from warping clamps were constructed to fit over every other set of braces. These clamps were held together by 2-in. notches cut in them, two of the pieces being placed with the notches up and two with the notches down, interlocking the first two pieces. Wedges were seldom required to bring them to a tight fit.

PLACING ANCHORAGE FOR POSTS.

After the centers of the posts were located, eight holes in the rock were spotted for anchor bolts, four holes for each post being located using a radius of 18 ins. A second ring of holes, using a 3-ft. radius were lined up with the holes in the first ring, one set of four holes being in line with the pole centers. These holes were put down 8-ins. with a jackhammer. Anchor bolts with their eyes facing the centers of the poles (see Fig. 1) were then cemented in the holes and allowed to set before the reinforcing rods were placed. These anchor bolts were made of 1½-in. iron, with an 8-in. shank and a 1½-in. bend at the top. The eyes were not welded and were made to pass a 1-in. square rod.

The rock surface was very irregular, and it was necessary to bend the reinforcing rods considerably in order to pass them through the eyes of the anchor bolts. For finding the angles of bending the apparatus shown in Fig. 3 was used. The upright board was 1x8 ins. and 6 ft. high, pointed at the base, a plumb-bob being suspended at its center line in order to place it in a vertical position. A horizontal line was drawn across the board at the height of the collar of the beveled pier, and on this line were marked the distances from the post center to the corner and side reinforcing rods. An 8x10-in. board holding order sheets was slid up and down on the edge of the larger board. The length to be included on the bend was taken from the point on the horizontal line on the board corresponding to the side or corner rods to the anchor bolt eye. A straight-edged board laid between these points gave the slope, which was struck off on the order blank and the length marked upon it. A short vertical line was drawn from the top of this line, and the total length of the reinforcing rod in the pole above the base was recorded upon it. To get the angle at the foot the rectangular straight-edge was placed on the top of the eye bolt loops, and a line struck intersecting the first line. Sufficient length was recorded on this line to allow the rod to pass from the inner bolt through the outer one to the edge of the footing. These data gave the blacksmith accurate dimensions of the angles and lengths of each portion of the rod. The rods were welded full length, and were placed in position as soon as the scaffold was completed.

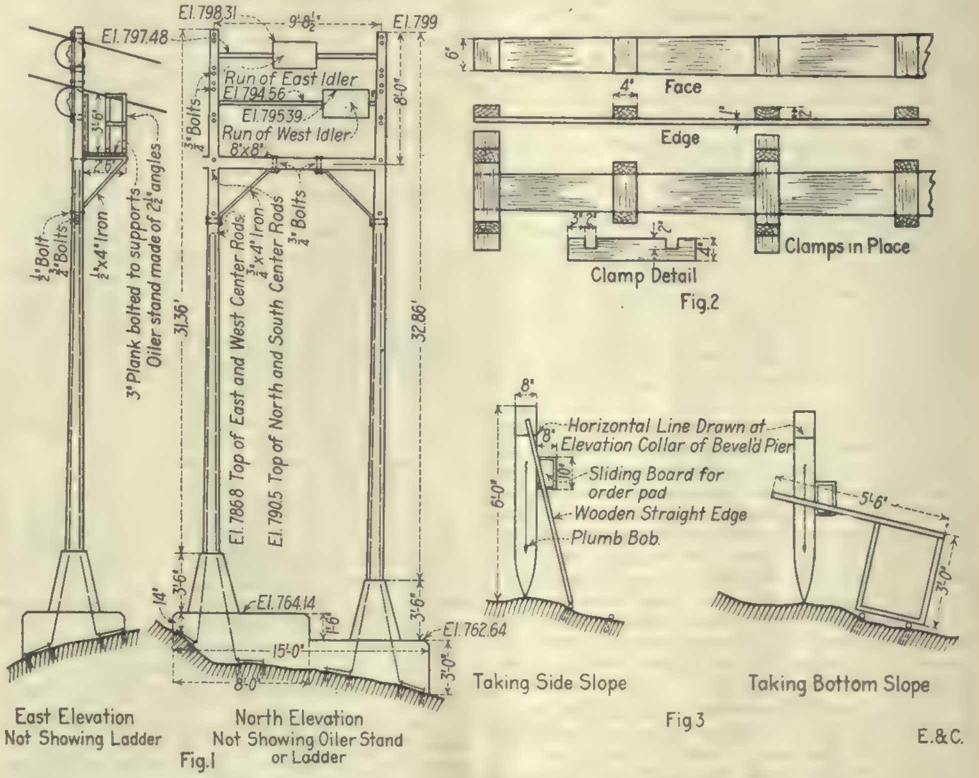


Fig. 1. Side and End Elevations of Concrete Idler Stand at Isabella Mine, Palmer, Mich. Fig. 2. Details of Forms for Concrete Idler Poles. Fig. 3. Apparatus Used in Finding Angles for Bending Bars in Foundation.

CONSTRUCTION OF IDLER STAND.

As soon as the anchor bolts had become firm a staging was erected to the proposed height of the idler. The base of the staging was about 8x16 ft., and the sides were carried up plumb.

The reinforcing rods were placed in position and bound only at the collar of the beveled pier. After the base forms were finished the rock footing was washed clean and the rods spragged into position, a transit being used to line up the bottom ring. The base was then poured, short lengths of rail, pieces of old cable, and wire being used for reinforcement. The forms for the beveled piers were immediately centered and filled and tamped thoroughly, pails being used to fill from the top. The mixing was all done by machine. The proportions used in the base and in the poles were 1 part cement, 3 parts sand and 2 parts small stones.

The wiring of the rods was completed while the base was setting for two days. The lower section of the pole forms was then centered, spragged and filled. The rods cleared the inside of the forms by about 1¼ ins., and it was necessary in tamping to watch them closely in order to keep them centered. The concrete proportions used for the poles were 1 part cement, 3 parts sand and 2 parts pebbles, maximum size ¾-in. The concrete was hoisted to the top of the forms in pails and was poured in and then tamped with long rods.

The middle section was added after the bottom section had set for a few days. The upper forms were spragged to the lower sections of the opposite pole already placed and filled. The top forms were handled in the same manner as the lower ones.

The holes for the bolts were made by inserting 1-in. iron pipe in the form, of just the length of the inside dimensions of the form. One end of the pipe was held in place by nails extending through from the outside, and the other end was held by a wooden plug in the hole through which the pipe was inserted. The brace form was set into the sides of the top forms and filled at the same time.

The forms were left in place several days, and after they were removed the entire stand was allowed to set for two weeks before the trimmings were put on. The idler stand was guyed at the top of the poles by four ¼-in. wires, but this precaution seems to have been unnecessary. It was found when the first guy wire was attached that one could easily sway the stand 3 or 4 ins. After five months' use the stand shows no signs of cracks, and it gets stiffer as the cement nears its setting limit.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by Hale H. Hunter, chief engineer, Meriden Mining Co., Hibben, Minn., in The Wisconsin Engineer.

Methods and Costs of Belt Conveyor Earth-Handling for the Lahontan Dam.

(Staff Article.)

The Lahontan Dam is a part of the works of the Truckee-Carson irrigation project in Nevada. The main structural and construction features of this dam were described in our issue of Feb. 12, 1913. One of the construction methods of novelty was the use of a belt conveyor system for handling the earth from which the main dam embankment was built. This embankment was 1,300 ft. long and in cross-section was composed of two parts: (1) An upstream part of a mixture of gravel and soil or silt in nearly equal parts which was found by careful and repeated experiments to approach the greatest density and impermeability, and, (2) a downstream part of pit run gravel to afford ready and harmless escape of water percolating through the upstream part. The conveyor system was designed to deliver separately or mixed the two embankment materials and from a description published during the progress of the work was as follows:

The gravel and silt are excavated by Bucyrus steam shovels in the immediate vicinity and carried in five-yard dump cars on 36-in. gage tracks to the mixing hopper. This hopper is shaped in cross-section like the letter "W" and is 110 ft. in length. Two tracks pass over the hopper, one above each section, so that the trains of cars bringing gravel may be switched onto the track passing over the proper section of the hopper, and the silt is likewise delivered to the opposite side. Guard rails are provided above the hopper so that the cars may be dumped without stopping.

Directly beneath this double hopper, centrally located, is a 36-in. Stephens-Adamson belt conveyor, extending the length of the hopper. A system of Stephens-Adamson reciprocating feeders, located at intervals below the two sections of the hopper, is arranged to deliver the gravel and silt onto the belt in certain definite proportions. These feeders are attached by connecting rods to eccentrics, mounted on a line shaft on each side. These eccentrics may be adjusted for length of throw and time of throw so that the proportion of gravel fed onto the belt in the center may be exactly predetermined and a thorough mixture thus secured. This conveyor, which has a capacity of 300 cu. yds. per hour, discharges its load onto a 30-in., 925-ft. belt conveyor, operating at right angles to the former and passing out over the dam. At the discharge end of this conveyor there are constructed two large hoppers of sufficient height to permit of a dump wagon passing beneath. Above these hoppers is arranged a very coarse grating, which further agitates and mixes the material as it passes through to the hoppers. A gate above is also so arranged that the stream of material may be divided or it may be diverted into either hopper. Gates below the hoppers allow the material to be delivered into the dump wagons and in this way is made the distribution over the dam. This capacity of 300 cu. yds. per hour is easily sufficient to supply 2,000 cu. yds. per day of eight hours, which is the rate at which it is desired to progress.

While the fill is being made on the downstream portion of the dam, gravel is taken from but one side of the double hopper, and it is thence distributed. When it is desired to work on the upstream portion the feeders below both sides of the hopper are set in operation and the mixture is thus delivered to the dump wagons to be distributed to the dam and "wetted and rolled down" by rollers.

The operation of the conveyor system and some of the costs recorded are reported by D. W. Cole, Project Manager, as follows:

The borrow pit is situated from ¼ to ½ mile from the dam. Material was loaded onto 4-yd. dump cars by electric excavators. Seven-car trains were hauled by 14-ton Porter locomotives over 36-in. gage endless track, cars being dumped into bins of about 500 cu. yds. capacity under which a 36-in. by 110-ft. belt conveyor was loaded by automatic feeders for delivering measured quantities of "silt" and "gravel" for composing the impermeable embankment mixture. The 36-in. belt delivered these materials onto the 30-in. conveyor extending 925 ft. from the storage bins to about the middle of the embankment. The total quantity of material handled in this manner was 612,000 cu. yds. The cost of this conveyor system "A" was as follows:

30-in. x 925-ft. conveyor, purchase price	$ 8,022.00
26-in. x 110-ft. conveyor, purchase price	1,497.00
Automatic feeders, purchase price	1,243.00
	$10,752.00
Freight	1,281.73
Laid in cost	$12,043.73
Labor and superintendence erecting supports, bins, etc.	5,067.41
Materials, lumber	3,732.12
Materials, miscellaneous	209.62
Supplies and miscellaneous	1,072.59
Labor, installing machinery, etc.	1,878.20
Overhead charges	2,369.09
Total for conveyor "A"	$26,372.76

Results of operation were as follows:

Item.	Cost.	Unit cost per cu. yd. of earth.
Labor—Conveyor operation	$ 9,857.27	$0.0161
Supplies—Miscellaneous	718.96	0.0012
Power plant operation	3,200.54	0.0052
Repair plant operation	1,269.87	0.0021
Depreciation	23,062.88	0.0376
Total	$38,109.52	$0.0622

The main conveyor was driven by a 100 h.p. motor installed midway of its length. The feeders and cross conveyor were driven by a 20 h.p. motor. Electric current was generated at the site of the work by utilizing the drop of the main canal and the total cost of production was about 1 ct. per kilowatt hour. Common labor was paid 30 cts. per hour and mechanics ranged from $3 to $5 per day. Work was carried on in one 8-hour shift daily extending over two years with intermissions of a few weeks during the coldest weather.

The conclusion is that the work was done at least as cheaply and probably at less cost than with the borrow pit tracks extending out over the dam on high trestles. Certainly the regularity and uniformity of distributing the material, together with the perfection of mixing the materials in the desired proportions, were far better achieved than would have been possible by dumping cars from any considerable elevation. The reliability and freedom from all mishaps with the belt conveyor were most satisfactory. The capacity was abundant and the output was limited only by the ability of the borrow pit crew to feed the belt at one end and the ability of the distribution force to place the material in the dam at the other end. Sometimes one and sometimes the other of these considerations governed the rate of progress which was never limited by the conveyor.

The Use of Locomotive Cranes and Some Data on Their Cost of Operation.

(Staff Abstract.)

The following report on the use of locomotive cranes and on their cost of operation was prepared by a committee of the American Railway Bridge and Building Association and presented at the annual meeting of the association in Detroit, Oct. 19-21, 1915.

The locomotive crane is a modern tool, its entire development having taken place within the last 25 years. It was designed to fill the demand for a portable crane that could be moved from place to place around an industrial plant, and at first was mounted on truck wheels and moved over ordinary roads. The first locomotive cranes were of small capacity, but from them has been evolved the modern locomotive crane which seems to embody every desirable feature. Future changes will probably be only in size and details of design.

The first locomotive cranes were of two to five tons capacity with short booms of about 15-ft. radius. They were mounted on short car bodies supported by four small car wheels. The propelling gear consisted of sprockets and chains and the term "locomotive" required some imagination.

The first real improvement was the adoption of gearing for propulsion, and this feature has now been developed to such an extent that cranes have been built capable of hauling several cars 20 miles per hour.

The four-wheel car was used exclusively for several years and cranes of 10 and 15 tons capacity were built on them. These cranes could not be hauled in trains, even at slow speeds, and the need of a crane that could be transported readily led to the adoption of the eight-wheel car about ten years ago, since which time the four-wheel cars has been confined to yard work. The use of the eight-wheel cars also permitted increasing their weight and capacity until now they are made in sizes up to 60 tons capacity.

The greatest handicap in the development of cranes is the limited width of gage. The wheelbase can be made any reasonable length, providing stability parallel with the track, but the limited width makes it necessary to have a heavy car and sufficient counterweight to prevent the car overturning when loads are lifted at right angles to the track. Even with all the weight that can be applied conveniently, the cranes have their full capacity only at short radius; for example, a 25-ton crane will handle its full capacity at 12-ft. radius, but will only handle 5 tons at 40-ft. radius, the radius being the horizontal distance from the center of the load to the center pin of the crane.

The use of outriggers, which are provided on the larger cranes, increases the width of the base and adds to the stability at right angles to the track. This increases the capacity considerably, especially in the larger sizes, and is of great advantage when using the crane on track that is not level. They should be used on both sides of the crane when handling heavy loads on poor track, as the breaking of the hoisting cable or the slipping of the hitch may cause the crane to tip over backwards. A modern locomotive crane in capable hands can be used for an endless variety of work. No railroad is so small that one or more can not be kept busy, nor is it necessary to use them every day to make them economical as will be shown by the figures contained in this report

USES OF LOCOMOTIVE CRANES.

Among the common uses to which a crane is put are the following:

Switching.—In almost all cases a locomotive crane can switch the cars that it loads and unloads, doing away with the necessity of having the cars "spotted" with a locomotive. On construction work this will save a large amount of work train expense. In storage yards it will save delays waiting for switch engines.

Hoisting.—Within its capacity a crane will do all kinds of hoisting either with one or two lines, and with a long boom or extensions of short boom it can place loads, such as roof trusses, etc., high above it.

Swinging.—As a crane can swing its boom through a complete circle and the radius can be varied, loads can be picked up and placed anywhere within its radius. This is a great advantage in taking material off cars behind a crane and placing it in cars ahead of the crane, or vice versa.

Handling Buckets.—A double-drum crane can operate any two-line clam shell or orange peel bucket and handle ore, coal, gravel or any other material that can be handled with such a bucket.

Handling Scrap, Etc.—When a locomotive crane is equipped with an electric generator and magnet, it will handle all kinds of metal, such as scrap, nails and spikes in boxes. The expense of hitching on is eliminated and the cost of handling is greatly reduced.

Pile Driving.—A leader truss with regular piledriver leaders has been designed to take the place of the boom on the larger sizes of cranes. This arrangement makes a first-class piledriver capable of doing the work of a regular piledriver, equal to or perhaps a little better, owing to its full-circle swing. Suspended or dangling leaders are often used with the regular crane boom. This is a pretty good makeshift, but is not to be compared to a regular driver.

Bridge or Building Construction.—A locomotive crane will switch the cars, unload the material, drive the cofferdam, make the excavation, drive the foundation piles, handle concrete material, tear out the old structure, erect the new one, and clean up and load the remaining material without the assistance of any other machine and with very few men.

Storage Yards.—In a storage yard a locomotive crane will switch the cars, will load, unload and pile material of all kinds, including timber and lumber, coal, scrap, rails, etc., and will pile it higher than is economical by hand.

Ballast Pit.—In a ballast pit it will make a good showing loading ballast, especially if the excavation is below the water line.

Roadway Service.—On the road it is of great value picking up freight that may have fallen from cars, such as logs, rock, etc. It will pick up and place rip-rap, and will load lumber, rails or any other heavy material. It can be used to good advantage as a light wrecker, being capable of handling freight cars, etc.

CAPACITY AND COST.

Cranes are built in sizes ranging from 3 to 60 tons capacity; the lightest ones being used chiefly around industrial plants and the larger ones for special purposes, such as bridge erection, etc. The best all-around crane for maintenance of way work is the eight-wheel crane of 20 to 30 tons capacity. Such a crane will cost from $7,000 to $8,000. The cost of operation depends on the number of days worked, the kind of work, etc., it being evident that a crane loading ballast will require more repairs than one doing light work in a storage yard. However, the average cost of operation will be about as follows:

Interest	$ 2.00
Depreciation	2.00
Repairs	2.00
Fuel	2.50
Supplies	0.50
Labor	6.00
Total	$15.00

This is somewhat higher than is usually claimed, but it is probably a fair estimate. Where fuel is cheap and wages low, it may be reduced somewhat but it is usual to underestimate such items as depreciation and repairs. Depreciation and repairs have been figured on the basis of a crane being kept in service 20 years, but that in the meantime it will have been completely rebuilt once. The daily rate is based on using the crane 200 full days during the year.

POSSIBLE EARNINGS.

What a crane will earn depends upon the class of work it is doing, and the amount saved depends upon the method superseded. For instance, a crane will not switch cheaper than a switch engine, it will not excavate or handle material cheaper than a good stiff-leg derrick, it will not drive piles cheaper than a good piledriver, or compete with any other good machine designed for special purposes. However, when its adaptability is taken into consideration, the fact that it may displace several machines (on account of being able to command a large territory) makes its value evident.

It is when the use of a crane is compared with manual labor that its great saving is shown. Figures have been obtained from a large number of sources and while they show considerable variation in general it may be claimed that a crane will save, as against hand work, as follows:

	Saving, per day.
Handling scrap and other material with a magnet	$40.00
Handling coal and other material with a clam shell bucket	40.00
Handling lumber and timber	30.00
On general construction work including switching	40.00

From these figures it will appear that a crane will pay for itself in a year's time.

A few comparative costs, selected at random, follow:

Material handled.	By hand, ct.	With crane, ct.
Scrap, ton	0.20 to 0.25	0.02 to 0.06
Coal, ton	See note.	0.05 to 0.10
Timber, M. ft.	0.40 to 0.50	0.12 to 0.20
Lumber, M. ft.	0.40 to 0.50	0.25 to 0.35
Piling, lin. ft.	0.004	0.002
Cast iron pipe (loading), cwt.	0.032	0.016
Cast iron pipe (unloading), cwt.	0.021	0.012

Note: The cost of handling coal is not given, as coal handled in any great quantity by hand generally has some labor-saving device, such as elevated tracks, etc.

The saving in money is not the only saving that can be credited to the crane, as the liability of personal injuries is much less where heavy material is handled by mechanical means.

A few typical examples of crane work follow:

A large locomotive boiler weighing 25 tons has been picked out of a river bed, hoisted 60 ft. and loaded on a car in 25 minutes. By hand it would have taken two or three days and in this case a work train would have been necessary to handle the car.

A stiff-leg derrick has been set up alongside a bridge and put into use in three hours. Without a crane it would take all day to unload and place the engine and derrick ready for setting up.

A tower 100 ft. high has been set up with a temporary boom extension in less time than would have been required to rig a gin-pole to do the erection.

At the Panama-Pacific Exposition there are a large number of statues ornamenting the buildings. These were placed very cheaply with a locomotive crane, the boom of which had been extended to over 100 ft. This enabled the crane to reach practically all locations, and the statues were set up quickly and without damage. To have rigged poles to handle each one would have taken a great deal more time and would have cost much more.

These examples might be continued indefinitely, but others will readily suggest themselves to the practical man. In general, however, it may be claimed that a crane will do hoisting where tracks are available in less time than it will take to rig up any other device.

GENERAL CONSIDERATIONS.

The following observations may be of assistance to any one contemplating the purchase of a crane:

The wheels, axles, journals, boxes, brasses, etc., should be of the standard used by the railroad purchasing the crane, so that repairs to the running gear can be made quickly.

The car should be built of steel and of such length that the boiler end of the crane will not extend beyond the end of the car, permitting the car to be coupled into the train without removing any parts of the crane, except the boom, which may be carried on an idler flat car. The car should also be long enough to give it riding qualities necessary for handling in ordinary freight trains. The length of a car required for this is about 24 ft. Aside from the number of wheels required to carry the weight, movement in freight trains makes it necessary that the crane have eight wheels and at least one truck should be of the standard swivel four-wheel type.

The propelling gear should be designed to propel the crane and whatever cars it will pull from four to six miles per hour. This speed is fast enough, and any surplus power of the engine should be devoted to tractive effort. The service required from the propelling gear is severe and it should be as simple as possible, of ample strength and easily replaced. Provision should be made to throw out of gear without the removal of collars or other fastenings under the car, and this feature should be handled entirely by levers or hand wheels at the side of the car or on top. The easier it is to throw the gears out the more likelihood there is of their being thrown out when short hauls are made in a train, as is often done in switching.

The car should be provided with standard draft rigging and brakes. It is a great advantage to have an air pump and engineer's valve on the crane itself, but this feature is not absolutely essential.

The boom should not be too long, except for special service, the ideal length being from 30 to 40 ft. The boom hoist should be of ample capacity and should be operated with a worm gear of such pitch as to require power to operate it in either direction.

The "A" frame should be of such design and material as to withstand shocks without cracking and at the same time should be rigid enough to keep the engine and gears in proper alinement.

As far as possible, the design of the engine and gears should be such as to permit the removal of any shaft, gear, etc., without having to remove other gears and shafts. Some cranes require the dismantling of the entire crane to replace gears that are most liable to wear out.

The reversible engine is favored by all who use it. Experiences of 15 years with hundreds of machines have proven that there are no objections to a reversible engine and its advantages in lowering a heavy load are enough to overcome any disadvantage. Needless to say the gears, shafts, sheaves and bearings should be made of the most suitable material to give the longest possible life.

There should be two drums, so that two-line buckets can be operated. One of these drums should be the main hoist for heavy loads and the other may be an auxiliary drum of lighter capacity to operate the holding line of the bucket, but both should be live drums (power operated) because when digging in a confined space (as in a cofferdam) the bucket is liable to straddle a strut and must be raised in an open position to clear. An automatic tag-line or take-up device should be furnished to handle the tag-line of the bucket.

The operating levers should be in such a position as to give the engineer the best view of what he is doing. At the same time the engineer should have ready access to the boiler compartment, so that he can fire the crane when the class of service will permit without inconvenience.

The boiler is the real limiting feature of the machine. To do work it must have energy, and the boiler is the only thing about the machine to produce energy. The boiler should be of proper size, well insulated and designed for hard service. It should be a free steamer and economy of fuel should be sacrificed if necessary to provide the maximum amount of steam. Reference to the cost of operating tables will show that the cost of fuel is a small percentage of the total cost and the results obtained are so great that extreme economy is not of importance.

Fuel and water should be carried in the greatest quantities for which space can be found.

Probably the most important feature of the locomotive crane is the manner in which the crane is fastened to the car. The up-lift on the center hold-down apparatus, or king pin, is great, and subject to shocks, and in case of breakage there is nothing to prevent the crane from overturning off the car. As this would happen without the slightest warning, this feature should be designed with absolute security in view. In buying cranes this feature should not be overlooked.

The sliding I-beam outriggers are to be preferred over the bracket type on the side of the car. They should be located as low as possible so as not to require much blocking. Jackscrews for the outriggers are not necessary.

An efficient device should be provided to take the load off the truck springs. This should be of such design that the crane will ride properly if this device is not removed before the crane is put into a train. The best device is, probably, a steel wedge between the arch-bar and the frame of the car.

The capacity of the crane at different radii should be plainly marked. An automatic indicator which will indicate the capacity at any position of the boom is simple and should be on every crane.

COST DATA.

The Chicago, Milwaukee & St. Paul Ry. has a number of self-propelled locomotive cranes ranging from 5 to 15 tons capacity, the latter size being most generally employed. The first cost of such a crane is from $6,500 to $7,500. The following data gives the range of the cost per day:

Interest	$1.08 to	$1.37
Depreciation	1.08 to	1.80
Repairs	0.26 to	1.00
Fuel	0.65 to	0.83
Supplies	0.12 to	0.15
Labor	4.40 to	5.85
Total	$7.59 to	$11.00

These figures are gathered from different localities with varying labor scales and costs of fuel and for cranes employed on different classes of work. The labor item only covers the men actually operating the crane and not the crew needed incidentally in handling material or the cost of a night watchman, which would be necessary in a majority of cases.

The general storekeeper in the Milwaukee shops of this company uses a locomotive crane with a magnet almost exclusively for handling scrap, and gives the total cost per day of operating it as $9.10. He states that he is able to accomplish an amount of work with the crane equivalent to what would require from $50 to $60 by hand labor.

Locomotive cranes are used at the company's two principal bridge yards which serve as distributing points for bridge material on the eastern lines and also in handling bridge material on track elevation work in Chicago and Milwaukee. At Tomah, Wis., the cost of operating a locomotive crane unloading and handling piles and bridge timber, including four laborers, which are all that are required in addition to the men on the crane, is $13.45 per 10-hour day. The cost of an ordinary yard crew is $14.25 per day, and a locomotive crane is able to accomplish the work of two yard crews.

The following are some comparisons of the cost of handling by hand and by crane:

	By hand.	By locomotive crane.
Timber	$0.42 per M.	$0.12 per M.
Reinforcing steel	0.24 per ton	0.11 per ton
Piling	0.004 per ft.	0.002 per ft.

Apart from the actual economy in handling material with a crane the use of this type of equipment enables loaded cars to be released in the minimum time and also assists the prompt shipment of outgoing material, avoiding congestion and enabling yard room to be used to the best advantage and the material to be piled more compactly and in better shape than by hand.

The cost of operating a 10-ton crane, estimated on a basis of 300 working days per year, is itemized as follows:

Coal, 875 lbs. at $7	$3.17
Valve oil	0.08
Black oil	0.01
Hard oil	0.01
Crude oil	0.01
Cotton waste	0.01
Boiler washing	0.22
General repairs	0.33
Heating crane shed	0.23
Interest on investment, 5 per cent	1.01
Depreciation, 7 per cent	1.41
Total	$6.49

The above data do not include labor, concerning which the following statement was made:

A saving of 50 per cent in the cost of labor is made by using a crane for handling heavy timber, piling and other heavy materials. A saving of 50 per cent of switching service is made by using a locomotive crane.

By the use of such a crane a saving of approximately $15 per day is made over and above the expenses of upkeep, interest on investment, depreciation, etc.

Mr. Eggleston of the Erie R. R. states that one of their ordinary cranes complete cost $13,300. Interest, depreciation, repairs, fuel and supplies cost per year approximately $3,650 (with an average of 300 working days). He also states that a crane with a magnet will handle as much scrap in a day as 50 laborers; as much timber, piling, etc., as 15 laborers, and as much miscellaneous bridge and building material as 10 laborers. It is invaluable in the placing of structures and structural material.

The above machine weighs 170,000 lbs. It has a piledriver attachment and can operate a drag scraper or a clam shell. Each movement is independent of all others. In turning the maximum speed is three revolutions per minute, while in propelling on straight and level track the speed is 300 ft. per minute. It is capable of handling, under same conditions, 20 loaded cars.

Equipped with a No. 2 "Arnott" steam hammer the crane can drive piles 34 ft. from center of track at the rate of 130 blows per minute. Two tons of coal and 2,000 gals. water will operate it continuously for 10 hours. It requires 2 men to operate, and 6 men will change from boom to piledriver in 3 hours, and the reverse in about 4 hours.

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Economy of Heavy Motor Trucking for Lynn, Mass., Water Works.

(Staff Abstract.)

When motor truck manufacturers began to give out estimates of the economy of motor trucking in municipal service, as compared to the use of horse-drawn vehicles, there was a tendency in some quarters to discount such statements as being prejudiced and misleading. However, in nearly every water department report from the larger and secondary cities, issued since 1914, mention is made of the saving effected by introducing the motor vehicle. Oftentimes the vehicles mentioned are small trucks or runabouts, but there is also reference to the heavier trucks. For example, the 1914 report of Mr. D. A. Sutherland, Superintendent of Water Works at Lynn, Mass., contains the following information relative to the 3-ton motor truck in use by the department:

In February the department purchased a 3-ton White motor truck with a specially designed body for carrying two lengths of 36-in. cast-iron pipe; also two 2-wheeled trailers, one to be drawn behind the truck carrying one length of pipe and the other to be left at the wharf to be loaded while the truck was on the road. A careful record has been kept of the operations of the truck and it has proved to be a great saving in hauling charges over contract price for hauling with horses.

The average round trip was 16 miles. The average tonnage per trip was 5.28. The average haul was 7.875 miles. Taking into consideration the depreciation, interest on first cost, repairs, labor, gasoline and oil, the figures show that it cost $1.83 per ton with an average haul of 7.875 miles. The price bid by contractors for 6.5-mile haul was $2 per ton. On this basis the cost by truck per ton mile was $0.151; cost by contract horse drawn $0.308 per ton mile. The truck made a longer haul for less than half the cost of hauling by horses.

The truck averaged 4.49 miles per gallon of gasoline and 82.1 miles per gallon of oil.

Ninth Annual Chicago Cement Show.—The Ninth Chicago Cement Show will be held February 12-19, 1916, at the First Infantry Armory and Coliseum, Chicago. Twenty-six cement companies shipping cement within 1,000 miles of Chicago have entered into an agreement to participate in a $10,000 exhibit of concrete products which will occupy the south half of the Armory. The materials for this exhibit will be drawn from the resources of practically the whole cement industry, including the Association of American Portland Cement Manufacturers. All duplication will be eliminated by a joint exhibit plan. The Second National Conference on Road Building will be held at the Auditorium Hotel February 15-18 in connection with the show.

4-17-23.

The Lighter Side of Engineering and Contracting

A Missive Received by County Surveyor.

I RECIEVED a misive from yow or your ofice about us filling in the diches at our crossings and constructing the water. I want yow too now i have provided a drain for the water. too run at the natural water course whare it always. run. and i want it too run thare too. I want the water too run whare it has always run on our place at the same places and it wont damage us their or the road either. but if you, or the Road Supirentendents or eny one else changes the natural water course along our land too run the water all at one place across the best land we have. the land will be wirthless and we cant rays nothing on it and it will be $500. dolars damage too us per year. while whare the water youst too run, the natural course it dident doo us now damage. you or now body else has eny rite too chang the natural water course. that will doo eny body any damage. if the water course is changed on our place we will Sue for damage it will be five hundred dollars damage too us pir year at least and futher yow had beter see after that they is a better Stone bed and properly placed and fixed. then to be looking after the Farmers business. and medeling with sumthing that yow have now rite too. the way the road has bin fixed it hant rite atall as it should be. and yow had three 3 road Supirentendents too see after it and the Epence of the three men. and then got now road. I wanter how meny Supirtendents they would hafter be too have a road. built rite as it aut to be. the road ovirseers pay would com hyer then the wirk of building the roads? I have told yow my opinion in regard too yow changing the natural water course along our land. and if yow change it. diferent from what it youst too be. I want the damage I mentioned pir year. at least. and the law will alow me it too.—R. W. G.

It Pays to be Insured.

JIM and Frenchy were working about 19 feet down on a sewer job. As there had been some signs of caving, a ladder was kept in one end of the shaft for quick ingress and egress. As dirt will sometimes do, a chunk suddenly let go and the two sewer rats humped themselves for the ladder. Just as they reached the foot of the ladder another and larger chunk let go. Jim, who was behind, calmly (?) remarked, "For God's sake, Frenchy, let me out first! You got life insurance! I ain't."—W. B. H., St. Joseph, Mo.

WHILE the Toledo and Delphos R. R. was building into Toledo some years ago, a contractor named Maloney had quite a large camp. His employes were Irish and Americans and his cook was quite an intelligent Irishman named Dooley who was very fond of whiskey. Maloney bought all produce through a local merchant in Toledo, who conducted a combination grocery, meat market and saloon. This merchant would call at the camp each day and receive orders for camp supplies from Cook Dooley. In a short time Dooley got well enough acquainted with the merchant to get whiskey on the order book and he arranged with this dealer when whiskey was purchased to "ditto" a dollar's worth of sugar or a dollar's worth of canned goods, so Contractor Maloney would not get next. The merchant's manner of dittoing was "do do do." At the end of the month when Maloney looked over the book to approve payment he called in the cook and said, "Say, Dooley, who the divil are all the 'Doe Does;' I didn't see any of them?"—J. F. L., Toledo, O.

Thanksgiving.

If hard times have got you humping,
If your bank account is nil,
If you've figured wrong and find your
bid is "low,"
If the union calls a walkout
If your skinner's got a knockout,
Be glad you do not live in Mexico.

Where they live on beans and chili,
Where the greasers dress so silly,
Where the peon pays the bill—
In Mexico.

If your turkey is a chicken;
Stringy, tough and hard to chew,
If you find your punkin' pie is mostly
dough,
If your debts pile up like mountains,
If your coin pours out like fountains,
Just be thankful you don't live in
Mexico.

Where they're always revoluting,
Where the Yaqui's always shooting,
Where the gringo gets the boot—
In Mexico.

If you can not grab a fortune,
If your son won't go to school,
If you can not build a house on Rich
Man's Row,
When the mules are most deceiving,
And the 'bo's are all a-leaving,
Cheer up, you're not in France or
Mexico.

Where the men are busy fighting,
Where the grub is not inviting,
Where might is always right—
In Mexico.

Hay Burners for Motive Power.

DURING the Civil War, according to profane history, a remarkable railway was in operation between Shreveport, La., and Marshall, Tex. The line bore the somewhat ambitious title of the Memphis, El Paso & Pacific. Its rolling stock consisted of three box cars and its motive power was gravity and oxen. The cars were loaded at Marshall, and a yoke of oxen put in the front car. The train then coasted down the long grade from Marshall. At the bottom of the incline the oxen were taken out and set to work hauling the train over the next summit. They then got aboard again and the train rolled merrily down the next grade. The performance was repeated until Shreveport was reached.

Leaving No Stone Unturned.

AN Irishman recently arrived in New York City lost his watch. He went to the police station and told the desk sergeant of his loss. The officer jollied him a little and finally reassured him by saying that "no stone would be left unturned until the timepiece was restored to its owner." Pat returned to his room and there on the mantel piece where he had left it was his watch. The next morning as he was going to his work he saw a gang tearing up an old granite block pavement preparatory to laying a new surface. Pat rushed up to the foreman and exclaimed: "Niver moind that now, Oi found me watch."

A SEWER contractor and the inspector had withdrawn from the dust and heat of the day to a restful thirst parlor, hard by. The conversation turned to holding capacity. "I'll bet," said the contractor, "that Adolph, the trench foreman, can drink a gallon of beer without taking the can from his face." "You're on," said the city's representative, "what'll we make it?" "Oh, the gallon in question and a dollar's worth of cigars." The stakes agreed upon Adolph was summoned and his boss stated the proposition. "Give me ten minutes to think it over," said he. "All right," said the boss, and in ten minutes Adolph was back and announced himself ready for the test. He made good with ease. "What made you hesitate in the first place, Adolph? That gallon was easy for you?" "Sure," said Adolph, "but before trying a gallon on a bet I wanted to make sure so I stepped up the street to the Dutchman's to experiment."

Skinner Mulvey says: "I've been settin' on this here threshold of prosperity for so long that I've worn a hole through the seat of my breeches. I'm beginnin' to think the door has a time lock and the clockwork has run down."

CURRENT NEWS

The Doings of the Week.

There were many optimistic developments in finance, industry and trade during the past week. Bank clearings were well above those of the previous week and nearly twice the amount for the corresponding period of last year. Bank deposits established a record; railroad gross earnings continued to rise; there was an increased demand for money, and a further pressure upon production in the leading industries. In the construction field there has been an improvement, judging from the amount of new work reaching the call for bids stage. Several fair-sized drainage and road contracts came up for advertising, and other large undertakings were advanced a step nearer the construction stage. Revised reports for national building indicate that work for the first 10 months of the year was 1.9 per cent less than for the same months of 1914. However, it is expected that November plan filings will bring the total for this year well above that of last year. Reports for the first 15 days of this month indicate a total filing of plans in excess of $68,000,000 in value. Statistics of percentage of building construction now going ahead or being figured in all states east of the Rockies, where gains are being shown in monthly plan filings, is 87.2, as compared with 61 per cent in 1914. In the iron and steel trade increased demands were the feature of the week. New orders for the U. S. Steel Corporation ran far in excess of current output. The corporation has withdrawn quotations in foreign markets. According to *The Iron Age* steel companies have the greater part of their output sold for four or five months, some for most of the first half of 1916, and in certain lines the market on forward deliveries has been sold to a standstill. Fabricating contracts for October represented 78 per cent of the capacity of the bridge and structural shops. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Nov. 17 were as follows:

Finished Iron and Steel.	Nov. 17.	Nov. 10.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.759	1.759
Iron bars, Pittsburgh........	1.60	1.50
Iron bars, Chicago..........	1.50	1.45
Steel bars, Pittsburgh.......	1.70	1.60
Steel bars, New York........	1.869	1.769
Tank plates, Pittsburgh.....	1.70	1.60
Tank plates, New York.....	1.869	1.769
Beams, etc., Pittsburgh.....	1.60	1.60
Beams, etc., New York......	1.769	1.669
Skelp, grooved steel, P'gh....	1.60	1.60
Skelp, sheared steel, P'gh....	1.70	1.70
Steel hoops, Pittsburgh......	1.75	1.75
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	2.25	2.20
Galv. sheets, No. 28, P'gh....	4.00	3.70
Wire nails, Pittsburgh.......	1.90	1.85
Cut nails, Pittsburgh........	1.80	1.80
Fence wire, base, P'gh......	1.75	1.70
Barb wire, galv., P'gh.......	2.75	2.70

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over 1.60 cts.

Railways.—No important developments in the railway construction field occurred during the past week. Conditions in this field, however, show a steady improvement and there are good prospects that important improvements will be taken up soon by the carriers. The consulting engineer of the Rock Island System reported that road should expend $27,000,000 during the next three years for the rehabilitation of its lines. The vice president of the New York, New Haven & Hartford R. R. stated that an expenditure of $25,000,000 should be made by that road for betterments and equipment. The chairman of the board of directors of the Denver & Rio Grande R. R. announced that several millions would be expended in the near future for broadgaging and extensions. These statements indicate that the railroad officials are at least in a more optimistic frame of mind. It has been only recently that they would even talk of spending money. The city of Cleveland, O., is calling for bids for grading a subway, and the city of Philadelphia, Pa., is advertising two more contracts in connection with its rapid transit developments. New York city awarded a $204,000 contract for track laying on the new rapid transit lines in Queens Borough.

Roads and Streets.—A fair amount of new road construction was advertised during the past week. Very little activity, however, is shown in the street paving line. The California Highway Commission is calling for bids on 12 miles of concrete road; the County Supervisors at Bakersfield, Cal., open bids Dec. 9 on 9 miles of highway; County Commissioners at Del Norte, Colo., are asking proposals on 8 miles of state primary road. Road Committee at Portsmouth, Va., opens bids Dec. 1 on 14 miles of gravel road; County Road Commissioner at Sault Ste. Marie, Mich., is advertising several road contracts, one of them covering 4½ miles of highway; County Supervisors at Kosciusko, Miss., ask bids on 30 miles of sand-clay road; Austin, Tex., is calling for proposals for 43,000 sq. yds. of street pavement. The Ohio State Highway Department opens bids Dec. 3 on 12 road contracts, the largest calling for an estimated expenditure of about $30,812. Road Commissioners at Osceola, Ark., are asking proposals for construction of 29½ miles of concrete road and 9 steel bridges. The contracts let include the following: Clearing, grubbing and grading 47 miles of road at Fort Myers, Fla.; 17,500 sq. yds. of concrete sidewalks for Charlotte, N. C.; a $106,000 contract for the County Commissioners at Greensburg, Pa., and $337,000 of contracts for constructing 50 miles of highway for Berrien County, Michigan.

Bridges.—Several good-sized bridge jobs reached the call for bids stage during the past week. County Commissioners at Norristown, Pa., open proposals Dec. 11 for reinforced concrete bridge over Schuylkill River at Phoenixville, Pa., to consist of five spans of 103 ft. each. State Highway Commissioner at Lansing, Mich., is asking bids for constructing a through riveted truss bridge of four spans of 100 ft. each and a Warren riveted truss bridge of two spans of 90 ft. each. Commissioner of Bridges of New York City opens bids Dec. 9 for construction of Unionport bridge over Westchester Creek. The Sanitary District of Chicago is asking proposals for superstructure metal for 11 highway bridges, about 1,000 tons being required. County Freeholders at Atlantic City, N. J., open bids Dec. 8 for a 742 ft. bridge over Mullica River.

Drainage and Irrigation.—Commissioners of Drainage District No. 7 of Marion, Ark., open bids Dec. 10 for 44 miles of ditches, requiring 1,800,000 cu. yds. of earth excavation. Bids will be opened Dec. 15 at Bemidji, Minn., for Judicial Ditch No. 36, requiring 127 miles of ditching, involving 1,162,600 cu. yds. of excavation and estimated to cost $212,195. Drainage District No. 1 of Tempe, Ariz., is calling for bids for 8.4 miles of open ditch. The South San Joaquin Irrigation District of Manteca, Cal., opens bids Dec. 6 for the construction of a $175,000 reservoir. The County Auditor at Des Moines, Ia., is asking proposals on two tile drain jobs, estimated to cost $11,000 and $26,100.

Water Works.—No important new undertakings in the water works field appear to have reached the call for bids stage during the past week. Henderson, Tenn., is asking proposals for 10-in. wells, 100 ft. to 250 ft. in depth; Houston, Tex., is calling for bids for three deep wells and installation of pumps and motors; St. Hyacinth, Que., opens tenders Dec. 14 for construction of mechanical gravity filtration plant of 4,000,000 imperial gal. capacity.

Sewerage.—Washington, D. C., is calling for bids on 12,000 ft. of 10 in. to 14 in. pipe sewer; Cuyahoga Falls, O., opens proposals Dec. 14 on sewers to cost about $20,000; Harbor Beach, Mich., is asking bids on a sanitary sewer system and disposal work; Baltimore, Md., is advertising two sewer contracts involving about 10,800 ft. of 8-in. to 18-in. pipe and 5,000 ft. of house connections.

Railway Conditions Improving.

For many months this country has stood upon the "threshold of prosperity." And now according to the weekly business reviews of the daily press the "threshold" at last has been crossed. Engineers and contractors will learn of this development from the newspapers for they have received as yet no invitation to the grand opening. Possibly the announcement may be a bit premature. Nevertheless there are many indications that if prosperity is not already here it is just around the corner. Not the least of these good omens of better times is the great increase recently in railroad gross earnings. Western lines are benefiting from the haulage of the immense crops while the exceptional industrial activity in the east is furnishing roads in that section with more freight than they can handle. Many railroads now have the greatest amount of traffic in their history. Statistics made public early in November by the Interstate Commerce Commission show that the increase in net revenues of 116 roads is the largest in two years. With the carriers once more in a prosperous condition, their stock and bonds will be better investments than they have been in the past. There is plenty of idle investment capital in the country. Money probably is more abundant and cheaper now than at any time since 1898. And that year by the way marked the beginning of the great period of railroad expansion that lasted with slight reactions for nearly 10 years.

More Winter Construction.

Old customs die hard. Some 250 years ago Dirk Van Dyke of New Amsterdam was awarded a contract by Governor Peter Stuyvesant for digging a drain, and thus goes down in history as the first contractor in this country. Dirk and his three men began excavating under the watchful supervision of four inspectors. When the frosts came and the ground froze they stopped work, thereby establishing a custom that contractors have religiously followed. This popular superstition that all construction must stop with the coming of freezing weather has been pretty thoroughly exploded in recent years. Nevertheless constructional activities in some sections of the country are practically at a standstill for six months in the year. There are many classes of construction that can be carried on, if proper precautions are taken, very nearly as well in the winter as in the warmer periods. And in many cases the work can be done at less cost because materials are cheaper and labor is more abundant. An increase in the amount of winter construction, especially in the building line, would prove a benefit to the contractor, workmen, the engineer, the architect, the manufacturer of supplies and equipment, and last but not least—the owner.

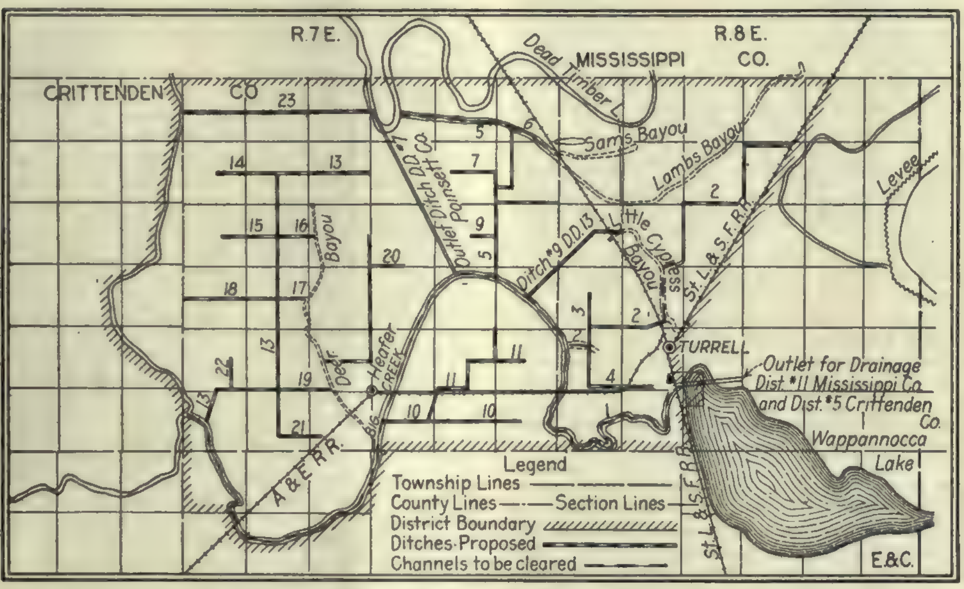
A 1,800,000 CU. YD. DRAINAGE JOB.

Bids Asked by District No. 7 of Crittenden County, Ark.

Requires Excavation of 44 Miles of Ditch.

Bids are now being asked on another good sized drainage contract in Crittenden County, Arkansas. The work is to be undertaken for Drainage District No. 7 for the purpose of draining about 37,100 acres of land. It requires the construction of about 44 miles of ditches involving about 1,800,000 cu. yds. of earth excavation.

The district is located in the northern part of the county. A branch of the St. Louis & San Francisco R. R. follows one boundary of the district. A line of the same railroad also crosses the district. The district can best be examined by going to Turrell, which is located on the above mentioned railroad. The location of the ditches is shown on the accompanying map.



Location of Ditch Work in Drainage District No. 7.

The excavation work is divided into four parts, each part of which will be offered separately to bidders. Bids also may be accepted for the work as a whole. Contract No. 1 calls for the construction of 14.3 miles of ditch, the total yardage being 404,900 and the estimated cost $32,400. The width of base of ditches in this section is 12 ft., and the average cut for the greater portion is 8 ft. Contract No. 2 cover 14.2 miles of ditch requiring 402,500 cu. yds. of excavation, the estimated cost being $32,190. On these ditches also the width of base will be 12 ft. About 2.7 miles of the ditch will have an average cut of 9.5 ft. The greater portion, however, will have an 8-ft. cut. Contract No. 3 requires the excavation of 12.1 miles of ditch, the yardage being 479,600 cu. yds., and the estimated cost $38,370. About 1½ miles of ditch will have a 20-ft. base and an average cut of 12 ft. The remainder will have a 12-ft. base, the average cut for the greater portion being 8 ft. Contract No. 4 covers Ditch No. 23, 3 miles in length. This will have a 44-ft. base, an average cut of 13 ft., requires 434,700 cu. yds. of excavation and is estimated to cost $37,740. The right-of-way to be cleared will be 110 ft. wide for all the ditches with the exception of No. 23. For this the width will be 220 ft. Side slopes will be 1:1.

Where not otherwise specified a berm 10 ft. wide will be left between the margin of the ditch and the inside toe of the waste bank. Openings not less than 10 ft. wide at the bottom will be left at the intersection of all natural drains and depressions and at other points located by the engineer. The slopes of the waste banks adjoining openings will not be steeper than 2½ to 1. On Ditch No. 23 the berms will be 15 ft. wide. Rough levees with crowns at least 4 ft. wide and side slopes not steeper than 2 to 1 will be constructed at certain locations. These levees are included in the dredging contracts and additional compensation for their construction at the rate of 18 cts. per cubic yard will be given. Where feasible the levees may be constructed with a dredge.

The excavation by floating dredges must be carried on at an average rate of not less than 30,000 cu. yds. per month for any period of six months from the time of beginning work which must be not more than six months from the date of the sale of the bonds. No machine with a boom less than 45 ft. long will be acceptable for the work.

Bonds to pay for the work will be offered for sale the same day that the contracts for construction are let. Payment for the work will be made in cash.

Bids for the work will be received at the Court House at Marion, Ark., on Dec. 10 by the Commissioners of the District. H. F. Willis, Turrell, Ark., is chairman of the Board. The Morgan Engineering Co., Memphis, Tenn., is the engineer.

A 500,000-Cu. Yd. Dredging Contract.

A fair sized Great Lakes dredging contract is being advertised for bids by the U. S. Engineer at Cleveland, O. The work calls for dredging portions of the west and east basins of the outer harbor at Cleveland. These areas have previously been dredged to a depth of about 25 ft. at mean lake level, but have shoaled to a present depth of 16 ft. to 23 ft. The dredging is to be done to secure a depth of 28 ft. No work will be required where the depth is 22.5 ft. or more.

The areas are protected by breakwater. The fluctuation of the water level is only that due to wind and seasonable variation, and during the usual working season, April 15 to Nov. 15, varies from about 1 ft. to about 2 ft. below mean lake level. The locality to be dredged and the route to dumping ground are unobstructed by bridges.

The total estimated quantity of material to be removed, exclusive of allowable overdepths, is about 500,000 cu. yds., place measurement. The material is believed to be sand and silt brought into the harbor by the Cuyahoga River. The excavated material will be transported and deposited in Lake Erie. The maximum distance, if handled in scows, will not exceed 8,500 ft., or 1,700 ft. if handled by pipe line dredge. The average distance will not exceed 6,000 ft. for scows or 1,000 ft. for pipe line dredge.

The funds for the work were appropriated in 1915. The amount available for payment of contractor's estimate is $75,000. Bids for the work will be received until noon Nov. 26 by the U. S. Engineer, Cleveland, O.

Rapid Transit Developments in Eastern Cities.

Rapid transit developments in New York City, Philadelphia and Boston are affording a considerable amount of heavy construction. Two important sections of the dual system of rapid transit of New York City are now being advertised for bids. One of these covers Section 2 of Routes 19 and 22 and is a part of the 7th Ave.-Lexington Ave. Rapid Transit R. R. The work provides for the construction of an elevated railroad in the Borough of the Bronx, extending over and along Whitlock Ave. and Westchester Ave. from Bancroft St. to Eastern Blvd. The contract time is 18 months. Bids are to be opened Nov. 30. The other New York job involves the construction of another tunnel under the East River. The contract covers Section 8 of Route 8 and is a part of the 14th St.-Eastern R. R. The section is to be a 2-track subsurface line, beginning under East 14th St., Manhattan Borough, about 80 ft. west of Avenue B, and extending easterly under East 14th St., private property, water front property at the foot of East 14th St. and the East River. It will then extend under water front property at the foot of North 7th St. and under that street to a point about 50 ft. west of Bedford Ave. The method of construction will be generally by tunnelling, but partly by excavation from the surface. The contract time is 34 months. Bids will be received by the Public Service Commission until Dec. 7.

Construction was started several months ago on the new rapid transit facilities for Philadelphia, Pa. Work is now under way on the Broad St. subway and on the Frankford elevated line. Contracts for about 20,520 ft. of this latter structure were awarded the latter part of October to the McClintic-Marshall Co., Philadelphia, at about $1,700,000. Two additional contracts for work on the Frankford elevated are now being advertised. One calls for concrete column foundations and piers for about 4,000 lin. ft. of 2-track elevated railway in Frankford Ave. from Unity St. to Dyre St. Bids for this are to be opened Dec. 7 by A. M. Taylor, director of city transit. The other contract provides for steel superstructure and appurtenant work for the 4,900 ft. of 2-track railroad. Bids on this are to be opened Dec. 14.

The Boston Transit Commission of Boston, Mass., on Nov. 11 opened bids for another section of the Dorchester Tunnel. This section (G) covers 1,280 ft. of 2-track subway and was let to Coleman Bros., Boston, at $382,394.

Progress on Wanaque Water Supply, New Jersey.

The State Water Supply Commission of New Jersey is progressing with the preliminaries for the Wanaque water supply development. Draft of the proposed contract between the Commission and the municipalities involved has been drawn up and is now under consideration. The cities that signified their intention of participating in the project and the amount of water desired are as follows: Newark, 10,000,000 gals.; Paterson, 5,000,000 gals.; Passaic, 4,000,000 gals.; Montclair, 2,000,000 gals.; Kearny, 2,000,000 gals.; Harrison, 2,000,000 gals.; Glen Ridge, 400,000 gals.

The Wanaque project as previously noted in these columns, provides for the development by the state of a minimum daily supply of 50,000,000 gals. at an estimated cost of $5,862,000. The reservoir will be located on the Wanaque River, near Midvale, and will require the construction of a dam 1,723 ft. long, of which 1,175 ft. will be earth fill with a concrete core wall. The remaining portion will be constructed of concrete masonry and will serve as a spillway. The supply will be delivered by pipe. It is proposed to deliver 50,000,000 gals. per day as far as Paterson through 90,000 ft. of 6-ft. steel pipe. From Paterson to Newark there will be 75,000 ft. of 5-ft. steel pipe, delivering 30,000,000 gals. daily, and from Newark there will be a line of 3 ft. pipe 15,000 ft. in length to deliver 10,000,000 gals. as far as Harrison and Kearney.

Two Government Buildings to Cost $2,490,000.

A considerable amount of large building construction is being undertaken this year by the U. S. Treasury Department. On Nov. 11 the department awarded the contract for the new Appraiser's Stores at Boston, Mass., and on Nov. 17 opened bids for the construction and equipment of a big central heating, lighting and power plant at Washington, D. C.

The work at Boston was awarded to the P. J. Carlin Construction Co., 1122 Broadway, New York City, at $611,000, the contract covering the construction except mechanical equipment. The contract for the elevators was let to the Otis Elevator Co. at $21,379, and the contract for the mechanical equipment was secured by the Standard Engineering Co., Washington, D. C., at $60,500. The government appropriation for the building is $805,947. The Appraiser's Stores will be an 8-story structure with a floor area of 18,000 sq. ft. and a basement area of 12,000 sq. ft. It will be faced with granite to a height of 8 ft. above the sidewalk and for the rest of the distance with red brick with granite trimmings. The ground foundation will be on concrete piers sunk to a depth of 45 ft. below street grade. On the harbor line bordering Fort Point Channel there will be a sea wall 135 ft. in length.

The power plant at Washington is one of the largest undertakings of the kind that has come up for letting this year. Bids were received on separate items of the improvement and on the work as a whole. On the latter basis W. G. Cornell Co., Washington, D. C., at $1,698,500 was low bidder, the contract time being 18 months. The other two bidders on this basis were George T. Kelly, Yonkers, N. Y., time 30 months; P. J. Carlin Construction Co., New York City, $2,090,000 and $2.160,000, time 24 months. The low bidders on separate parts of the job were as follows: Excavation, etc., Geo. E. Wyne, Washington, D. C., $397,000; turbo alternator, General Electric Co., $105,000; condensing equipment, Westinghouse Electric & Manufacturing Co., $26,259; boiler equipment, E. Keeler Co., Williamsport, Pa., $111,900; automatic underfeed stokers, Combustion Engineering Corp., New York, $39,472; boiler feed pumps, International Steam Pump Co., Philadelphia, $11,254; steam, water and exhaust piping, Hanley-Casey Mechanical Equipment Co., Chicago, $188,785; open feed water heaters, Cary Machinery & Supply Co., Baltimore, Md., $3,830; switching apparatus and power house transformers, General Electric Co., $65,000; electric crane, Niles-Bement-Pond Co., $8,840; coal and ash handling apparatus, Gifford-Wood Co., Hudson, N. Y., $31,000; alternating and direct current cable, General Electric Co., $156,900; switching apparatus and measuring instruments, etc., General Electric Co., $80,000; rotary converters and transformers, General Electric Co., $87,000; concrete pipe tunnels and steam lateral system, Wm. Dall Co., Cleveland, O., $280,000; tunnels, supplementary concrete tunnels, lateral system and tile duct system, James Ferry & Sons, $413,083; pipe connections in substation buildings, Hanley-Casey Mechanical Equipment Co., $8,611; changes and alterations in buildings for substations, W. G. Cornell Co., $52,520.

Steel Towers for Radio Station, Guam.

The Bureau of Yards and Docks of the Navy Department is now calling for bids for the two steel towers for the high power radio station at Guam. Each tower will be approximately 400 ft. in height, of the self-supporting type, triangular in plan, the base of each leg forming the corner of a triangle 90 ft. on each side in plan. Each tower will be supported by and anchored to a concrete foundation. Insulating devices will be furnished and installed by the contractor, as well as lightning protection, winches, operating platform and ladders. The total net weight of the two towers is estimated at 480,000 lbs.

The radio station is located on Mount Tonjo at an altitude of about 1,000 ft. above sea level and is about 6½ miles from Piti. Material must be hauled from this place to the station. The government will build a wagon road from Piti to the station. The road will have heavy grades, with a probable maximum of 20 per cent. Bids for the two towers will be received until 11 a. m. Jan. 8 by Bureau of Yards and Docks, Washington, D. C.

$52,000,000 for Railway Betterments.

Great expenditures will have to be made soon by many railroads mainly to put their lines in condition for the most economical operation. An idea of the large sums involved is given by recent statements of railway officials. According to the special request of J. W. Kendrick approximately $27,000,000 will have to be spent in order to secure a thorough rehabilitation of the Chicago, Rock Island & Pacific Ry. The major part of this expenditure, it is stated, should be made during the first three years. The more important items include the following:

Grade revision, new lines, sidings and second tracks	$6,008,000
Improvements to existing cars and locomotives	3,442,000
Ballast and bank widening	3,587,000
Tin plates	3,000,000
Track elevation and grade separation	3,392,000

In an address at New Haven, Conn., Edward Buckland, vice president of the New York, New Haven & Hartford R. R., estimated that his company should expend $25,000,000 within the next five years. Of this total $2,500,000 is for a new bridge over the Thames River at New London, Conn.; $1,500,000 for electrical facilities between New Haven and New York City, and $3,000,000 for trackages, yards and sidings. Improved and additional signals would require $1,000,000, and new passenger cars, freight cars and locomotives necessitate expending $9,000,000.

Municipal Industrial Railway for Jersey City, N. J.

An industrial railway development of considerable magnitude is proposed by the city of Jersey City, N. J. The plan provides for the construction of a marginal railway with a main stem 5 miles in length and with sidings 16 miles in length. This line would form a loop and would practically give a rail outlet to every available industrial section.

The new route would connect with the Hoboken Shore Road, which serves the great steamship lines terminating at Hoboken; with the New Jersey Junction R. R., which is a continuation of the West Shore R. R. from Weehawken; with the Delaware, Lackawanna & Western R. R., the Pennsylvania R. R., the Lehigh Valley R. R., the Central R. R. of New Jersey, the City Dry Docks situated on the Hudson River, the Brooklyn Eastern District Terminal and its connections, and the South Shore Cove Water Development.

The project was initiated by the Chamber of Commerce of Jersey City. The state legislature recently passed an act empowering the municipality to own and operate such a railroad. The total estimated cost of the improvement is $1,600,000.

Rapid Transit Developments for Chicago.

A step toward securing a comprehensive plan for rapid transit development for Chicago was taken last week by the city council committee on local transportation. The committee approved a proposal of its subway committee for the preparation of such a plan, and requested the preparation of an ordinance for that purpose. The plan calls for the appointment of three engineers to study all phases of the local transit problems. One engineer is to be a resident of Chicago and the other two are to be men thoroughly familiar with transportation conditions in New York, Philadelphia or Boston.

The report recommended that the engineering board consider the following: Uniform operation of elevated and surface lines; valuation of the elevated properties; location and general plan for subways that can be extended to meet the city's growth and development; physical connections between subways and elevated and surface lines; universal transfers for all three types of service; necessary extensions of elevated lines to provide rapid transit by their use instead of by subways; a financial plan covering investments already made and also the additional capital required from the companies for subways and for the extension of elevated lines.

The $672,000 Federal St. Viaduct, Youngstown, O.

The East Federal St. viaduct dispute at Youngstown, O., now seems in a fair way toward settlement. Plans for the new bridge to replace the present structure and to elevate the grade crossing have been agreed upon by engineers of the railroad and the city and it is possible that construction may be started soon on the $675,000 improvement. The City Council has adopted the report of the City Engineer and has authorized legislation to substitute the new plan for the Council plan.

The main features of the new plan include the erection of a viaduct, the rearrangement of the tracks of the Lake Shore R. R., between Oak St. and Himrod Ave., the removal of the Lake Shore freight station east to Stafford St., and the relocation of the Lake Shore passenger station. The estimated cost is $672,000, apportioned as follows: City, $117,000; Lake Shore & Michigan Southern R. R., $270,000; Erie R. R., $135,000; Pennsylvania R. R., $35,000; Mahoning & Shenango Ry. & Light Co., $117,000.

The viaduct will be of steel girder and I-beam construction with a concrete floor. It will have a 42-ft. roadway and two 8-ft. sidewalks. The westerly approach from Federal St. will be on a 5 per cent grade, supported by retaining walls. The easterly end of the viaduct will be on a 4 per cent grade, and the approaches in Wilson Ave. and Himrod Ave. will join the grade just west of the viaduct. All streets, grades of which are to be changed, will be paved with brick; the viaduct will be paved with creosoted wood block.

Improvements for the Denver & Rio Grande R. R.

Announcement was made last week by Edward T. Jeffery, chairman of the board of directors of the Denver & Rio Grande R. R., that the company's "expanding business throughout Colorado makes it almost imperative to spend millions in the near future in the extension and development of the lines in Colorado and Utah." It is understood that definite information regarding these improvements will be given out in the course of the next few weeks by the new president, H. U. Mudge.

This plan of development for the Denver & Rio Grande is believed to include the broad gaging of the tracks not now on standard gage and the construction of extensions. One line will extend from the Rio Grande del Norte's south fork over the Continental Divide to Durango by way of the San Juan Basin. The line not only would shorten the distance from Denver to Durango, but also would eliminate bad grades on Cumbres Pass. As projected the line will leave the Creede broad gage of the Rio Grande at South Fork station and follow up the south fork of the Rio Grande del Norte, crossing the Continental Divide at an altitude of 10,000 ft., 39 ft. lower than where the narrow gage crosses. On the other side of the South Fork pass there would be a 2 per cent grade against a 4 per cent on the present line.

The Sanitary District of Chicago, Chicago, Ill., is asking bids for the fabrication and delivery of the superstructure metal work for 11 highway bridges to be constructed over the Calumet-Sag channel. Six of the structures are riveted truss bridges and the other five are plate girder bridges.

PERSONALS

Mr. T. Brindle of Ashland, Ohio, division engineer with the Ohio State Highway Department, has been appointed as engineer for the Ohio Brick Manufacturers' Association. Mr. Brindle was resident engineer for the State Highway Department at Ashland for five years and was also county surveyor for Ashland county. In 1914 he was appointed division engineer at Ashland.

Mr. Edward M. Boggs, member of the American Society of Civil Engineers, and chief engineer of docks and wharves of the San Francisco & Oakland Terminal Railways, has been appointed chief engineer of the Department of Way and Structures, succeeding Mr. George H. Binkley. This department is formed by the consolidation of the Departments of Maintenance of Way and Structures and of Docks and Wharves.

Members of the water works contracting and supply fraternity of St. Paul, Minneapolis, Duluth and other places recently surprised Mr. and Mrs. James M. Pitblado of 3737 Lyndale avenue, recently married, with a very fine silver service as a wedding present. Mr. Pitblado is the assistant contracting manager of the Minneapolis Steel & Machinery Co. of Minneapolis, and is widely known and much liked by the water works men of his own and surrounding states.

Mr. C. J. McDonough has been appointed division engineer for the New York State Highway Department at Buffalo, N. Y. He was assistant city engineer of Buffalo from 1901 to 1904, and from that time until 1907 was assistant engineer on the New York State Barge Canal. He was promoted to the office of first assistant engineer on the Barge Canal in 1907 and in 1912 was made acting division engineer on Barge Canal terminals. He became division engineer in the State Highway Department in 1914, being stationed at Syracuse.

Mr. G. M. Harbert has been appointed county road engineer of Harrison county, West Virginia, with headquarters at Clarksburg. Mr. Harbert was transitman in charge of party on the Bitter Root Valley irrigation project in Montana in 1909. He was connected with the Southern Pacific construction department during the two years following. In 1911 he was assistant city engineer for Baker, Ore., and since 1912 he has been assistant engineer for the West Virginia State Road Bureau, with headquarters at Morgantown.

Mr. Alfred P. Bosworth has been appointed city engineer of Tulare, Cal. Mr. Bosworth is a graduate of Rensselaer Polytechnic Institute of Troy, N. Y., and was for two years with the department of revaluation of the Southern Pacific Railroad. For the past four and a half years he has been connected with the engineering forces of the California State Highway Commission in the San Francisco and Fresno offices and on construction. Mr. Bosworth as city engineer will also take over the duties of superintendent of streets and the superintendent of water works and sewers.

Burns & McDonnell, consulting engineers of Kansas City, Mo., announce the removal of their offices from 821-26 Scarritt Building to Suite 400 Interstate Building. The firm is widely known and is largely engaged in appraisals, rate investigations, and the designing of public utilities. Both Mr. Clinton S. Burns and Mr. R. E. McDonnell are members of the American Society of Civil Engineers and of the American Water Works Association. Mr. Burns is also a member of the New England Water Works Association, while Mr. McDonnell is a member of the Western Society of Engineers.

Mr. Alexander W. Macpherson has been made assistant chief engineer of the San Francisco & Oakland Terminal Railways, department of way and structures. Mr. Macpherson is a graduate of the University of California, College of Civil Engineering, class of 1904. He then entered the service of the Southern Pacific Railway as assistant engineer in the maintenance of way department, and in 1905 became assistant engineer for the Oakland Traction Company.. In the following year he was appointed assistant engineer for the Oregon Railway & Navigation Company and held that position for two years. He then again became assistant engineer for the Oakland Traction Company and in 1912 became engineer of maintenance of way and buildings for the San Francisco & Oakland Terminal Railways. In his new position he will have direct charge of all maintenance of way, construction and paving work, docks and wharves, exclusive of overhead bonding and signals.

CONTRACTORS.

The Standard Paving Company has been incorporated with a capital stock of $32,500, to carry on a general paving contracting business, with offices at 424 Central Office Building, San Antonio, Texas. Mr. J. Q. Gray, formerly president of the Standard Roofing Company, is president of the new company. Mr. C. E. Hoff of Hoff & Williams, Muskogee, Okla., is vice president, and Mr. E. E. Krueger of the Herman Construction Company of St. Louis is secretary. The Standard Paving Company has been in business for some years, though now newly incorporated. The company has constructed $45,000 worth of asphalt pavement in Parsons, Kan., in 1913; $95,000 of asphalt in McPherson, Kan., in 1913-14; $30,000 brick pavement in Tulsa, Okla., 1913-14; $275,000 concrete and brick in San Antonio in 1914-15. At present the company has under way 65,000 sq. yds. of concrete and brick pavement.

The Uvalde Rock Asphalt Company, 411 Swearingen McCraw Building, San Antonio, Texas, which was recently awarded the contract to construct five miles of paving at Beaumont, Texas, has under way similar contracts in Taylor, Dallas and San Antonio, Texas, the total amounting to 225,000 sq. yds. of paving, all of it natural rock asphalt. The company controls the Uvalde rock asphalt mines at Cline, Texas, and claims to produce an economical paving material which is used quite extensively in Texas. Work which has already been completed in Dallas, Beaumont, Houston and San Antonio totals 365,000 sq. yds. The price ranged from $1.85 to $2.15 per sq. yd. for 2-in. Uvalde rock asphalt surface on 5-in. concrete base, prices varying with the freight rate and distance from the mine. The company was organized in 1911 with its present officers. Mr. J. Blewitt Smyth of Beaumont is president; Mr. R. L. White, vice president and general manager; Mr. T. S. Reed, vice president; Mr. Charles E. Walden, secretary, and Mr. Frank Alvey, treasurer. The main offices are at San Antonio, as above, but the company has branches in Houston and Beaumont.

OBITUARIES

James J. Campbell, superintendent of the Menominee, Mich., Water Company, died recently after a brief illness. Mr. Campbell had been in the employ of the company for thirty years, and had been superintendent since 1897.

Eben R. Dyer, for many years superintendent of the Portland, Me., Water District, died recently at his home in Portland, aged 70. Mr. Dyer was an active member of the New England Water Works Association.

William Frederick Allen, general secretary and treasurer of the American Railway Association, died at his home in South Orange, N. J., November 9, aged 69. Mr. Allen was a noted engineer and in 1883 as secretary General Time Convention took the leading part in proposing and securing the adoption of the present system of standard time. His first engineering work was that of rodman on the Camden & Amboy railroad in 1862. The following year he became assistant engineer for that road, and in 1868 was made resident engineer for the West Jersey railroad. In 1872-73 he was assistant editor of the Official Railway Guide, and since 1873 has been general manager for that publication. In 1875 he was made secretary of the General Time Convention and in 1877 of the Southern Railway Time Convention. In April, 1886, he became secretary of the American Railway Association. Mr. Allen was a member of a great many technical and scientific societies and was U. S. delegate to the International Meridian Conference in 1884, and to the International Railway Congress at Paris in 1900. He was delegate from the American Railway Association to many conventions. He was also a frequent contributor to the technical and popular magazines on the subject of railways and standard time.

CIVIL SERVICE NEWS

The United States Civil Service Commission announces an examination for marine engine and boiler draftsman on Dec. 8-9. Salary, $5.04 per diem. Also an examination for marine engine draftsman for submarines Dec. 21. Salary $5.04 per diem.

NEW CATALOGUES

Steam Shovel.—Paper, folder. Thew Automatic Shovel Co., Lorain, O.

Circular No. 26, showing the operation of the Thew Combination Boom Shovel and explaining the practical advantages of its construction. A description of this new shovel appeared in our issue of Oct. 13.

Core Drills.—Paper, 6x9 ins.; 128 pp. Ingersoll-Rand Co., 11 Broadway, New York City.

Illustrated and descriptive booklet, Form 9201, devoted to Calyx Core Drills and their work in coal and metal mines, stone quarries, canals or tunnels. Gives sizes and capacities of the different types and shows the apparatus in operation in various fields.

Blue Printing Machine.—Paper, 6½x3½ ins.; 20 pp. Wickes Brothers, Saginaw, Mich.

Describes the Wickes Continuous Electric Blue Printing Machine and shows views of the machine and its operations. Gives some comparative current cost data and specifications with instructions for installation.

Air Compressor Installations.—Paper, 4x9 ins.; 8 pp. The Gardner Governor Co., Quincy, Ill.

Gives some "Helpful Hints" on the subject, pointing out the details to be considered in the selection and location of air compressors, choice of air tank, pipe fitting, safety valve, lubrication, cooling water, repairs, etc. Shows a number of Gardner-Rix types.

CATALOGUE REVIEWS

Water Sterilization by Ultra Violet Rays.—Paper, 6½x9 ins.; 9 bulletins. The R. U. V. Co., Inc., 50 Broad Street, New York City.

The R. U. V. Company has sent in a number of pamphlets dealing with the various phases of the above subject. Bulletin No. 112, 6 pp., describes the use of ultra-violet ray sterilization in swimming pools and shows a number of typical installations. Bulletin No. 113, 4 pp., describes the advantages of the process to bottlers. Bulletin No. 114, 4 pp., shows the application of the R. U. V. system in hospitals. Bulletin No. 115, 4 pp., describes its use in raw water ice plants. Bulletin No. 117, 12 pp.; Bulletin No. 118, 12 pp., and Bulletin No. 119, 12 pp., take up the subject of sterilization by ultra-violet rays in general and describe the apparatus used for drinking water systems, bottling plants, etc. Give diagrams of installations, photographs of apparatus, etc.

The other two pamphlets are reprints of papers read before two technical societies by Mr. M. von Recklinghausen of the R. U. V. Company, in which he explains the theory and application of the ultra violet ray purification process. These are illustrated by photographs and drawings, and give information on the bactericidal power of the rays, capacity of the apparatus, operating costs, etc.

RAILWAYS

BIDS ASKED.

Arizona:

Tucson, Ariz.—Until Nov. 27, according to report, by city manager, for constructing subway under railroad tracks at Congress St., to cost about $70,000. L. R. Walker, engineer, Tucson.

New York:

New York, N. Y.—Until 12:15 p. m., Dec. 7, by Public Service Commission for the First District, for supply of 19 portions of special work, frogs and switches for use in construction of Rapid Transit R. R., Lexington Ave. line.

Ohio:

Cleveland, O.—Until noon, Dec. 2, by A. R. Callow, City Commissioner of Purchases and Supplies, for grading subway at Hamilton Ave. and Pennsylvania R. R.

Pennsylvania:

Philadelphia, Pa.—Until noon, Dec. 14, by A. M. Taylor, Director of City Transit, for stel superstructure and appurtenant work for two-tracked elevated railway in Frankford Ave., comprising about 4,000 ft. of structure.

Philadelphia, Pa.—Until noon, Dec. 7, by A. M. Taylor, Director of City Transit, for concrete column foundation and piers for about 4,000 ft. of two-tracked elevated railway in Frankford Ave.

PROSPECTIVE WORK.

Colorado:

Denver, Colo.—Denver & Rio Grande R. R., according to an announcement of Edward T. Jeffery, Chairman Board of Directors, will in the near future expend several millions of dollars, standard gaging line in Colorado and in building new extensions. The latter will include a line from the Rio Grande Del Norte South Fork over the Continental Divide to Durango, by way of San Juan Basin.

Florida:

Pensacola, Fla.—Pensacola, Mobile & New Orleans R. R. is reported to have sold sufficient bonds to complete the last link of its line to Mobile, Ala. About 17 miles yet remain to be completed, and it is said work on this will be started at once. Henry McLaughlin, Pensacola, Fla., is President.

Illinois:

Metropolis, Ill.—Illinois Central R. R. is reported to have secured right of way for a new line 100 miles in length, from Grayville to Metropolis. It is said that the line will be double tracked, and construction will start shortly.

Chicago, Ill.—Special report of J. W. Kendrick to Directors of Chicago, Rock Island, Pacific Ry. is reported to recommend expenditure of $27,000,000 during next three years for rehabilitation of the line. Of this sum $6,000,000 is for grade revision, new lines, sidings and second tracks; $3,442,000 for improvements to existing cars and locomotives; $3,442,000 for ballast and bank widening; $3,000,000 for tie plates and $3,392,000 for track elevation and grade separation.

Kansas:

Hutchinson, Kans.—Arkansas Valley Interurban Co. is considering building north, either from Halstead or Newton.

New York:

Sanford Lake, N. Y.—Champlain & Sanford R. R. has secured most of the right-of-way which proposed 60 mile line, from Sanford Lake east to Fort Ticonderoga. E. Scharson, 71 Broadway, New York, is president.

North Carolina:

Kingston, N. C.—Chamber of Commerce is taking steps to secure construction of street railway system.

Pennsylvania:

Northumberland, Pa.—Right of way is being secured for extension of present third rail system from Scranton via West Nanticoke, Berwick, Bloomsburg, Danville, Northumberland, Sunbury, and thence to Harrisburg. J. F. Richards, Sunbury, is interested.

Connellsville, Pa.—Baltimore & Ohio R. R. is reported contemplating constructing third track between Greene Junction and Indian Creek, 7 miles.

Texas:

Buena Vista, Tex.—Proposition is under consideration for construction of gas-electric interurban railroad, to connect with Orient R. R. and run northwest up Pecos Valley, a distance of 25 or 35 miles, affording railroad facilities to the Imperial, Cimmaron and Grand Falls Irrigation Systems. Pecos Valley R. R. Association, V. L. Sullivan, chairman is interested.

Dallas, Tex.—Interurban electric railway interests centering in Dallas are reported to have reached agreement for construction of large system of terminals and Union Station here. Stone & Webster, Engineering Corp., Boston, Mass., is interested.

BIDS OPENED; CONTRACTS LET

Kentucky:

Manchester, Ky.—Construction work is under way for projected line of Cumberland-Manchester Ry. from Manchester to Barbourville. E. G. & W. T. Garrard have grading contract.

New York:

New York, N. Y.—Thomas Crimmins Contracting Co., New York City, has been awarded contract, at $204,898, by Public Service Commission, for track laying on New Rapid Transit Line in Queens Borough.

Utah:

Spanish Fork, Utah.—Wasatch Grading Co., Salt Lake City, Utah, has started work on its contract for grading for extension from Spanish Fork to Payson, for Salt Lake & Utah Electric Ry. Extension will be about 6 miles long.

ROADS STREETS

BIDS ASKED.

Alabama:

Bay Minette, Ala.—Until Dec. 14, by County Commissioners, for grading, draining and surfacing several roads.

Arkansas:

Osceola, Ark.—Until 2 p. m., Dec. 1, by Board of Commissioners, Osceola & Little River Road Improvement District No. 1, Mississippi River, for the construction of approximately 29.5 miles of concrete road and 9 steel bridges. Pride & Fairley, engineers, Osceola. Advertisement in this issue.

California:

Bakersfield, Cal.—Until Dec. 9, by County Supervisors, for grading, paving and constructing culverts on 7 miles of road; also for grading and constructing culverts on 2.1 miles of road.

Sacramento, Cal.—Until 2 p. m., Dec. 6, by State Highway Commission, A. B. Fletcher, Highway Engineer, for about 12 miles of highway in Imperial County to be paved with Portland cement concrete. Work includes 47,300 cu. yds. of excavation without classification and 11,610 cu. yds. of concrete in pavement.

Colorado:

Del Norte, Colo.—Until 1 p. m., Dec. 1, by Rio Grande County Commissioners, Fred A. Catchpole, secretary, for the construction of 8 miles of state primary road No. 60, from end of present completed road to Trout Creek, about 2½ miles above South Fork Station, on Denver & Rio Grande R. R.

Florida:

Warrington, Fla.—Until Nov. 30, by Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for tandem road roller for Warrington.

Indiana:

Indianapolis, Ind.—Until 10 a. m., Nov. 26, by Board of Park Commissioners, for parkway and boulevard, along east and south bank of Pleasant Run.

Indianapolis, Ind.—Until 10 a. m., Nov. 29, by W. T. Patten, County Auditor, for two or more aeroplane road machines.

Iowa:

Dubuque, Ia.—Until 8 p. m., Dec. 2, by J. J. Shea, city recorder, for improving the intersection of Rhomberg Ave. and the alley lying between Ninth and Tenth Ave. and the alley running from Rhomberg Ave. to Lincoln Ave., between Ninth and Tenth Aves.

Ida Grove, Ia.—Until Nov. 30, by City Clerk, for paving several streets.

Michigan:

Sault Ste. Marie, Mich.—Until 3 p. m., Jan. 13, by H. A. Osborn, County Road Commissioner, for two road contracts. Advertisement in this issue.

Sault Ste. Marie, Mich.—Until 3 p. m., Jan. 13, by H. A. Osborn, County Road Commissioner, for constructing about 24½ miles of highway. Advertisement in this issue.

Minnesota:

St. Paul, Minn.—Until 10:30 a. m., Nov. 29, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Hamline Ave.

Mississippi:

Kosciusko, Miss.—Until 11 a. m., Dec. 6, by J. H. Oliver, Clerk, County Supervisors, for 2 miles of gravel road and 30 miles of sand clay road. M. D. Smith, Consulting Engineer, Kosciusko.

Boonville, Miss.—Until Dec. 6, by County Commissioners, for grading and surfacing 7 miles of road and for grading 4 miles of road.

Missouri:

Kansas City, Mo.—Until 2 p. m., Dec. 21, by City Purchasing Agent, for furnishing asphaltic cement for a period of one year. Estimated quantity 1,000 tons. Advertisement in this issue.

New Jersey:

Mount Holly, N. J.—Until Nov. 29, by James Logan, County Engineer, for 13,280 sq. yds. water bound macadam on Vinceton and Buddtown Road and 10,500 sq. yds. of water bound macadam on Vinceton and Eayerstown Road.

Omaha, Neb.—Until 10 a. m., Nov. 27, by John A. Bruce, City Engineer, for grading on Parker St., Browne St. and 18th St.

Ohio:

Columbus, O.—Until 2 p. m., Dec. 3, by Clinton Cowen, State Highway Commissioner, for 12 contracts for state highway.

Xenia, O.—Until noon, Dec. 4, by C. W. Whitmer, Director of Public Service, for furnishing equipment and keeping paved streets in city clean.

Columbus, O.—Until noon, Dec. 2, by Geo. A. Borden, Director of Public Service, for paving on Bryden Alley with brick, on Lucas St. with brick and on Sidney Alley with brick.

Texas:

Austin, Tex.—Until 10 a. m., Nov. 26, by P. W. Powell, Superintendent of Streets, for 43,000 sq. yds. of pavement, vitrified brick, asphalt, rock asphalt, bitulithic or other materials. F. C. Welborn, City Engineer.

Virginia:

Portsmouth, Va.—Until Dec. 1, by Committee for Purchase and Improvement of Roads, for constructing 14 miles of gravel roads. G. P. Coleman, State Highway Commissioner, Richmond.

Washington:

Walla Walla, Wash.—Until Nov. 27, by County Commissioners, for 2 miles of road.

PROSPECTIVE WORK.

California:

Jackson, Cal.—The Merchants' Ass'n of Amador County is advocating a $250,000 road bond issue.

Connecticut:

Hartford, Conn.—Supt. of Streets Leon F. Peck has recommended the paving of two miles of streets with macadam.

Indiana:

Indianapolis, Ind.—The Marion County Commissioners have been petitioned to improve with concrete, 34th St., between Suth-

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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The Touring Car Introduces a New Problem in Sanitation.

The touring car has introduced, in some localities, a new problem in sanitation; more accurately, it has introduced a new factor in an old problem. The reduction in price of such cars has put them within reach of those of moderate means and has greatly increased the number of automobile campers in regions where some public water supplies have their origin. The increase in the number of campers of this class is in very constant ratio to the increase in the number of touring cars in regions adjacent to mountain roads. The reason for this is characteristically American. The new motorist, both from choice and necessity, lives close to the ground. In the early days of touring cars they were within reach of only those of independent means whose scale of living embraced the payment of the rather exorbitant charges of the keepers of wayside inns. The new tourist lacks both the inclination and the wherewithal to pay these charges, so he goes on past the inn to some appropriate camping site, where he makes a camp. Such sites are usually on the banks of a running stream. Thus it is seen, as the Bulletin of the California State Board of Health points out, that unless care in preventing the pollution of streams is observed, and unless all refuse is either burned or buried there is a good chance that a favorite camping spot may become a source of disease dissemination.

In California, for example, automobile camping has become a form of recreation within the reach of thousands of people. In pleasant weather hundreds of them may be seen encamped along the road wherever abundant water and shade are available. The Bulletin reports that during a single month of the past summer 2,610 machines passed a given point along a popular mountain road. If each car carried an average of three passengers it is likely that over 5,000 persons camped beside the highway during that single month. That this may present a real problem in the patrol of watersheds is readily seen.

Keeping the Money at Home on Contract Work.

Some cities do not advertise their public works contracts except in one or more newspapers in the locality where the work has its origin. The general reason advanced in support of this practice is that it "keeps the money at home" by its tendency to cover up the letting, thereby limiting the competition to the local contracting firms. Doubtless this reason has been advanced in some cases where it was desired to play local favorites behind the more or less transparent screen afforded by this rather plausible sounding attempt to counterfeit the truth. However, it is not doubted that this view has honestly been held in some quarters and it is for this reason that we again call attention to the fallacy in the reasoning upon which this line of action rests. We are again indebted to the 1914 report of the Director of the Philadelphia Department of Public Works for a forceful illustration of the point at issue. To quote:

> We (the present administration) have advertised our contract work more extensively in local papers and especially in engineering journals published outside of Philadelphia, as shown by this table:
>
> | | | |
> |---|---|---|
> | 1906 | 15 ads | (6 months) |
> | 1907 | 30 ads | (9 months) |
> | 1908 | 39 ads | (12 months) |
> | 1909 | 31 ads | " |
> | 1910 | 26 ads | " |
> | 1911 | 33 ads | " |
> | 1912 | 40 ads | " |
> | 1913 | 55 ads | " |
> | 1914 | 62 ads | " |
>
> The cleaning up of our specifications and widespread advertising of contract work has not only increased the number of competitors, but has made it possible for contractors not living in Philadelphia to have an opportunity to bid on the work. In other words, Philadelphia is no longer what she was prior to December 4, 1911—a "closed city." Philadelphians have always participated in contract work in other cities. Some of the largest undertakings, especially in Washington, Baltimore and New York, have always been done by Philadelphia engineers and contractors backed by Philadelphia capital, but owing to conditions which have obtained until recently, it has been impossible for outsiders to figure on Philadelphia work with any advantage. . . .
>
> Of course, the outside concerns employ Philadelphians almost exclusively, so that the city gets the advantage of work coupled with low prices, which comes from widened competition. Even when contracts have been awarded to local concerns the competition has resulted in much reduced prices.

The last quoted paragraph clearly refutes the argument that money cannot be kept at home when it is paid to an outside contractor. Not only does he employ local labor almost exclusively, but he commonly buys his materials from the same sources, local and otherwise, as would any local contractor. So as far as the cost of labor and materials are concerned, and this is ordinarily about 90 per cent of the total contract cost, it is seen that the argument in favor of the local contractor has no weight.

When it comes to a consideration of the contractor's profit there is more to be said in favor of giving that profit to a local rather than an outside contractor—but not much more. Maybe the local contractor will spend all his profits in his home town, but he is quite likely to invest some of his earnings elsewhere. On the other hand, it does not follow, by any means, that the out-of-town man will not spend any of his profits in the city where he earned them. Moreover, it may not be amiss to mention the deplorable fact that outside contractors frequently bring much more money to a city than they take away.

Again, in considering this matter of contractor's profit, the gain of the individual is the composite loss of the many. If a local bidder gets, say, $10,000 more for his work than an outsider would charge, the local taxpayers manifestly pay that $10,000. Is $10,000 in the hands of an individual a better business asset to a city than the same sum left in the hands of the taxpayers? We doubt it.

Clearly this is a matter in which full reciprocity should exist between cities. This desirable neighborly relation is best promoted by widely advertising the contracts to be let.

Acknowledging Assistance Rendered by Subordinates in the Prepartion of Professional Papers.

We have long noted with approval the practice of a certain professional man, who gives credit, in his professional papers, to the subordinates who collaborated with him in their preparation. This credit is given in brief terms, but at the same time prominently and clearly. It is not over done, neither is it done grudgingly. A simple statement is used to record the simple fact that important aid was rendered by an assistant in the preparation of the paper.

There are good reasons why this practice should become more general than it is at present. Some are negative, others positive. Occasionally we learn, by chance, that a paper read by some expert was actually written out by an assistant who did not get so much as honorable mention in the paper as finally read. In such cases we feel that the assistant was not treated fairly; that it would have done the expert no harm to be generous and fair enough to bestow credit where it was due. Our final feeling in such cases is tinged with disappointment at the expert's exhibition of narrowness. If others are similarly impressed, and very likely they are, since opinion generally favors the giving of credit where it is due, the expert has a negative reason for giving credit, namely, to prevent criticism of himself for withholding it.

The positive reasons, however, are the more cogent. It is encouraging to a young subordinate to have his chief publicly acknowledge assistance rendered by the younger and less well known man. It puts the young man "on the map"—it introduces him to his contemporaries. Greater interest attaches to his work if he feels that his results will bear his name when given out. Moreover, this tends to quicken his sense of responsibility and will lead to greater industry, closer application and better work.

It is understood, of course, that when a subordinate writes out a paper for his chief he does so merely to economize the latter's time. Also it is understood that the chief revises the manuscript and lends to it his endorsement. This makes the paper valuable and puts the seal of authority upon it. Nevertheless, the subordinate is better satisfied if his assistance is acknowledged and the expert loses nothing in being generous in this particular.

The Present Steel Market.

Existing conditions in the steel business are unique in a number of particulars and show how difficult it is to predict, with any degree of certainty, the character or amount of future demands. Many steel companies have their output sold for four or five months in advance, while some have sold for deliveries covering a period of at least a year. An indication of the present condition of the steel market may be gained from the fact that the United States Steel Corporation withdrew quotations in foreign markets a short time ago. Although such an action has been taken at various times in this country, to check the demand for certain products, it does clearly indicate the tremendous change that has taken place within a few month. Even though manufacturers of semi-finished steel and of steel products have advanced prices sharply, in an effort to check the excessive demand, this action has generally failed to accomplish its purpose, and the demand for most steel products has continued to increase. Present prices make it practically certain that the 1906 prices for iron ore will be materially advanced, as we already have a record production of pig iron. Capacity is being rapidly increased by the construction of additions to plants throughout the country in an effort to meet the foreign demand and the rapidly increasing orders from consumers in this country. It is difficult for those not closely in touch with the steel trade to appreciate and be governed by the change which has taken place in the steel market during the last few months.

The oustanding feature of the present unbalanced steel market is the excessive demand for semi-finished steel; in fact, there has never been a time in the steel history of this country when semi-finished steel commanded prices so out of proportion to those quoted for finished products. Another feature of the present market, which should be taken advantage of by those contemplating the building of large structures requiring heavy structural shapes, is the very limited demand for heavy rolled sections. In fact, many structural mills are in actual need of orders for the larger structural sizes, while they are compelled to refuse orders for the delivery of the lighter sections in the near future. In explanation of this condition it may be said that the large number of plant extensions now under construction to increase capacity has resulted in an unusually heavy demand for the light structural shapes commonly used in mill construction. The increasing demand for steel cars has also tended to make worse this unbalanced condition. On the other hand, there has been a sharp decrease in the number of large commercial buildings and heavy steel bridges built.

The present unbalanced steel market has, of course, been due largely to war demands, but we should not lost sight of the fact that flexibility of output will probably be demanded more and more as this country develops its foreign trade. Those mills and shops which are unable to take advantage of rapidly changing demands will continue to be placed at a decided disadvantage.

ROADS AND STREETS

Methods of Resurfacing Old Roads.

(Staff Abstract.)

The essential points to be considered in the selection of a proper type of surface for an old stone road are the character and amount of traffic, the grades, and, as a rule, that most important factor, the funds available for the work. When the traffic has been determined and the character of surfacing selected a thorough study should be made of the existing foundation and drainage facilities. Many surfaces have been sacrificed for the want of proper attention to the foundation, and too often it is taken for granted that any stone road is a suitable base for most any type of surface. Test holes should be made at sufficient intervals in the road to determine the depth of the existing foundation, and usually it is found that a considerable portion must be restored before a surface can be applied. Irrespective of the type of surface selected, the preparation of the foundation must be given the same careful attention. Too much stress cannot be laid on the desirability of having proper lines and grades before resurfacing, in order to avoid increasing or perpetuating the difficulties of future improvement of these roads. The question of providing proper under drainage must be considered and drains installed where necessary.

In order that the various methods to be employed can be described conveniently, this paper will be divided into the following classifications: (1) Water-bound and bituminous macadam; (2) bituminous-concrete and sheet asphalt; (3) vitrified or other block pavements.

WATER-BOUND AND BITUMINOUS MACADAM.

The methods used in the preparation of the base for both water-bound and bituminous macadam are the same. If any holes or depressions are found in the base, the road should be dug out and replaced with good-sized clean stone, keyed with a smaller size, and rolled with a ten-ton power roller until thoroughly compacted. The roadway should then be cleaned thoroughly and the existing surface broken or loosened with picks, harrows, or, if necessary, rollers equipped with spikes, so that the new material will bind properly with the old surface. Where the new surface is wider than the old base or where, in improving the lines, it rests partly on the old surface and partly on the old shoulder, it is necessary to provide a new first course or base where an old one does not exist, in order to support properly the top layer or wearing surface.

After the base course has been finished, there should be laid a layer of properly graded, approved stone, passing a two and one-half mesh screen, and being retained on a one-inch mesh screen, this stone being known as "1½-inch stone." The stone should be spread upon the base course with shovels, from piles along the side of the road or from a dumping board, but in no case should the stone be dumped upon the first course surface. This layer should be rolled with a roller weighing not less than ten tons, until it is compacted to a firm and even surface. The total thickness of the surface course should be not less than 3 or 4 ins. after rolling. When a surface course of a depth of 3 ins. is specified it should be laid in one layer, and a 4-in. course should be laid in two layers of 2 ins. each.

Should difficulty be experienced, while rolling, in getting the stone to compact thoroughly, sprinkling with water or spreading lightly with screenings will prove beneficial.

After the surface course of stone has been thoroughly rolled, screenings, varying in size from dust to ¾-in., should be spread with shovels from piles along the side of the road, or from dumping boards; but, again, in no case should the screenings be dumped directly upon the surface of the stone. These screenings should then be thoroughly rolled with a ten-ton steam roller, additional dry screenings applied, and the rolling continued without the use of water until the interstices of the stones are filled. The road should then be sprinkled with water, rolled, additional screenings spread and the sprinkling and rolling continued until the surface is well-bonded and set. The rolling, in all cases, should begin at the sides and work toward the center of the roadway, thoroughly covering the area with the rear wheels of the roller and should be continued until the surface is hard and smooth and shows no perceptible tracks from vehicles passing over it.

To protect a water-bound macadam road from the ravages of automobile traffic it should be given a bituminous surface treatment of either approved tar or asphalt. Prior to applying this bituminous material, the surface of the road should be cleaned thoroughly by sweeping with machine and hand brooms. After all the caked dust has been scraped off and the stone exposed uniformly over the surface, the bituminous material should be applied.

BITUMINOUS MACADAM.

In resurfacing with bituminous macadam, the base course should be prepared as for water-bound macadam, after which stone passing a 2½-in. screen and retained on a 1-in. screen should be spread upon the base course, with shovels, from piles along the side of the road, or from a dumping board, to a depth of 3 ins. after rolling. After the broken stone has been laid and placed true to line and grade and cross-section, it should be rolled, with a roller weighing not less than ten tons, until the stone has been thoroughly compacted and ceases to creep in front of the roller. When the rolling has been finished, there should be spread evenly over the surface a quantity of approved bituminous binder, not less than 1½ nor more than 1¾ gals. to each square yard of surface area. The binder should be heated to the proper temperature for the material used.

After the bituminous binder has been applied, there should be spread a layer of ¾-in. dry, crushed, approved stone, free from dust, and in such quantity as will just cover the surface and fill the surface voids. Rolling should be continued until the surface is thoroughly bonded; the surface then should be swept clean of all loose stone and an application of bituminous binder, of approximately one-half gallon to the square yard of surface area, applied evenly. This binder, in turn, should be covered immediately with a thin layer of dry stone chips, free from dust and rolled lightly. The quantity of chips should be just sufficient to absorb the excess of bituminous material remaining on the surface and to prevent the existence on the surface of an excess of binder.

BITUMINOUS CONCRETE AND SHEET ASPHALT RESURFACING.

Bituminous concrete and sheet asphalt pavements should be laid on a concrete base, instead of on the old existing macadam foundation which, heretofore, has been the generally accepted practice for country roads.

In view of the increased amount and change in character of traffic, even though slightly more expensive, it is advisable to provide for either a 4-in. or a 5-in. concrete base on top of the broken stone or telford base, due to the tendency of macadam to shift or to consolidate further under traffic and possible sub-grade trouble, all of which tend to bring about a wavy or uneven condition of the surface.

In resurfacing old waterbound macadam roads, where the base consists of either telford or macadam, the broken stone surface should be removed to a depth sufficient to conform to the required cross-section and grade. Where the telford surface is exposed the irregularities are broken off with a napping hammer and the depressions filled in and upon this prepared surface is placed a 4-in. concrete base, mixed in the proportion of 1:3:6, laid so as to secure a very rough but regular surface to form a bond between the concrete base and the bituminous top. In conjunction with the concrete base a concrete header curb should be constructed extending 6 ins. beyond the fixed edges of the bituminous pavement and to the finished grade. After the concrete base has developed a hard set, and from one to two days prior to the placing of the bituminous wearing surface, the base should be cleaned thoroughly of loose and foreign material, by sweeping, and then covered with an asphaltic cut-back mixture consisting of equal parts, by volume, of asphaltic cement, 55 to 65 penetration, and commercial naphtha, 52 to 55 gravity, the mixture being applied by a pressure distributor at the rate of ⅛ gal. to the square yard. The object of this paint coat is to secure a better bond between the concrete base and the bituminous top. The bituminous top, 2 ins. in thickness, is laid under the same requirements as to preparation, laying, rolling and inspection as for a standard sheet asphalt pavement.

The following penetrations are recommended for the asphaltic cement:

	Heavy team or motor traffic. Penetration.	Medium or light traffic. Penetration.
Trinidad asphalt...	45-50	50-55
Bermudez, Mexican and California...	50-55	55-60

Experience has demonstrated that the turning of traffic on and off a bituminous surface will result in grinding or cracking the edges and also, unless a perfect bond has been secured with the base—and this cannot be relied upon—heavy wheel loads, at a distance of 1 to 2 ft. from the edge, will produce a spreading of the bituminous surface. To prevent this provision should be made, no matter what the formation may be, for a 6-in. concrete header curb on either side of the road if it is not paved to the full width.

In resurfacing with a sheet asphalt top, the concrete foundation should be laid true to line and grade; and the binder and wearing surface laid to a uniform depth and raked to true cross section and grade, after which it must be rolled thoroughly.

Unquestionably, the most important single point in the laying of sheet asphalt wearing surface is the rolling. More pavements are failing today through displacement from original form than from all other causes combined, and aside from the other reasons to which this result may be attributed—and there are undoubtedly many—it is certain that unless a pavement is free from waves at the time of its completion it never will be, as the tendency of the pavement is to push under traffic, thus increasing the wavy condition.

It is important, therefore, that all pavements be thoroughly compressed, carefully rolled and cross-rolled.

In the preparation of bituminous mixtures all materials should be subjected to rigid plant and laboratory inspection.

VITRIFIED AND OTHER BLOCK PAVEMENTS.

Where the character of traffic demands block pavements, it is poor practice to lay them on other than a stable foundation. Under these circumstances it is, as a rule, more economical to use either a 5-in. or 6-in. concrete base, the depth depending upon the character and volume of traffic for which it is designed. If a concrete base is used, it should be laid true to line, grade and cross-section, after which a sand cushion should be spread to a uniform depth of from 1 in. to 1½ ins. This cushion should be shaped carefully, to a true cross-section, by means of a templet having a steel faced edge covering at least half the width of the area to be paved. The cushion should then be moistened slightly and rolled over its entire surface with a hand roller. After rolling the templet should be drawn over the surface again to shape the cushion finally.

The blocks meeting the required test should be laid on edge in straight rows at right angles to the curb, except at intersections, which should be paved at an angle of 45 degrees to the center lines of the intersecting roadways. After the blocks, as laid, have been inspected and approved for rolling, and the surface swept clean, the pavement should be rolled with a self-propelled roller weighing not less than three, nor more than five, tons. The rolling should commence at the edge and continue back and forth toward the center until the center of the roadway is reached, then the opposite side should be rolled in a like manner. The pavement should then be rolled transversely at an angle of 45 degrees, repeating the operation in the opposite direction. Before and after this rolling has taken place, all broken or injured blocks should be removed and replaced.

After thorough rolling the joints should be filled with grout, composed of one part clean sand and one part Portland cement. Special attention must be paid to the mixing and placing of the grout; the standard practice recommended by the National Brick Manufacturers' Association should be followed. Soon after the joints have been grouted and the cement filler has set, the expansion joints next to the curb should be poured. Attention also should be paid to securing a proper bituminous filler, which will not be too brittle in winter nor too soft in summer.

The same general practice as here outlined for vitrified block pavement is applicable to a more or less extent in the laying of either granite or wood block, the difference, as a rule, being that in the laying of granite block the sand cushion is from 1½ to 2 ins. in depth. The blocks should be sorted and gaged, those of the same width and depth being paved in consecutive rows across the full width of the road and rammed with hand rammers instead of being rolled, after which they should be grouted with a cement grout.

In paving with wood block a layer of mixed sand and cement 1 in. in thickness, mixed dry in the proportion of one part of Portland cement to four parts of sand, should be spread upon the base and brought to a surface parallel to the grade and contour of the finished pavement.

Prior to the laying of the wood blocks this cushion of sand and cement should be sprinkled lightly with clean water and the blocks immediately set thereon. Care should be taken to set the blocks with the fibre of the wood vertical, in straight parallel courses, at right angles to the curb. After laying, the blocks should be rolled with a self-propelled roller weighing not less than three nor more than five tons, and the joints then filled with fine, clean, dry sand passing a 10-mesh sieve.

No attempt has been made to give in detail the specifications for all classes of material entering into the various methods of resurfacing, as this information can be obtained from any of the standards now in use.

The foregoing description, however, covers in general the methods employed in resurfacing work, but, in order that the best results may be obtained, there are several points which should be emphasized in summarizing the subject.

In the resurfacing of waterbound macadam it is frequently the case that the engineer in charge of the work allows too small a stone to be used, which, it is true, will require decidedly less rolling, but will not stand the motor traffic of today.

Another fault quite often found is the spreading of screenings before the 1½-in. stone is thoroughly locked, and very frequently using too large quantities of screenings, thereby causing a heavy crust to form on the road surface.

The success of the bituminous treatment of waterbound macadam roads depends entirely upon the cleanliness of the road before the application of the material.

Many failures are due to the lack of proper care in this most important detail. In cleaning the surface of the road, the sweeping should be windrowed along the edges of the wearing surface in order to prevent the running off of the bituminous material, which later should be swept back on the road. Special attention should also be given to the applying of the chips, just sufficient chips being used to prevent the traffic from picking up the bituminous material.

In bituminous macadam or penetration work, no bituminous binder should be applied unless the stone surface is thoroughly dry, and the temperature of the air is 65 degrees or higher, and special attention paid to the heating and applying of the binder.

One of the important features in connection with obtaining the best results in bituminous concrete construction is the use in the wearing surface of good, hard, durable stone, free from dirt and decomposed material, as decomposed stone in the mixture will naturally develop weak spots in the pavement and ultimately result in failure.

The penetration of the asphaltic cement used in the mixture should be governed by the character of the traffic requirements.

As before stated, the success of all bituminous concrete and bituminous pavements is very largely dependent upon the rolling, and the best results can be obtained only by using a light roller for the initial compression and a heavier roller for the final compression, with an equal amount of transverse and longitudinal rolling.

In the laying of sheet asphalt or bituminous concrete, where brick gutters are used and adjacent to block runners along car tracks, it is good practice to lay the finished surface of the pavement from one-eighth to one-quarter of an inch higher than the brick gutters or runners.

It is difficult in the rolling to secure final compression next to these blocks, and traffic will further compress that portion of the pavement, naturally causing the development of low spots which hold water and result in deterioration.

Special attention should be paid also to the heating of the various aggregates entering into the pavement and also to the combined mix, as many failures are caused by overheating. No overheated material should be used under any circumstances, as failure is bound to result.

In vitrified block paving avoid the tendency to place too great a depth of sand cushion, as latter-day experience has proven that the sand working up in the joints has been responsible for many failures, and the success of the pavement is dependent very largely upon the method of mixing and applying the grout filler. The grouting, although a simple proposition, has in many cases been handled so carelessly that the success of a good pavement has been destroyed.

The practice of placing transverse joints in brick pavements appears to be unnecessary, as the curb joints generally will suffice.

In laying wood block pavements, care should be taken to see that the wood blocks are properly protected from the elements when delivered on the job and before laying, as too frequently the material is delivered along the line of work so far ahead of the laying that the blocks dry out, and, after placing, if they become saturated undue expansion results.

The old road having been resurfaced, its life and success depends upon the maintenance, which in turn depends largely upon attention to details. A patrol maintenance system will do more to preserve roads and pavements and prevent deterioration than any one thing.

The trouble in the past has been that the average engineer has been interested only in the construction end of the work, while the most important problem confronting the road engineer of today is the rehabilitation and proper maintenance of the old resurfaced roads.

Extract from a paper before the Pan-American Road Congress by W. D. Uhler, Chief Engineer, Pennsylvania Highway Department.

Gravel Road Building in Iowa As Shown by 1915 Experiments.

The experiments in gravel road construction that have been carried out during the past season by the Good Roads section of the Engineering Experiment Station and the Iowa Highway Commission, have given considerable new information regarding methods of construction, and costs of this particular type of road.

While it is highly desirable to secure a gravel containing about 60 per cent of material, retained on a one-quarter screen, and having from 15 per cent to 20 per cent of clay binder mixed with it, the summer's experience indicates that a good road can be built with any kind of gravel if it is properly handled. On the Fort Dodge work, the gravel consisted of pebbles ranging from ½ in. in size down to fine clay. The clay content was about 20 per cent and only about 40 per cent of the material was retained on the ¼ in. screen. The pebbles were of good, hard durable material, and the clay was very thoroughly mixed with the sand.

On the Spirit Lake work, several different supplies of gravel were drawn upon. Some of the material was exceedingly coarse containing pebbles up to 3 in. or more in size and being deficient in bonding material. Other material that was used, ranged from about 2 ins.

down, was fairly well graded, and contained about 15 per cent of bonding material.

At Rockwell City, an exceedingly variable local deposit was used. The gravel contained at least 60 per cent of sand and 20 per cent to 25 per cent of clay.

Whatever the character of the material, good results can be obtained if care is exercised in securing uniform mixing of the materials on the road. It is also important to rake out the larger stones and put them in the bottom layer. It is believed that no stones larger than will pass a 2-in. ring should be used for the wearing course of a graveled road.

PREPARATION OF ROAD BED.

In shaping the trench for the lower course, several methods were tried, some of which did not prove to be very satisfactory. The elevating grader with a short horizontal apron, was used for a few days and apparently will prove to be very satisfactory for this class of work. The material which was excavated in forming the trench for the lower course, was delivered by the apron far enough out at the side to form the shoulders for the upper course. Later, the trench for the lower course was plowed by means of the tractor and a heavy road plow, and the material thus loosened, was graded out to form shoulders for the upper course by means of a blade grader. This method did not prove to be very satisfactory because the tractor repacked the material that had been loosened during the plowing, and it was very difficult to finish the grading without additional plowing. At another place, the heavy scarifier was used to loosen the road surface, and after it had made a few rounds, the loosened material was graded out with a blade grader for shoulders. Probably the following methods can be used satisfactorily:

1. Elevating grader with horizontal apron.
2. Scarifier and blade grader.
3. Road plow, and blade grader, if each furrow is graded out as soon as plowed.

ROLLING THE ROAD BED.

After the road bed has been shaped, it is thoroughly rolled with a roller weighing at least 10 tons. The purpose of the rolling is twofold:

1. To compact and seal up the road bed so as to make it as nearly waterproof as possible.
2. To develop any fundamental weaknesses in the foundation if such exist.

Experience has shown conclusively that you cannot regularly compact a layer of gravel that is more than 6 ins. thick. For that reason a gravel road should be constructed in two layers, each of which will be about 6 ins. thick before compacting.

In order to get the right amount of material in the roadbed the wagon should be measured and the distance should be computed. The dumper should then be given a stick of the length that a load should spread or should be given a cord of the right length with a stake at each end. If the loads are dumped the right distance apart spreading is considerably easier. The spreading may be done with shovels or with rakes as fast as the loads are dumped. But if the hauling is being done by a large force it may be more convenient to dump a number of loads of gravel and then spread them with a blade grader. For this work a light grader that can readily be drawn by two horses is better than a heavier machine.

After the gravel has been spread it should be thoroughly harrowed to evenly mix the material. If the material in the road is thoroughly stirred up a sufficiently uniform texture can be secured to give reasonably uniform wearing qualities. The harrowing has another important function, that is, to thoroughly distribute the bonding material through the mass. This bonding material is often clay from the overburden or from dirty gravel that is mixed with the better material. Sometimes it is clay that is thrown upon the surface from alongside the road. To be effective this binder should be thoroughly and uniformly mixed through the entire body of the gravel surface.

The most satisfactory harrow is one that is made of 1¼ round iron spaced about 6 ins. apart. The harrow is arranged to be drawn by one corner and weighs about 250 to 300 lbs. The teeth must be long enough to thoroughly stir the entire thickness of the layer. The most satisfactory length seems to be about 8 ins. below the frame.

ROLLING THE GRAVEL.

After the gravel has been spread and harrowed it is rolled once over. At this stage it will have a wavy appearance due to the fact in spite of the utmost care there is a lack of uniformity in the spreading and some difference in the density of the layer of gravel. The blade grader is run over the surface dragging the high spots and depositing the material in the low places. Two or three rounds are necessary to produce the desired uniformity. It is important, however, to take very light cuts with the grader dragging only a small amount of material along the surface. When once the blade is set it should not be again shifted during the round. To do so is to insure additional uneven places to take care of. As soon as this smoothing has been completed the roller is run over the surface for another round or two and the grader again used to smooth the inequalities. On the work done during the past summer it was usually found necessary to repeat this operation four or five times. But this was due to the unusual weather conditions which made it impossible to secure as favorable a foundation as would ordinarily be the case. Probably during an average season, three times over with the grader between rolling will be enough.

The important thing is to get the gravel so well spread that it rolls down uniformly. As soon as this stage is reached the rolling is carried on continuously until the layer is thoroughly compacted. If the gravel has been placed during dry weather and continues to dry out after being placed on the roadway it is useless to attempt to compact it with a roller or by any other means. It should, however, be kept in shape by frequent trips with the grader until a rain wets it sufficiently to permit rolling. This, of course, may be a considerable time at certain seasons of the year but if the gravel has been spread between suitable earth shoulders the traffic cannot spread it out over the roadway and waste it during the period when it is too dry to pack. When it does receive enough water to pack properly the roller will finish a good many feet of road in a day. During the period when the road is being kept in shape the grader should be used in preference to the drag. The drag has a tendency to increase the waviness of the surface unless provided with runners.

The preceding notes are extracted from a paper by T. A. Agg in the Iowa State Highway Commission Service Bulletin for November, 1915.

State Highway Mileage on June 1, 1915.

(Staff Abstract.)

The following tabulation of state highway mileage is taken from a bulletin prepared by the office of Public Roads and Rural Engineering, U. S. Department of Agriculture:

State.	Total all surfaced roads in state Miles.	Total all public roads in state. Miles.	Percentage of surfaced roads in state.
Alabama	5,491	49,639	11.1
Arizona	400	5,987	6.7
Arkansas	1,085	36,445	3.0
California	9,388	48,069	19.5
Colorado	655	30,571	2.1
Connecticut	3,300	12,582	26.2
Delaware	241	3,000	8.0
Florida	2,625	17,954	14.6
Georgia	12,500	83,986	14.9
Idaho	611	18,406	3.3
Illinois	9,000	94,141	9.6
Indiana	26,831	63,370	42.3
Iowa	2,505	104,027	2.4
Kansas	1,170	111,536	1.0
Kentucky	10,636	58,000	18.3
Louisiana	697	24,962	2.8
Maine	3,264	25,528	12.8
Maryland	2,706	17,025	15.9
Massachusetts	8,928	17,272	51.7
Michigan	8,859	68,906	12.8
Minnesota	6,206	91,890	6.8
Mississippi	1,800	44,072	4.1
Missouri	8,000	120,000	6.6
Montana	100	23,319	0.4
Nebraska	250	80,338	0.3
Nevada	65	12,751	0.5
New Hampshire	1,025	15,116	6.8
New Jersey	4,500	14,842	30.3
New Mexico	900	16,920	5.3
New York	22,398	80,112	27.9
North Carolina	6,166	49,802	12.4
North Dakota	200	61,593	0.3
Ohio	28,312	83,681	33.8
Oklahoma	500	71,325	0.7
Oregon	3,994	42,930	9.3
Pennsylvania	3,976	87,387	4.5
Rhode Island	1,246	2,121	58.8
South Carolina	4,888	45,549	17.3
South Dakota	290	56,354	0.5
Tennessee	5,554	45,913	12.1
Texas	9,790	128,971	7.6
Utah	1,653	7,970	20.7
Vermont	3,278	15,082	22.7
Virginia	4,482	43,399	10.3
Washington	4,250	37,000	11.5
West Virginia	825	31,629	2.6
Wisconsin	11,500	61,090	18.8
Wyoming	450	10,569	4.3
Total	247,490	2,273,121	10.9

DRAINAGE AND IRRIGATION

Construction Methods and Costs, Sacramento Valley Irrigation Project.

Contributed by P. A. Welty, Supervising Engineer, now of Paso Robles, Cal.

II.

MESSES.

The company operated messes over 90 per cent of this work. The men were charged 25 cts. per meal and were fed as well as it was possible while trying to make the mess self-supporting. Messes should be on the work or as close as possible to it. Roustabout teams travel at about four miles per hour and if the work is two miles from the mess an hour a day is lost going and coming. A 10-hour day was paid for and worked except in the winter when short days reduced the shift to 9 hours. The larger messes were located as nearly centrally as possible in an area of 36 square miles. The mess tents or cars were screened as flies were a great nuisance in the valley. Latrines were constructed and the men were forced to use them or be discharged. Every effort was made to keep camps orderly and the bunk-cars clean.

The experience was that a 20-man mess or less does not pay expenses, 30 or 60 will pay out and on 60 or more the company makes a little money. Cooks cost $50 to $65 and board, and flunkeys $30 and $35 and board. A flunkey was allowed for a mess of over 18 men to 35, then an additional helper for each 18 men boarders. Cooks in summer were very unreliable and shiftless and were the principal worry of the work. At the larger camps a "relief" cook was kept flunkeying or on one of the crews awaiting an opening which was sure to develop unless a Chinese cook was had, in which case he was reliable.

Expense of moving camp is too great to have it in a smaller area, and time lost by the men and stock on the road is an argument against greater than a three-mile radius. Also the climate in the rainy season is hard on stock and owners will not rent them unless they are well stabled. Some of the larger structure camps had 50 head of stock working therefrom, and if an old ranch barn could not be located a stable tent was necessary which was very expensive as all tenting went to pieces in a year's weathering. From May to October men and animals were better off outside as during this time no dew fell. A division or general foreman looked after the camp and the work in this territory and in company with the structure engineer kept the work coordinated and crews busy in systematic order, checked up the cost cards turned in by the foremen against the timekeepers' records, kept up progress reports, cost data, worked up contractors' estimates. At the general mess it was found well to have two bunk cars and two mess cars for isolated work or jobs of longer than one week's duration. These cars were of great utility and are pretty generally used in California by ranchers, contractors, etc., where it is at all possible to haul them over the roads.

The cars, bunk and mess, which held from 12 to 20 men were made of pine, screened, 8 ft. wide, 7½ ft. high and 16 ft. to 24 ft. long. Bunk cars were arranged upper and lower, some cars were combined cook and diner, others single. The company had about 15 such cars and they saved their cost in tents many times over. "Fly Camps" were moved about quickly and often, and these cars were left on the running gears, if in a camp for a month the gears were usually taken out and the cars set on wooden horses.

These isolated camps must be under a dependable foreman. At the general mess was had such equipment as tank wagons, centrifugal pump and engine for foundation work and the larger articles that no one crew needs all the time, and enough stock for material hauling and grading crew, material yard for the immediate territory, cement shed and stock feed. Enough iron work and horseshoeing will be found to keep a blacksmith at $3.50 a day busy and will prove a great saving over work done in the local towns. At some of these messes a carpenter was had at $3.50 per day and three laborers at $2.50 per day working up small bridges, checks, delivery gates, etc., in knock down sections of sides and bottoms. The carpenter marked off the dimensions with vertical guide cleats from a template and the laborers sawed out the pieces with a cross cut saw, the planks being ricked in stacks and bundles. At the larger camps where there were 30 or more stock a "stable-buck" ($2.75) was essential. He was the first man in the barn in the morning and was usually busy all day, cleaning out manure, bedding down, filling troughs, and mangers, mending harness, seeing that the skinners attend to their sore-neck mules, hauling away mess slops, etc.

A commissary wagon and team was required for about every 20 mile route with four messes on it. The wagon should be a light farm wagon on bolster springs with bows and tarpaulin. During the winter the men needed a light fire in their tents or cars and fuel being high a credit was had in this way on the form lumber, which gradually became worked up into scraps after many uses; only a light quick fire was needed. All scraps of lumber were also hauled in from the field by the various crews on timber work. In some of the camps lean-to sheds were put up out of redwood material, doing no sawing and very little nailing as this lumber was later worked up into structures. In the larger camps a shed like this with two stoves afforded an excellent loafing room and clothes drying room and was appreciated by the men. As a rule there were no fires in the sleeping tents or cars at the larger camps, where the loafing room was provided. These temporary sheds were better and more economical than tents for the winter months.

ROADS.

It was required by the supervisors before any roads were accepted that they be graded. Roads were usually graded 30 ft. wide with 1 ft. cut at each side for gutter drainage and the earth thrown in to the center and crowned with 0.5 ft. fill at center and taper-off to zero 8 ft. each side of the center line. In early summer when soil conditions were good an outfit with 26 mules, grading machines, roller and ten men could crown and roll ¾ mile per day. Later in summer they would complete less. This work cost from $90 to $135 per mile counting overhead expenses. Graveling a strip 8 ft. wide and 6 ins. deep costs $800 per mile for county work for a three-mile haul. This was simply spread on the road by the inspector in a strip 8 ft by 6 ins. If it was "pit" gravel there was enough clay "slickens" in it so that the road would soon become good, as the gravel "sets up" naturally, but if it was river or creek gravel it was a nuisance from being too clean and was avoided by drivers until winter rains forced vehicles to use the gravel stretch. Usually by the next summer enough mud had been carried on and enough rolling done to make a fair road. The plan on recently built roads, is to plow a furrow along each wheel tread throwing the dirt "out" previous to dumping the gravel, then throw this dirt back on top of the gravel near the edge and roll it when it will bond almost immediately. Roads not crowned and graveled are impassable in the rainy season. Along most all the gravel roads and next to them there are parallel dirt roads which it is the custom of the country to use in summer.

COST KEEPING.

Costs were kept on the structure work both force account and contract. On the latter the contractors' costs and company costs were kept. The system followed was that when the projected structures on a unit were approved of a card for each was made out and filed in the general office. When construction began in the area, the designer would place on the front of the card the data designating type of structure, material and dimensions necessary for the crew foreman's knowledge. The structure number on the card would indicate whether it was a check, flume, etc. The card would be taken to the field and the instrument man detailed to do the structure staking would record on the cards the grade data as given by the engineer and stake the structures in the order asked for by the construction engineer. The card would be issued to a crew foreman who started the work, the general foreman arranging the work along a line or over an area as was best. Where the structures were in groups the foreman received all the cards at once and segregated the crew's time and charged it against the several structures. Where more than one crew worked on a structure the card passed through the different foreman's hands. Each foreman noted the man-hours spent by his crew on the structure indicating by the proper symbol "letter" what the work was. Each foreman noted every piece of material and units used also. The foreman completing the work would turn the card over to the general foreman who would check it against the timekeeper's records (this only occasionally to catch up any errors of commission or omission by the foreman), made extensions (the warehouse and field prices were given by the structure engineer) and return them to the general office where the cost-keeper worked the cards up and recorded the data on the period and summary cost sheets. On contract work the cards were of assistance in working up the estimates. The cards were next turned back to the designer where they originated and so a check was had on the structure progress. The advantages of the cards were: (1) Uniform system of recording all the cost data which the foreman readily acquired, also one form for the cost keeper to work up. (2) The card had the necessary data on it and saved the transference of these data from one department to another, such work being always a source of error. (3) Absolute structure progress was recorded. The cost cards were assembled twice per month and showed on the Period Report, the unit cost, structure cost, period cost, crew cost and total cost.

Cost keeping was practiced with the idea of comparing and criticizing design, material, men, and methods and for estimating cost of new work yet to be done. At times the work was allowed to lapse on some types of structures on which the costs were known. The cost keeper in the general office was on the engineering staff and devoted only part of his time to the structure cards. At certain busy periods on the work a field cost keeper was necessary. The last two years of the work a very efficient system of time keeping was in force on the project in which men's time was kept and they were paid off by check signed by the foremen in the camp in which they were employed. This system was partly in compliance with certain California state labor laws. It placed considerable responsibility upon the foreman of the camp, but was such an improvement in timekeeping that many of the general foremen without other help were able to keep the time and cost cards, in addition to their regular duties. Costs are wanted currently as the work proceeds to be of value to the engineers and foremen and are close enough if they are within a few cents. If they are to balance to the cent the auditor's ledger accounts must be segregated by the field men and as all bills and charges do not get into the office immediately costs worked up in this way may be 60 days or more old before they are available.

In working up the labor cost a crew rate was used which changed frequently as men came and went. The foreman, strawbosses, carpenters, laborers, etc., day rate were averaged to get a "man-day rate," team and wagon cost about $2.50 a day, same as did a laborer. Cost keeping on all classes of work cost something less than 1 per cent which covered office and field work, stationery and horse and cart.

LABOR.

California is the "Hoboes" paradise. Old men are found there who have gone up and down the state with their bed-rolls on their backs for the past 50 years. Up north, or in the hills at the lumber and mining camps in summer, and down in the valley in the winter. The large grain ranches of the Sacramento valley have been farmed with this "bo" labor for 40 years, in fact, no other labor could have lived with so small a part of the year being employed. As a rule the labor found there is what is known as "short stake" men, they only want so much money, usually $15, and if you pay $2.50 per day (the minimum), they remain a week and if you pay $3 they stay five days and so on, some only want a day to get a few meals. In the summer the men shipped out from the cities seldom remain over a week. Many able men are found among them, but seldom do any of them want a steady job or responsibility at more pay.

Every camp usually has men coming, men working, and men going constantly. One concrete crew which averaged 10 men per day had 128 names on its roll in one year, only the foreman and one other man being on throughout the year. Near the "wet" towns the trouble with men over "booze" was quite noticeable on all work, dirt-work especially would cost more money not only from inefficiency of men but from idle mules in the corral on account of scarcity of "skinners." All labor is better in the winter. Bonus schemes have been tried to induce men to stay, also free railway fares if they remain 30 days, free meals on rainy days if they did not work, free meals Sunday; one camp advertised free chicken dinner on Sunday. With the splitting up of the large holdings and the incoming of the many settlers the "bo" is passing out, for the homeseekers and their sons are earnest and willing workers at "$2 and found," as is the custom in the valley.

CONCRETE PIPE.

Several different areas of from 80 acres to 750 acres were watered with concrete pipe lines, each piece of work being a separate contract. These scattered jobs totaled about 40 miles of work. The contractor furnished all material and labor for making and laying the pipe except in two instances where the company furnished gravel and water system for curing the concrete. The company furnished the trenches for the pipe layers and did the backfilling, also paid overhaul on pipe hauled over one mile.

Some of the advantages of concrete pipe

over earthen laterals are as follows: (1) Saving in rightaway, as only an easement over a 4-ft. strip is necessary. (2) Saves cutting the farms into isolated pieces and consequent structures. (3) Reduces the high land area and saves heavy cuts and fills, syphons or flumes. (4) Prevents evaporation and seepage losses. (5) No weed cutting or maintenance and repairs to earth levees and structures. (6) A good head for delivery easily maintained.

The pipe can be laid on an undulating grade line, paralleling the country usually—curves up to 20° are not prohibitive. Some of the pipe lines headed at the main canal, other lines received their supply from wells, the water being forced into a pipe tower approximately 10 ft. high at the pump, in this way creating artificial head if necessary. The pipe lines easily stood a head of 25 ft., the head being controlled at intervals and at gates of branch lines by overflow weirs. While concrete pipe irrigation systems have almost every point in their favor and should be almost everlasting there are some points of caution to be considered in their installation. The materials and workmanship must be of the best, and care observed in laying and backfilling. In operating, the system should be filled slowly and all air must be expelled.

The design of the system requires care, as the conditions are constantly varying. "Water-hammer" splits many lines and requires that frequent air vents be located especially on the high points in the line. These air vents are most important. The heat in the valley caused some trouble by cracking the cement joints of the pipe lines as they were laid. The contractor repaired such leaks by terms of the contract. The leaks in the larger diameter of pipe are easily found and patched by a workman going through the line with lantern and push-cart of material, but the leaks in the smaller sizes, especially if partially backfilled, are difficult to locate and repair. Pipe should be laid only in cooler seasons or shaded with some screen other than backfill.

The contractor used experienced labor. The pipes were made in collapsible steel forms; a mixer was used at the yard; a sprinkler system was kept in use constantly spraying the pipe for a week or ten days; the mix was in proportions of one part cement to four parts aggregates. The pipes were bevel joint, made in 2-ft. lengths and called "Moist tamp" pipe. The cost of pipe work per lineal foot is given in Table I.

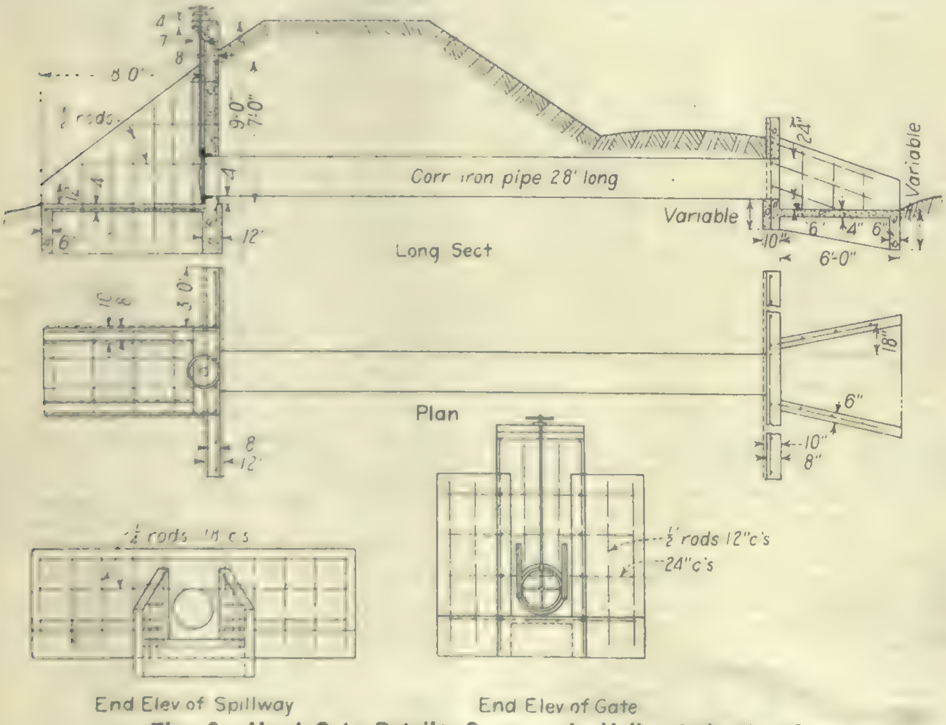


Fig. 6. Head Gate Details, Sacramento Valley Irrigation Co.

Mess cost and "overhead" is not considered. Delivery valves for either alfalfa checks or orchard service cost about $3.50 each, air vents and regulating towers of pipe cost per foot, the same as pipe, Table I.

The trenches were dug by "bo" hand-labor letting the "stations" out to different men at from 22 cts. to 27 cts. per cubic yard. As a rule the trench was staked deep enough so that a 2-ft. fill would result in place over the top of the finished line and the contractor required 6 ins. clearance each side of all diameters of pipe for his pipe layers. Some soil was easy digging and the men made good "stakes"; other soils were so hard and tenacious that even with the assistance of dynamite they could not make expenses and would throw the work up. Where dynamite was used the dirt would be removed by pick and shovel to plow-pan and then every 5 or 6 ft. one-half stick of ¾-in. size 40 per cent dynamite would be discharged at the necessary depth. The company furnished the dynamite and auger and the men did the work. The final cost to the company of this work, including labor, dynamite, tools, "cave-ins" and lines rained upon after they were accepted requiring touching up, was 30 cts. per cubic yard. Recent work on larger contracts has been more economically done with trenching machinery. Backfilling was usually done by two men, two head of stock, and a push-board resembling a Mormon scraper. Some of the lines for alfalfa irrigation, where there were not so many delivery spouts to hinder, were cheaply backfilled with a road-grader.

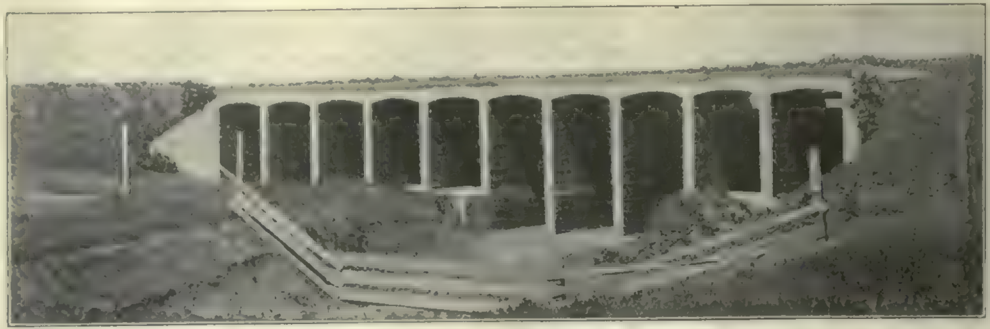


Fig. 7. Reinforced Concrete Flood Gate, Sacramento Valley Irrigation Co.

TABLE I.

Diameter, ins.	8	10	12	16	18	24	30	36
At the yard	$0.17	$0.23	$0.29	$0.36	$0.47	$0.58	$0.80	$1.32
To lay in the trench	.05	.06	.06	.08	.12	.13	.16	.20
Cost of trench, including dynamite	.06	.07	.11	.13	.14	.17	.21	.27
Cost of backfilling	.005	.005	.01	.02	.023	.025	.027	.03
Cost of engineering and inspecting	.03	.03	.03	.03	.03	.035	.04	.05
Cost of hauling 1¼ mile, loading and unloading	.04	.07	.08	.10	.13	.18	.20	.23
Total in place	$0.355	$0.465	$0.58	$0.72	$0.913	$1.12	$1.437	$2.10

Except where crossing the fields the roads in the valley are good and concrete pipe were hauled with a breakage loss of less than 1 per cent, the hauling contractor being responsible for such loss if the pipe were hauled by contract. The pipe are best hauled on wagons arranged with deck 8x14 ft., pulled by a four-up team, the skinner being paid $2.75 per day. Rent, feed, repairs, wages, etc., on such an outfit will cost $8.75 per day, and if properly rigged will haul pipe at the figure given above on first mile or two. Some work was let hauling pipe at 25 cts. ton-mile with additional charge of 25 cts. to pay for unloading. The gravel used in making the pipe was obtained from the river or two of the larger creeks and except for the smaller sizes of pipe required no screening or regrading. The gravel best suited for the pipe was shipped in at a cost off the cars of $2 a cubic yard. It weighed about 3,300 lbs. per cubic yard and tested 24 per cent voids, the bulk gravel shrunk about 20 per cent in the pipe making. Excellent sand (Yuba) off cars at Willows cost $1.27. Cement cost $2.75 per bbl. Table II gives data on cement pipes.

The cost of an irrigation system of concrete pipe for alfalfa land watering ten-acre tracts, including a reinforced concrete head-gate and intake to the pipe line, the water being gravity flow from a canal the cost of which is not here considered is $35 per acre; for orchard planting it would be $15 more. Where orchard land was developed in ten-acre tracts by boring wells (the well to water about 80 acres), building concrete pump-pit and pump-house of corrugated iron, installing electrical equipment, necessary pipe lines, and tree-row deliveries, the cost per acre was $80.

Concrete pipe if well made of good material for general use on an irrigation works is unsurpassed, but there are some few conditions where its installation will require frequent repairs and loss. It should not be laid on soft, yielding earth or in boggy places or in newly made fills, if speed or economy or permanent construction are expected.

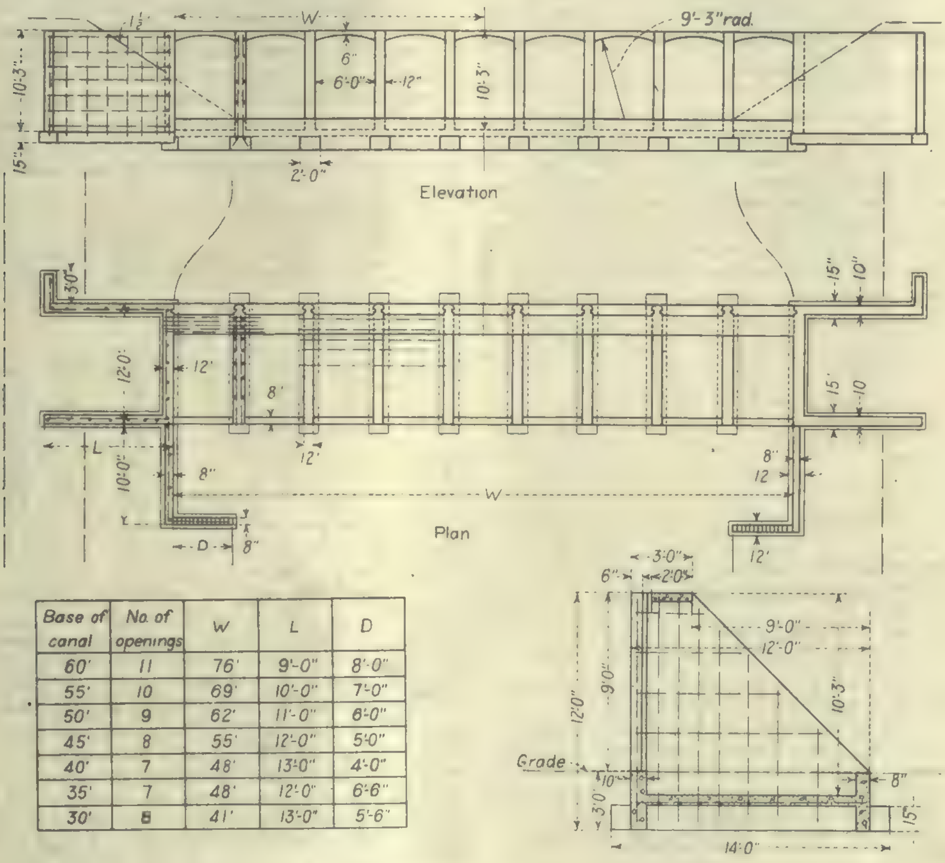
CONTRACT WORK ON TIMBER STRUCTURES.

The company furnished at the material yards at railroad towns in the vicinity of the work, wire, nails, hardware and lumber; the contractor furnished all labor and stock hauled, excavated, framed, erected and backfilled the structures and graded bridge approaches. He did not "puddle" the structures as it was intended doing this where necessary when the new ditches were being "tempered" in the spring with the delivery of the first water. As has been previously mentioned, some structures went out when a head of water was run in against them the following spring on "rush orders" for water, because of the early dry weather.

The bids were canvassed on 1,000,000 ft. B. M. of work to be placed in 1,450 structures, the work to be done from August to February. Some of this work was withdrawn, it being decided to be county work, and construction areas were thus reduced so that the final estimates totaled only 500,000 ft. B. M. of lumber. The two units covered by this contract embraced 25,500 acres, the land being developed for sale in 40-acre tracts. The average section of land (640 acres) required in structures 8 open-type delivery gates; 17 closed type delivery gates; 13½ checks and headgates and drops; 1 culvert under laterals; 5¾ bridges; 1 hog-gap, and ½ revetment; an average cost per acre for these irrigation structures was $2. No road culverts or bridges in drains are mentioned, as this was county work. Main canal structures and some reinforced concrete syphons and bridges also not included here are reported separately as they were built under other contracts.

TABLE II.

Inside diameter, ins.	6	8	10	12	16	18	20	24	30	36
Wall thickness, ins.	1 1/16	1¼	1 2/5	1½	1¾	1⅞	[illegible]	2½	2¾	3
Outside diameter, ins.	8⅛	10½	12 4/5	15	19½	21¾	24	29	35½	42
Weight per ft., lbs.	25	36	53	69½	103	130	150	208	286	408
Feet per ton	80	55	38	28	19½	15	13½	10	7	5
Cu. feet per lin. feet	16	25	35	45	68	82	90	1 30	1 80	2 65
Trench width required, ins.	18	20	22	24	28	30	32	36	42	48
Ydge. per ft. trench 2-ft. fill on top pipe	14	17	19	22	29	32	36	44	[illegible]	74



Base of canal	No. of openings	W	L	D
60'	11	76'	9'-0"	8'-0"
55'	10	69'	10'-0"	7'-0"
50'	9	62'	11'-0"	6'-0"
45'	8	55'	12'-0"	5'-0"
40'	7	48'	13'-0"	4'-0"
35'	7	48'	12'-0"	6'-6"
30'	8	41'	13'-0"	5'-6"

Fig. 8. Details of Reinforced Concrete Check for Main Canal, Sacramento Valley Irrigation Co.

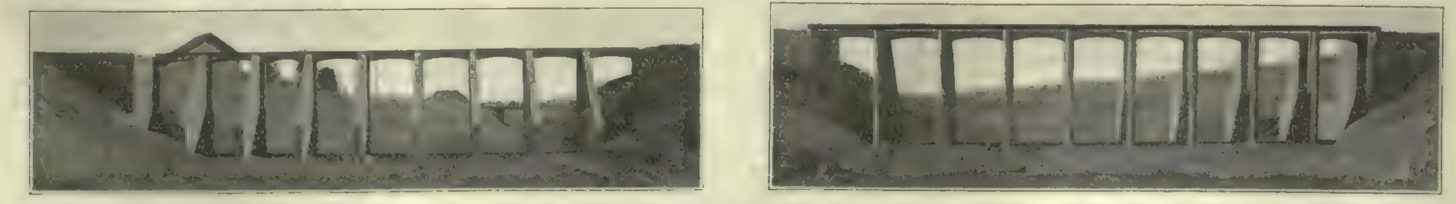


Fig. 9. Front and Rear Views of Reinforced Concrete Check, Sacramento Valley Irrigation Co.

Some "bo" labor and some local farmers were used on the work by the contractors, about 60 per cent of the work was "subbed," the balance being day work. Some of the excavations were let to Italians.

The structures were sawed mostly with a gasoline circular saw-rig and hauled to the field knocked down and crated; some were sawed with crosscut saw, ricking the lumber in piles and tacking on guides to saw by.

The contractor's average crew rate per day was $2.92. He paid excavators $4.50 to excavate for a single wall check if the wings did not exceed 20 ft. in length. He paid $2.50 to excavate for a 10-ft. closed box delivery gate. He hauled out the material and paid $5 for the excavation, erection, and backfilling of small single bridges, 6 to 10 ft. span. He paid 9 cts. per cubic yard for bridge-approach grading and furnished stock and tools and stock feed. Redwood lumber at the yard cost the company $25 per M; pine, $21 per M, and nails, per cwt., cost $3.25.

All timber in structures was redwood except bridges, which were 55 per cent redwood and 45 per cent pine; stringers, railing, decking, being pine, and caps, posts, sills, wings, bulkheads being redwood. The contractor was paid $40 per M for doing the work on all structures except the bridges, for which he received $11.50 per M and 17½ cts. per cubic yard for grading approaches. The cost of the contract completed to the company was $31,600. Table III gives the costs of wood structures.

PERMANENT STRUCTURES.

In the area mentioned above covered by the contract for timber structures, contract was let for building reinforced concrete and corrugated iron pipe structures. The work was begun toward the end of November and finished by April 1, the crews being on the job 135 days, only losing eight days of this time on account of rains, the winter being remarkably open. By the terms of the contract the company furnished at the nearest railroad warehouse, cement, iron, hardware, wire for reinforcement, bolts and lumber which became a part of the structure, and corrugated iron pipe. The contractor furnished form timber, nails, form wire, gravel, did hauling, excavating, placing pipe and concrete and backfilling. For his work he received 70 cts. per linear foot all diameters pipe and $14 per cubic yard for the concrete. His prices were higher than were usually paid, but it was judged to be only fair, for it was the rainy season and lost time and flood damage were to be expected; there were few passable roads in the winter rainy season, the structures were badly scattered and again the contractor puddled and completed the work, leaving no force account work to be done except one grading job and a minimum of extra work. The winter was so open the contractor cleared a fair profit. Some few scattered jobs of dirtwork filling gaps in levees cost us 22 cts. per cubic yard, or a total on this contract of $318. Table IV gives the costs.

The pipe was 14 and 16 gage double riveted and soldered ranging from 18 ins. to 48 ins. in diameter, laid in lengths from 16 to 60 ft. Where two pipes joined they were concreted together.

Engineering, inspection, horse hire, etc., cost 3 per cent of the contract. Total cost of this contract to the company was $18,800; material used in the structures at company expense cost $7,100. The contractor shipped in 800 cu. yds. gravel at $2.50 per cubic yard, and 14 M ft. B. M. of lumber at $24. Average crew rate, $3.05 per day. The contractor paid in wages from $2.50 to $4.50 per day. Part of the time he was on the work, but is not included in the time cost, which was 174 foreman days, 287 carpenter days, 230 straw-boss days, 1,148 labor days and 644 stock days; also plow, wagon, scraper.

The contractor operated his own mess half the time and boarded around the balance.

The checks, head gates and drops were placed in laterals having a depth of water of 3.5 ft. or greater. The drain syphons were built where a lateral crossed a drain of considerable size. The road syphons were built on main county roads usually near towns. The workmanship was first-class. Road syphons in place of bridges are higher at first cost, but are free from repairs and also remove the humps out of roads occasioned by bridges so frequent in irrigated districts. Drain inverted syphons are more satisfactory than any other way to cross drainage; first cost, maintenance, and operation, also the canal flow is a known quantity, and can be designed for, but flood water is always an unknown quantity. Flumes are a source of expense, even if of permanent materials. Some of the syphons were provided with "blow-offs" at the lowest point for cleaning. Cost per acre of this class of work was $0.75.

TABLE III.

Number of structures built.		Average B. M. per structure.	Cost to company of lumber, hardware, etc.	Cost per completed structure to company, overhead excepted.	Cost per M completed work, this type.
183	wing-type open delivery gates...	310′ R W	$ 8.25	$ 20.60	$63.40
351	closed box delivery gates........	204′ R W	5.35	12.10	59.70
282	checks, headgates and drops.....	462′ R W	12.40	30.95	66.75
31	drain lateral culverts............	630′ R W	17.20	42.40	67.25
174	bridges	1,340′ R W and pine	32.20	48.00	*44.40
29	hog-gaps and riders' gates.......	340′ R W	12.50	29.60	†87.20
2	breakwaters	2,036′ R W	57.30	156.00	66.80
1,052					

*Average approach contained 80 cu. yds. at 18 cts. =$14.50. This $14.50 is included in the above cost.

†These structures required much fitting, joining and labor in erecting.

MAIN CANAL STRUCTURES.

The canal was partly built under irrigation district bonds about 25 years before the company took hold of this enterprise, but had been abandoned on account of legal entanglements. The farm lands on the east side had had immunity from floods except at the larger creeks where the canal crossed. The farmers on the west had cut the west levee where they pleased and so the old canal had acted as a protection levee for the land to the east and as a drainway for the land to the west for years, accumulating more water every mile of its course. Permanent structures of reinforced concrete were placed in the main canal throughout, except where a few structures of redwood were in place and were considered efficient for a few years to come.

In projecting the drainage structures for the main canal the original condition of the drainage of the country had to be ascertained and restored. The canal crossed the drainage of the country and at every ravine, creek, or depression there had to be provided an inlet to the canal for the drainage from the west. Directly opposite there was supposed to be provided an outlet to pass the same water out that was taken in. This was done, as near as possible, in frequent cases additional inlet culverts were constructed through the west bank to pass in local surface drainage which flowed on down the canal. Some of the swales and depressions on the east side of the canal had become obliterated by cultivation during the protection afforded by the old canal and the farmers objected to have outlets put through the levees and the original condition restored. Others were better pleased, as frequent outlets being provided above them lessened the large quantities of stored water that their lands had been receiving under the old condition where maybe for several miles there were many inlets and no outlets until some well defined creek crossing or "break" in the east levee would let the water out in a flood.

Four types of structures will be briefly outlined, a number of each having been built by both day work and contract, the costs and methods being given farther along.

TABLE IV.

Corrugated iron.	Number built.	Average lin. ft. of pipe in structure.	Average cu. yds. in structure.	Average cost per lin. ft. pipe laid (include concrete joints).	Average cost cu. yd. concrete.	Cost average per structure.
Concrete and C. I. pipe syphons under roads	25	43½ of 27″	10.8	$3.08	$19.87	$348.60
Concrete and C. I. pipe syphons under drains	9	20½ of 27″	19.2	$3.08	19.87	444.65
Concrete check headgates..............	24	....	9.6	.....	19.87	190.75

(1) Head-gates to lateral canals were of three types, both having reinforced concrete wings at intake and spillway end—some were built with concrete pipe, some corrugated iron pipe, and some reinforced concrete barrels through the levee. Figure 6 gives plans of one type.

(2) Open type flood gates were reinforced concrete with a flat arch top 8 ft. wide, same as crown of the levee, the opening 6 ft. wide and 9 ft. high, with necessary wing walls, seep walls, etc. These were built singly or in series (as many as 13 such openings being provided out and ten openings into the canal at one depression), were graded with 1 ft. of earth on top to the levee grade and were passable for carts and horses of the ditch-riders. See Fig. 7. These structures at the larger drain crossings had a 24-in. pipe under the canal, usually 120 ft. long, to pass water from late rains or seepage after the canal was closed for the irrigation season, which was usually from May to October. These pipes had to be syphonic to clear under the canal grade in most cases and were subject to clogging up unless they get a scouring every winter in the rainy season.

(3) So-called closed type flood gates were simply corrugated iron or concrete pipe laid through the levee, singly or twin, at proper places to pass drainage into or out of the canal, usually into it. Concrete headwalls and wings were poured to inside end to which was fixed a flap gate which tightened up when water was let into the canal, but was open in the winter for the entrance of flood waters.

(4) Checks, except a few old ones in place of redwood, were built of reinforced concrete. See Fig. 8. The openings were 6 ft. wide and varied in number from 13 near the head of the canal to 6 near its present end. The canal was rebuilt to carry 1,200 cu. ft. per second on .0001 grade. The base narrows from 60 ft. near the head to 30 ft. at its present southerly end, side slopes 1½:1 and 2:1, crown 8 ft., height of banks 10 ft., depth of water 8 ft. The checks were projected about every four miles to control the head of water; also for use in winter to help regulate and pass out the flood water.

WATER WORKS

The Valuation of Water Works Properties.

VIII. Detailed Appraisal of a Water Works.

BY HALBERT P. GILLETTE.

In this article will be given nearly all the details of an appraisal of a waterworks system supplying a city of 25,000. The appraisal was made several years ago, but the details may serve as a general guide.

The physical property was estimated to cost $748,326 reproduced new, exclusive of $57,787 estimated cost of tearing up and repaving streets over mains and services. This was set up as a separate item, for the company had actually laid nearly all its mains and services prior to the paving of the streets.

The value of the water rights was estimated to be $290,420 in addition to the above. It was found that the development cost (or deficit in fair return during the entire history of the plant) exceeded 30 per cent of the actual cost of the physical plant, without providing a depreciation fund.

In addition to the overhead charges given herein, it was estimated that a brokerage fee of 5 per cent would be incurred in selling the securities needed to obtain the capital with which to build the plant.

The following is a summary of the estimated cost of reproducing the physical plant new:

SUMMARY OF COST OF REPRODUCING THE PHYSICAL PLANT NEW.

1.	Dams and reservoirs..................	$ 41,800
2.	Supply lines	86,356
3.	Pumping machinery	23,098
4.	Filtration tanks and settling basins.	1,829
5.	Tanks and standpipes................	561
6.	Distributing mains..................	235,818
7.	Services	49,098
8.	Hydrant connections	5,421
9.	Meters	10,519
10.	Paving	425
11.	Buildings	13,943
12.	Tools and instruments..............	4,255
13.	Teams and vehicles.................	2,581
14.	Furniture and fixtures.............	1,483
15.	Telephone and signal apparatus....	265
16.	Miscellaneous equipment and apparatus	558
17.	Real estate	112,266
	Total items 1 to 17................	$590,276
18.	Overhead charges — engineering, management, legal, interest and contingencies	123,865
	Total items 1 to 18................	$714,141
19.	Stores and supplies................	11,601
20.	Working cash capital...............	22,584
	Total items 1 to 20................	$748,326

The details of this summary are as follows. It should be noted that the power plant for operating the pumps was an electric plant that also operated a street railway and lighting system.

DETAILS OF COST OF REPRODUCING THE PHYSICAL PLANT NEW.

1. DAMS AND RESERVOIRS.

Reservoir No. 1.

Main Reservoir—	
Clearing, 3 acres @ $150..............$	450.00
Excavating and puddling, 13,900 cu. yds. @ $1........................	13,900.00
Grubbing and removing stumps and brush on 3 acres @ $180............	540.00
Coffering and pumping................	2,000.00
Sheet piling, 60,000 ft. B. M. @ $40...	2,400.00
Excavating for same, 740 cu. yds. @ $3	2,220.00
Log cribbing, 16,000 lin. ft. @ $0.20..	3,200.00
Iron, 3,648 lbs. @ $0.04..............	145.92
Spillway—	
Excavation, 42 cu. yds. @ $1.........	42.00
Lumber, 3,864 ft. B. M. @ $28........	108.19
Iron, 400 lbs. @ $0.04...............	16.00
Plank, Walks and Platforms—	
Lumber, 4,730 ft. B. M. @ $28........	132.44

Iron, 210 lbs. @ $0.04	8.40
Brick foundation, 4,030* @ $20	80.60
1 gauge 17 ft. long 1 in. x 12 in. painted	3.00
1 recording instrument house 3 ft. x 3 ft. 6 ins.	10.00
1 recording chronograph	155.00
Rustic Bridge—	
50 lin. ft. @ $3	150.00
Wagon Road (0.5 mile)—	
Clearing 1 acre @ $150	150.00
Grading and leveling for Corduroy, 984 cu. yds. @ $0.75	738.00
Corduroy, 0.4 mile @ $450	180.00
1 10-ft. hinged gate	6.00
Fence (painted)—	
Double rail, 260 lin. ft. @ $1.75	455.00
Steps over fence with platform on top	10.00
Total Reservoir No. 1	$27,100.55

*In cement.

Dam No. 1.

Clearing and grubbing	$ 20.00
Excavation, 278 cu. yds. @ $1	278.00
Concrete, 26 cu. yds. @ $10	260.00
Sheet piling, 2,184 ft. B. M. @ $40	87.36
Lumber in weir and spillways, 936 ft. B. M. @ $28	26.21
Iron, 90 lbs. @ $0.04	3.60
Wire screen, 66 sq. ft. @ $0.10	6.60
By-passing water during construction, 5% of cost	34.08
Total Dam No. 1	$ 715.85

Dam No. 2.

Clearing and grubbing	$ 10.00
Building weir	12.00
Excavation, 156 cu. yds. @ $1	156.00
Sheet piling, 1,197 ft. B. M. @ $40	47.88
Lumber in spillway, 143 ft. B. M. @ $28	4.00
Iron, 20 lbs. @ $0.04	.80
Wire screen, 66 sq. ft. @ $0.10	6.60
By-passing water during construction, 5% of cost	11.86
Total Dam No. 2	$ 249.14

Dam No. 3.

Clearing and grubbing	$ 20.00
Excavation, 278 cu. yds. @ $1	278.00
Concrete, 24 cu. yds. @ $10	240.00
Sheet piling, 3,264 ft. B. M. @ $40	130.56
Log cribbing, 810 lin. ft. @ $0.20	162.00
Lumber in weir and spillways, 936 ft. B. M @ $28	26.21
Iron, 90 lbs. @ $0.04	3.60
Wire screen, 66 sq. ft. @ $0.10	6.60
By-passing water during construction, 5% of cost	43.34
Total Dam No. 3	$ 910.31

Dam No. 4.

This is a small earth dam with log cribbing, and estimated to cost	$ 250.00

Main Reservoir No. 2.

Excavation, 7,270 cu. yds. @ $0.75	$ 5,452.50
Concrete, 281 cu. yds. @ $10	2,810.00
Cement facing, 1,236 sq. yds. @ $1	1,236.00
Paving (sidewalk), 150 sq. yds. @ $3	450.00
Fence (ornamental), 560 lin. ft. @ $2	1,120.00
Pipe Railing—	
2-in. pipe, 652 lin. ft. @ $0.10	65.20
2-in. tees, 60 lin. ft. @ $0.233	13.98
Painting above, 652 lin. ft. @ $0.02	13.04
Pipe—	
227 lin. ft. 8 in. converse lock joint @ $0.90	204.30
41 lin. ft. 8-in. converse lock joint, perforated, @ $1	41.00
258 lin. ft. 12-in. converse lock joint, perforated, @ $1.15	296.70
17 lin. ft. 12-in. converse lock joint, perforated, @ $1.25	21.25
4 8-in. gate valves, 912 lbs. @ $25	100.00
2 12-in. gate valves, 746 lbs. @ $42	84.00
1 12-in. check valve @ $42	42.00
2 12-in. elbows @ $12	24.00
1 8-in. x 8 in. x 8 in. tee @ $9	9.00
1 12 in. x 12 in. x 12 in. tee @ $13	13.00
5 8-in. elbows, 45°, @ $9	45.00
1 12-in.-8-in. reducer @ $8	8.00
1 12-in. nozzle @ $10	10.00
24 lin. ft. 12-in. screw pipe @ $1.60	38.40
Special work	200.00
Total Main Reservoir No. 2	$12,297.37

Reservoir No. 3 (Under Construction).

Expenses under Requisition No. 60, as per accounting records	$ 276.60

2. SUPPLY LINES.

Creek No. 1-Creek No. 2.

5,400 lin. ft. 10-in. wood pipe @ $0.35¼	$ 1,903.50
Drayage, 9 miles, 5,400 lin. ft. @ $0.01	54.00
Excavation, 5,400 lin. ft. trench, 2 ft. x 2.5 ft., 1,000 cu. yds., @ $0.65	650.00
Labor, 5,400 lin. ft. @ $0.05	270.00
Fittings—	
2 10-in. gate valves, 600 lbs	59.50
1 10-in. 45° elbow, 298 lbs	11.92
1 4-in. gate valve, 71 lbs	8.25
1 10-in. x 4-in. tee, 400 lbs	16.00
1 10-in. check valve	43.50
1 2-in. air valve	22.50
1 4-in. gate	10.26
1 4-in. x 10-in. saddle	2.70
1 4-in. check	5.83
1 2-in. gate	5.13
1 2-in. plug-cock	1.38
1 4-in.-2-in. reducer	.31
1 2-in. union	.23
600 lin. ft. 4-in. pipe @ $31.68 per C.	190.08
Labor and drayage on fittings	100.00
Trestles—190 ft. trestles @ $1.50 ft.	285.00
Total Creek No. 1-Creek No. 2	$ 3,640.09

Creek No. 2-Creek No. 3.

3,001 lin. ft. 12-in. pipe @ $0.42		$ 1,260.42
4,322 lin. ft. 14-in. pipe @ $0.59¼		2,560.79
Drayage, 8 miles, 7,323 lin. ft. @ $0.01		73.23
Excavation, 7,323 lin. ft. trench, 2 ft. x 2.5 ft., 1,357 cu. yds. @ $0.65		882.05
Labor—		
3,001 lin. ft. @ $0.06		180.06
4,322 lin. ft. @ $0.08		345.76
Fittings—		
2 12-in. gate valves, 746 lbs.		76.30
1 12-in. check valve, 373 lbs.		38.15
1 12-in. 30° elbow, 260 lbs.		10.40
1 14-in. x 10-in. x 12-in. "Y," 570 lbs.		22.80
1 air valve complete		49.00
2 blow-offs as follows:		45.30
4-in. gate	$10.26	
4-in. x 14-in. saddle	3.15	
32 ft. 4-in. pipe	9.14	
	$22.65	
Labor and drayage on above fittings.		85.00
Trestles—400 ft. trestles @ $1.50		600.00
Total Creek No. 2-Creek No. 3		$ 6,229.26

Creek No. 3.

2,219 lin. ft. 10-in. wood pipe @ $0.35¼	$ 782.20
13,200 lin. ft. 16-in. wood pipe @ $0.67	8,884.00
Drayage, 15,419 lin. ft. @ $0.01	154.19
Excavation, 15,419 lin. ft. trench, 2.5 ft. x 2.5 ft., 3,573 cu. yds. @ $0.65	2,322.45
Labor—	
2,219 lin. ft. @ $0.05	110.95
13.200 lin. ft. @ $0.10	1,320.00
Fittings—	
2 10-in. gate valves, 600 lbs.	59.50
1 14-in. gate valve, 555 lbs.	58.00
1 10-in. check valve	22.75
1 16-in. gate valve, 760 lbs.	71.60
1 16-in. x 14-in. x 10-in. "Y," 580 lbs.	23.20
1 20-in.-16-in. "Y"	25.00
1 16-in. 45° elbow, 445 lbs.	17.80
2 air valves	100.00
2 blow-offs	50.00
Labor and drayage on above fittings.	225.00
Total Creek No. 3	$14,226.64

Creek No. 3 to Pumping Station.

25,394 lin. ft. 20-in. continuous stave pipe @ $1.15	$29,203.10
1 411 lin. ft. 18-in. continuous stave pipe @ $1.25	1,763.75
Miscellaneous	35.50
Excavation—	
17,575 cu. yds. @ $0.65	11,423.75
1,012 ft. planking @ $0.20	202.40
Bridge, 8,390 ft. B. M. @ $20	167.80
Fittings (from settling basin)—	
40 ft. 12-in. screw pipe @ $156.60 C.	62.64
807 ft. 12-in. wood pipe @ $0.42	338.94
112 ft. 12-in. converse pipe @ $0.90	100.80
26 ft. 2-in. pipe @ $9.76 C.	2.54
1 12-in. screw gate valve @ $54	54.00
2 12-in. gate valves @ $38.15	76.30
1 12-in. tee	14.50
1 12-in. x 20-in. saddle	4.00
2 20-in. gate valves with recording stand @ $135.35	270.70
1 2-in. plug cock	1.38
1 2-in. elbow	.10
1 6-in. x 20-in. saddle	4.00
32 ft. 2-in. pipe @ $9.76 C.	1.32
1 2-in. plug cock	1.38
1 6-in. blow-off	33.00
6 ft. 6-in. pipe	3.54
2 20-in. long-sweep cast-iron bends, 2,020 lbs.	161.60
1 20-in. gate	108.35
3 2-in. air valves @ $70	210.00
3 blow-offs, 6-in. valve, 30-ft. 6-in. pipe, @ $33	99.00
Labor and drayage, fittings	774.29
Total Creek No. 3 to Pumping Station	$45,118.68

20-in. Main.

2,280 lin. ft. 20-in. pipe @ $0.85¼	$ 1,943.70
Excavation, 528 cu. yds. @ $0.65	343.20
Labor, 2,280 lin. ft. @ $0.05	114.00
Making connection with sub-station as per Voucher No. 270	1,028.72
Total 20-in main	$ 3,429.62

Tunnel No. 1.

340 lin. ft. 4 ft. x 5 ft. 6 in.—	
Excavation, 340 cu. yds. @ $3	$ 1,020.00
Timber, 38,760 ft. B. M. @ $40	1,550.40
Iron, 300 lbs. @ $0.04	12.00
Total Tunnel No. 1	$ 2,582.40

Tunnel No. 2.

100 lin. ft. 4 ft. x 5 ft. 6 ins.—	
Excavation, 100 cu. yds. @ $3	$ 300.00
Timber, 11,400 ft. B. M. @ $40	456.60
Iron, 100 lbs. @ $0.04	4.00
Total Tunnel No. 2	$ 760.60

Lowering Main.

Requisition No. 63: Cost	$ 3,162.51
Total Tunnels 1 and 2 and lowering main	$ 6,505.51

Creek No. 1 Line.

Upper flume about 1,200 ft. long made of 1x12-in. boards and measuring 1x 1 ft., Cost Requisition No. 19		$ 317.56
Lower flume, 975 ft. long, built of 2-in. plank, and measures 10 x24 ins., supported on a wooden trestle, about 12.5 ft. high, bents about 8 ft. centers, 17,000 ft. lumber @ $40	$680.00	
Nails, etc.	10.00	
		690.00

Creek No. 2—No. 1 Line.

12-in. and 10-in. wood pipe line, Cost Requisition No. 78		$ 2,666.45

Creek No. 2—Power House Line.

200 lin. ft. 12 in. cast-iron pipe	$ 30.00	
3,350 lin. ft. 12-in. wood pipe @ $1	3,350.00	
1 14-in. valve	65.00	
1 12-in. valve	42.00	
1 12-in.-10-in. cast-iron reducer	10.00	
1 14-in.-10-in. sheet iron special	10.00	
1 special (sheet iron)	10.00	
1 drain box	15.00	
		$ 3,532.00
Total creek lines		$ 7,206.01

3. PUMPING MACHINERY.

Sub-Station.

1 centrifugal 8-in. Worthington turbine pump, direct connected to 150-hp. induction motor.		
1 centrifugal 10-in. Worthington turbine pump, direct connected to 250-hp. induction motor.		
Cost of pumps and motors	$4,700.03	
Erection	1,645.03	
Total		$ 6,345.06
Authority J. O. No. 498 machine installed 1910, includes cost of switchboards.		
1 10-in. Neptune meter in place		$ 742.50
1 12-in. Neptune meter in place		891.50
2 water gages		20.00
3 Pressure gages		60.00
Pipe Pit, 27x12x5-ft.—		
Excavation, 60 cu. yds. @ $0.75		$ 45.00
Lumber in sides, 1,470 ft. B. M. @ $40		46.80
Top, 972 ft. B. M. @ $16		15.55
Iron, 20 lbs. @ $0.04		.80
Manhole, 3x3x5-ft.—		
Excavation, 1.6 cu. yds. @ $1		1.60
Lumber, 180 ft. B. M. @ $40		7.20
Top, 30 ft. B. M. @ $16		.48
Iron, 5 lbs. @ $0.04		.20
Box Drain, 200x3x1-ft.—		
Excavation and backfill, 146 cu. yds. @ $1		146.00
Lumber, 6,000 ft. B. M. @ $40		240.00
Iron, 60 lbs. @ $0.04		2.40
Pump control switchboard		419.90
Total Sub-Station		$ 8,984.99

Power House.

1 Worthington 10 and 16 and 25x13x18-in. triple expansion duplex steam pump	$4,185.00	
Labor and miscellaneous, 10%.	418.50	
		$ 4,603.50
1 Worthington 14 x 20 x 15 - in. double expansion steam pump	$1,885.00	
Labor and miscellaneous, 10%.	188.50	
		2,073.50
Piping—		
1 18-in. valve with floor stand.	$115.10	
1 12-in. valve with floor stand.	60.00	
3 10-in. valves with floor stand	123.00	
2 8-in. valves with floor stand	60.00	
1 4-in. valve with floor stand.	12.25	
4 8-in. flanged tees	50.00	
2 10-in. flanged tees	32.00	
1 18-in. flanged tees	40.00	
48 ft. 12-in. pipe	75.17	
27 ft. 10-in pipe	32.81	
62 ft. 8-in. flanged pipe	54.13	
3 12-in. flanged elbows	36.00	
3 10-in. flanged elbows	25.00	
5 8-in. flanged elbows	27.00	
1 8-in. "Y" bends	10.00	
2 8-in. tees	20.00	
2 12-in. gate valves	80.00	
1 10-in. gate valve	63.00	
4 18-in. gaskets	7.60	
9 12-in. gaskets	9.00	
16 10-in. gaskets	12.80	
23 8-in. gaskets	12.75	
36 ft. 18-in. pipe	268.60	
44 ft. 10-in. pipe	53.46	
18 ft. 8-in. pipe	15.71	
9 ft. 12-in. pipe	14.09	
Labor	300.00	
		1,609.47
Foundations—		
48 cu. yds. concrete @ $10	$480.00	
Piling, 1,600 lin. ft. @ $0.25	400.00	
		880.00
Total Power House, all to water department		$ 9,166.47

Power House. Equipment Prorated at 8 Per Cent to Water Department.

Boilers and Auxiliary Boiler-Room Apparatus:	
Boilers	$18,977.10
Ash conveyor and coal-handling apparatus	2,085.77
Mechanical stoker	6,060.00
Holly gravity return system	517.00
Feed water heater	497.00
Fuel economizer	5,192.00
Steel stack and draft apparatus	8,944.50
Pumps and piping in boiler-room	1,900.88
	$39,174.25
Miscellaneous Piping and Apparatus in Engine-Room:	
Steam piping and condensers	$ 2,812.56
Worthington control injector condenser	7,138.00
Worthington surface condenser	9,359.80
Traveling crane	2,118.00

Miscellaneous piping and equipment	746.35	
Miscellaneous tools	395.00	
Crosby indicator	90.00	
	$22,659.71	
Total to be prorated 8% to water	$61,833.96	
8% of $61,833.96	$ 4,946.72	

4. FILTRATION TANKS AND SETTLING BASINS.

Settling Basin, Creek No. 3.

Excavating and puddling, 960 cu. yds. @ $1	$ 960.00
Flume, lumber, 320 ft. B. M. @ $28	8.96
Iron, 30 lbs. @ $0.04	1.20
By-passing water during construction, 5%	48.50
	$1,018.66

Settling Tanks.

Creek No. 2—	
Estimated cost	$ 190.00
Creek No. 1—	
Upper tank, estimated cost	160.00
Lower tank, estimated cost	460.00
	$ 810.00
Total	$ 1,828.66

5. TANKS AND STANDPIPES.

Erecting water standpipe as per accounting records, Requisition No. 55	$ 560.89

6. DISTRIBUTING MAINS.

Line from Reservoir No. 2.

Pipe:		
2,300 lin. ft. 12-in. converse lock joint pipe at $0.90		$1,970.00
50 lin. ft. 8-in. Matheson pipe @ $0.60		30.00
		$2,000.00
Fittings:		
2 8-in. check valves	$ 40.00	
3 8-in. gate valves	75.00	
4 4-in. gate valves	48.00	
4 8x8x4-in. tees	36.00	
1 8-in.-90 elbow	9.00	
1 8-in.-45° elbow	9.00	
4 4-in.-90° elbows	12.00	
3 special tees	150.00	
1 2-in. valve for sprinkling	2.00	
		381.00
Pig Lead for Pipe:		
136 12-in. joints	1,632 lbs	
4 8-in. joints	32 lbs.	
	1,664 lbs.@ $0.0525	87.36
Oakum:		
33 lbs. @ $0.09		2.97
Weight of Pipe:		
2,300 ft. 12-in. @ 26.06 lbs.	59,938 lbs.	
50 ft. 8-in. @ 14.31 lbs.	716 lbs.	
	60,654 lbs.	
Drayage:		
60,654 lbs. pipe = 30 tons.		
1,664 lbs. lead = 1 ton		
31 ton miles @ $0.50		15.50
Excavation:		
2,350 ft. trench 4x2-ft. @ $0.20 ft.		470.00
Bell Holes:		
140 @ $0.08		11.20
Dipping Pipe:		
2,350 lin. ft. @ $0.05		117.50
Labor:		
2,350 lin. ft. @ $0.04		94.00
Total, line from Reservoir No. 2		$3,179.53

14-in. Main from Reservoir:	
Work done as per accounting records under Requisition No. 60	$11,182.94

Miscellaneous Mains (a).

Material:		
379 ft. ¾-in. black iron pipe @ $0.0328	$ 12.43	
740 ft. 1-in. black iron pipe @ $0.0468	34.63	
220 ft. 1¼-in. black iron pipe @ $0.0639	14.00	
1,113 ft. 1½-in. black iron pipe @ $0.0765	85.14	
12,038 ft. 2-in. black iron pipe @ $0.0976	1,174.91	
600 ft. 3-in. black iron pipe @ $0.2052	123.12	
		$1,444.29
Weight of Pipe:	Lbs.	
379 ft. ¾-in. @ 1.115 lbs.	422.59	
740 ft. 1-in. @ 1.668 lbs.	1,234.32	
220 ft. 1¼-in. @ 2.244 lbs.	493.68	
1,113 ft. 1½-in. @ 2.678 lbs.	2,980.61	
12,038 ft. 2-in. @ 3.609 lbs.	43,445.14	
600 ft. 3-in. @ 7.536 lbs.	4,521.60	
	53,097.94	
Drayage:		
53,098 lbs. = 26.5 tons.		
Average haul, 1 mile.		
26.5 ton miles @ $0.40		10.60
Excavation:		
15,090 lin. ft. 2x1.5 ft.		
1,952 cu. yds. @ $0.65		1,268.80
Labor:		
15,090 lin. ft. @ $0.02		301.80
Total, Miscellaneous Mains (a)		$3,025.49

Miscellaneous Mains (b).

Material:		
550 ft. 3-in. screw flange pipe @ $0.185	$ 101.75	
4,651 ft. 6-in. screw flange pipe @ $0.517	2,404.57	
123 ft. 8-in. screw flange pipe @ $0.7625	93.79	
		$2,610.11
64 3x7½-in. flanges @ $1.13	72.32	
520 6x11-in. flanges @ $2.00	1,040.00	
14 3x13½-in. flanges @ $3.41	47.74	
		1,160.06
128 ⅝-in. bolts 2½ ins. long @ 2.09 cts.	2.68	
2,080 ¾-in. bolts 3 ins. long @ 5.66 cts.	117.73	
112 ¾-in. bolts 3¼ ins. long @ 5.66 cts.	6.34	
		126.75
32 3-in. gaskets @ $0.19	6.08	
260 6-in. gaskets @ $0.41	106.60	
7 8-in. gaskets @ $0.55	3.85	
		116.53
Weight of Pipe:	Lbs.	
550 ft. 3-in. @ 7.536 lbs.	4,144.80	
4,651 ft. 6-in. @ 18.762 lbs.	87,262.56	
123 ft. 8-in. @ 28.177 lbs.	3,465.77	
	94,873.13	
Flanges:	Cu. ins.	
64 3x7½-in. @ 27.85 cu. ins.	1,782.4	
520 6x11-in. @ 66.76 cu. ins.	34,715.2	
14 8x13½-in. @ 129.22 cu. ins.	1,809.1	
	38,306.7	
38,307 cu. ins. @ .281 lbs. =	10,764.27	
Bolts	847.31	
	11,611.58	
	106,485 lbs.	
106,485 lbs. = 53.2 tons.		
Average haul, 1 mile.		
53.2 ton miles @ $0.40		21.28
Labor, 5,324 ft. of pipe (mostly on trestles) @ $0.25		1,331.00
Total, Miscellaneous Mains (b)		$5,365.73

Miscellaneous Mains (c).

Material:		
1,799 ft. ¾-in. galvanized iron @ $0.045	$ 80.96	
10,250 ft. 1-in. galvanized iron @ $0.0648	664.20	
3,880 ft. 1½-in. galvanized iron @ $0.1057	410.12	
41,261 ft. 2-in. galvanized iron @ $0.1377	5,681.64	
500 ft. 4-in. galvanized iron @ $0.4360	239.80	
		$7,076.72
Weight of Pipe:	Lbs.	
1,799 ft. ¾-in. @ 1.12 lbs.	2,014.88	
10,250 ft. 1-in. @ 1.67 lbs.	17,117.50	
3,880 ft. 1½-in. @ 2.68 lbs.	10,398.40	
41,261 ft. 2-in. @ 3.61 lbs.	148,952.21	
550 ft. 4-in. @ 10.67 lbs.	5,868.50	
	184,351	
Drayage:		
184,351 lbs. = 92 tons.		
Average haul, 1 mile.		
92 ton miles @ $0.40		36.80
Excavation:		
57,740 lin. ft. trench 2x1.5 ft.		
7,485 cu. yds. at $0.65		4,865.25
Labor:		
57,740 lin. ft. @ $0.02		1,154.80
Total, Miscellaneous Mains (c)		$13,133.57

Miscellaneous Mains (d).

Material:		
1,913 ft. 4-in. Matheson pipe @ $0.27		$ 516.51
153,146 ft. 6-in. Matheson pipe @ $0.42		64,321.32
47,915 ft. 8-in. Matheson pipe @ $0.60		28,749.00
3,980 ft. 10-in. Matheson pipe @ $0.90		3,582.00
		$97,168.83
Pig Lead:	Lbs.	
107 4-in. joints	428	
9,009 6-in. joints	54,054	
2,818 8-in. joints	22,544	
235 10-in. joints	2,350	
	79,376 @ $0.0525	4,167.24
Oakum:		
1,590 lbs. @ $0:09		143.10
Weight of Pipe:	Lbs.	
1,913 ft. 4-in. @ 4.51	8,627.63	
153,146 ft. 6-in. @ 7.22	1,105,714.12	
47,915 ft. 8-in. @ 11.22	537,606.30	
3,980 ft. 10-in. @ 15.09	60,058.20	
	1,712,006	
Drayage:		
1,712,006 lbs. pipe =	856 tons	
79,376 lbs. lead =	39.7 tons	
1,590 lbs. oakum =	.8 tons	
	896.5 tons	
Average haul, 1 mile.		
896.5 ton miles @ $0.40		358.60
Excavation:		
202,974 ft. 3x2 ft.		
3,980 ft. 3.8x2 ft.		
46,225 cu. yds. @ $0.65		30,046.25
Bell Holes:		
12,169 @ $0.08		973.52
Dipping Pipe:		
206,954 ft. @ $0.025		5,173.85
Labor:		
206,954 ft. @ $0.025		5,173.85
Total, Miscellaneous Mains (d)		$143,205.24

Miscellaneous Mains (e).

Material:		
6,410 ft. 6-in. Converse lock joint pipe @ $0.3640		$ 2,333.24
8,064 ft. 8-in. Converse lock joint pipe @ $0.6745		5,439.17
650 ft. 10-in. Converse lock joint pipe @ $0.846		549.90
5,950 ft. 12-in. Converse lock joint pipe @ $0.90		5,355.00
		$13,677.31
Pig Lead:	Lbs.	
378 6-in. joints	2,268	
475 8-in. joints	3,800	
39 10-in. joints	390	
350 12-in. joints	4,200	
	10,658 @ $0.0525	559.55
Oakum:		
213 lbs. @ $0.09		19.17
Weight of Pipe:	Lbs.	
6,410 ft. 6-in. @ 9.44	60,510	
8,064 ft. 8-in. @ 14.31	115,396	
650 ft. 10-in. @ 19.29	12,539	
5,950 ft. 12-in. @ 26.06	155,057	
	343,502	
Drayage:		
343,502 lbs. pipe = 172 tons.		
Average haul = 1 mile.		
172 ton miles @ $0.40		68.80
11,000 lbs. lead and oakum, 5.5 tons, 5.5 ton miles @ $0.40		2.20
Excavation:		
14,474 ft. trench 3x2 ft.		
6,600 ft. trench 4x2 ft.		
5,172 cu. yds. @ $0.65		3,361.80
Bell Holes:		
1,242 @ $0.08		99.36
Dipping Pipe:		
21,074 ft. @ $0.04		842.96
Labor:		
21,074 ft. @ $0.03		632.22
Total, miscellaneous mains (e)		$19,263.37

Miscellaneous Mains (f).

Material:		
20,009 ft. 6-in. wood pipe @ $0.30	$6,002.70	
9,319 ft. 8-in. wood pipe at $0.38	3,541.22	
8,221 ft. 10-in. wood pipe @ $0.48	3,946.08	
		$13,490.00
Drayage:		
37,549 ft. @ $0.15		56.32
Excavation:		
29,328 ft. 3x2 ft.		
8,221 ft. 3.8x2 ft.		
8,831 cu. yds. @ $0.65		5,740.15
Labor:		
37,549 ft. @ $0.05		1,877.45
Total, miscellaneous mains (f)		$21,163.92

Fittings on Mains.

Crosses:		
21 2x2x2x2 in., 20 lbs. each		$ 6.30
2 4x4x6x6 in., 85 lbs. each		6.80
175 6x6x6x6 in., 90 lbs. each		630.00
33 6x6x8x8 in., 124 lbs. each		163.68
37 8x8x8x8 in., 145 lbs. each		214.60
4 6x6x10x10 in., 247 lbs. each		39.52
7 10x10x10x10 in., 330 lbs. each		92.50
1 10x10x12x12 in., 357 lbs. each		14.28
Reducers:		
104 6x8 in., 90 lbs. each		374.40
Plug Ends:		
11 2 in.		11.00
205 6 in.		205.00
16 8 in.		24.00
12 10 in.		36.00
"Y" 's:		
1 8x8 in., 220 lbs		22.00
1 8x10 in., 292 lbs		29.20
Tees:		
4 10x10x6 in., 203 lbs. each		32.48
2 6x6x6 in., 99 lbs. each		7.82
1 12x12 in., 279 lbs. each		11.76
2 6x8x8 in., 120 lbs. each		9.60
Elbows:		
1 12 in.		10.40
2 6 in. 45°		10.00
2 2 in. 45°		4.00
1 10 in.		10.00
4 10 in. 45°, 278 lbs. each		47.58
Pig Lead:		
10,442 lbs. @ $0.0525		548.21
Oakum:		
210 lbs. @ $0.09		18.90
Weight:	Lbs.	
Fittings	50,326	
Lead	10,442	
Oakum	210	
	60,978 = 31 tons.	
Drayage:		
31 ton miles @ $0.40		12.40
Painting:		
649 fittings @ $0.10		64.90
Labor:		
649 fittings @ $0.50		324.50
Total, fittings on mains		$ 2,981.93

Valves on Mains.

5 ¾-in. valves @ $1.17	$ 5.85	
25 1-in. valves @ $1.89	47.25	
1 1½-in. valves @ $3.60	3.60	
114 2-in. valves @ $5.13	584.82	
5 4-in. valves @ $10.25	51.25	
346 6-in. valves @ $15.10	5,234.60	
138 8-in. valves @ $23.10	3,187.80	
15 10-in. valves @ $41.75	626.25	
8 12-in. valves @ $50.15	401.20	
		$10,142.62
Valve Boxes:		
208 in paved streets @ $3.96		823.68

449 in unpaved streets @ $0.45		202.05
1,000 nipples or reducers @ $1.00		1,000.00
Pig Lead:	Lbs.	
10 4-in. joints	40	
692 6-in. joints	4,152	
276 8-in. joints	2,208	
30 10-in, joints	300	
16 12-in. joints	192	
1,000 joints @ 6.7	6,700	
	$13,592 @ $0.0525	713.58
Oakum:		
272 lbs. @ $0.09		24.48
Weight of Valves and Reducers:	Lbs.	
5 ¾-in. valves @ 10 lbs.	50	
25 1-in. valves @ 15 lbs.	375	
1 1½-in. valves @ 25 lbs.	25	
114 2-in. valves @ 40 lbs.	4,560	
5 4-in. valves @ 71 lbs.	355	
346 6-in. valves @ 135 lbs.	46,710	
138 8-in. valves @ 228 lbs.	31,444	
15 10-in. valves @ 300 lbs.	4,500	
8 12-in. valves @ 373 lbs.	2,984	
1,000 reducers @ 35 lbs.	35,000	
Lead	13,592	
Oakum	272	
	139,867	
Drayage:		
139,867 lbs. = 70 tons.		
Average haul = 1 mile.		
70 ton miles @ $0.40		28.00
Excavation:		
657 valve holes @ $0.08		52.56
Painting:		
512 valves @ $0.10		51.20
Labor:		
145 valves @ $0.15		21.75
512 valves @ $0.50		256.00
Total, valves on mains		$13,315.92

7. SERVICES.

5,157 ½-in. services @ $ 7.72	39,812.04
654 ¾-in. services @ $ 8.91	5,827.14
30 1 -in. services @ $11.56	346.80
10 1¼-in. services @ $12.50	125.00
6 1½-in. services @ $16.00	96.00
34 2 -in. services @ $30.87	1,049.58
5 3 -in. services @ $44.70	223.50
11 4 -in. services @ $46.40	510.40
12 6 -in. services @ $70.49	845.88
*10 ½-in. services @ $ 7.72	77.20
*9 ¾-in. services @ $ 8.91	80.19
*1 1 -in. services @ $11.56	11.56
*3 2 -in. services @ $30.87	92.61
Total	$49,097.90

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*These services were put in paved streets; for additional cost see Paving.

The following services were installed along Creeks No. 1, No. 2 and No. 3 in return for various Rights of Way and Water Rights, and are included under the heading "Water Rights":

365 ft. ½-in. pipe @ $2.79 per C.	10.18
390 ft. ¾-in. pipe @ $3.28 per C.	12.79
4,405 ft. 1¼-in. pipe @ $6.39 per C.	281.48
375 ft. 2-in. pipe @ $9.76 per C.	36.60
	$ 341.05
5,535 ft. trench	200.00
Laying pipe @ $0.02 ft.	110.70
Miscellaneous fittings, etc.	34.10
Total	$ 685.85

8. HYDRANT CONNECTIONS.*

72 6-in. hydrant connections 32 ft. long.
74 4-in. hydrant connections 32 ft. long.

2,304 ft. 6-in. Matheson pipe @ $0.42	$ 967.68
2,368 ft. 4-in. Matheson pipe @ $0.27.	639.36
192 Matheson nipples @ $1.20	230.40
72 6-in. valves @ $15.10	1,087.20
74 4-in. valves @ $10.25	758.50
4,368 lbs. lead @ $0.0525	229.32
90 lbs. oakum @ $0.09	8.10
Labor	1,500.00
Total hydrant connections	$ 5,420.56

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*Hydrants owned by city.

9. METERS.

39 ½-in. Crown @ $12.00	$ 468.00
4 ½-in. Empire @ $9.00	36.00
2 ½-in. Keystone @ $12.00	24.00
52 ¾-in. Crown @ $21.00	1,092.00
1 ¾-in. Standard @ $14.55	14.55
12 1 -in. Crown @ $30.00	360.00
6 1½-in. Crown @ $52.32	313.92
1 1½-in. Union @ $34.10	34.10
21 2 -in. Crown @ $65.00	1,365.00
1 2 -in. Rotary @ $60.00	60.00
5 3 -in Crown @ $140.73	703.65
1 3 -in. Trident @ $95.20	95.20
7 4 -in. Crown @ $250.00	1,750.00
1 4 -in. Rotary @ $130.00	130.00
1 4 -in. Trident @ $144.00	144.00
4 6 -in. Crown @ $523.40	2,093.60
1 6 -in. Trident @ $350.28	350.28
1 8 -in. Crescent @ $585.00	585.00
Labor—140 meters @ $5.00	700.00
Labor—20 meters @ $10.00	200.00
Total, meters	$10,519.32

10. PAVING.

Cost of Paving account of services:	
10 ½-in. services	70.80
9 ¾-in. services	203.65
1 1-in. services	59.44
3 2-in. services	90.87
Total, paving	$ 424.76

11. BUILDINGS.

Power House:		
431,844 cu. ft. = $36,605.99 prorated to Water Department, 19%		$ 6,955.32
Sub-Station:		
Estimated value to Water Dept.		2,000.00
Total, power house and sub-station		$8,955.32

Miscellaneous Buildings.

Pump Shed at Reservoir:		
84 sq. ft. @ $0.50		$ 10.08
Tool House:		
Frame with shingle roof, 108 sq. ft. @ $0.50		54.00
Water Barn:		
Frame buildings, painted, two stories, stable and warehouse, first floor, machine shop, second floor, sheeting outside, shingle roof. General dimensions 78x30 ft. with 4,680 ft. floor area @ $0.75		3,510.00
Wagon Shed No. 1:		
General dimensions 32x14 ft., 1,148 sq. ft. @ $0.15		172.20
Wagon Shed No. 2:		
General dimensions 70x14 ft., 980 sq. ft. @ $0.15		147.00
Platform and Driveway:		
33,000 F. B. M. lumber @ $22.	$726.00	
330 lbs. iron @ $0.04	13.20	
		739.20
Fence:		
280 1-in. x 6-in. boards, 6x8-in. posts.		
Lumber, 3,720 F. B. M. @ $22.	$81.84	
Iron, 50 lbs. @ $0.04	2.00	
Digging, 35 post holes @ $0.50.	17.50	
Gate	20.00	
Painting, two coats, 560 sq. yds. @ $0.15	84.00	
		205.34
Yard Equipment:		
300 ft. 2-in. hose & $0.30	$90.00	
4 2-in. hydrants @ $4.00	16.00	
4 2-in. nozzles @ $0.87	3.48	
1 iron trough 4x2 ft.	5.00	
132 ft. galv. 2-in. pipe @ $13.77 per C.	18.17	
8 2-in. elbows @ $0.09	.72	
6 2-in. tees @ $0.13	.78	
10 ft. 1-in. galv. pipe @ $6.48 per C.	.65	
3 2-in. reducers @ $0.13	.39	
3 1-in. faucets @ $0.80	2.40	
Labor	12.00	
		149.59

15. TELEPHONE AND SIGNAL APPARATUS.

Signalling System from Power House to Reservoir:	
Poles at holes 60 ft. 1 @ $8.12	$ 8.12
Poles at holes 50 ft. 2 @ $5.80	11.60
Poles at holes 45 ft. 8 @ $5.20	41.60
Poles at holes 40 ft. 3 @ $4.65	13.95
Labor, digging and setting 14 poles @ $7.00	98.00
6 pins and arms (with hardware) 17 @ $0.80	13.60
Labor on same, 17 @ $0.60	10.20
Glass insulators (D. P. D. G.) 102 @ $0.06	6.12
Wooden pins, 102 @ $0.02	2.04
No. 14 W. B. B. wire, 2.6 miles, 220 lbs. @ $0.06	13.20
Labor stringing wire, 2.6 miles @ $12.00	31.20
1 automatic float at reservoir @ $10.	10.00
1 indicator board mounting 6 lamps and six-point rotating switch at station @ $5.00	5.00
Total, telephone and signal apparatus.	$ 264.63

16. MISCELLANEOUS EQUIPMENT AND APPARATUS.

Tank for pipe dipping:		
Sheet iron 27-in., 6-in. x 36-in. No. 11 gage		$ 108.50
Foundation for tank, 7 yards		49.00
Planking, 2,100 F. B. M.		31.50
Draining table 6x9 ft.		4.00
Derrick, legs 42 ft., mast 34 ft., boom 38 ft.		100.00
Boiler, self-contained water tube		175.00
Lamp pole		10.00
Five signs		50.00
One sign at Creek No. 3		18.00
Pipe and fittings for dipping tank:		
68 ft. 4-in. pipe	$21.54	
4 4-in. tees	2.40	
3 4-in. plugs	.35	
1 4-in. cap	.30	
2 4-in. flanges	.63	
1 4-in. elbow	.41	
1 1-in. bushing	.02	
2 1-in. elbows	.08	
11 ft. 1½-in. pipe	.84	
554 ft. 1-in. pipe	25.92	
3 1-in. valves	2.94	
2 1-in. tees	.10	
2 1-in. unions	.20	
10 1-in. close return bends	.20	
1 1-in. safety valve	2.60	
Labor on above	$11.60	
		70.13
Total, miscellaneous equipment and apparatus		$ 557.60

UNIT PRICES USED IN ESTIMATING COST OF SERVICES.

In estimating the cost of services the following unit prices were used:

½-in. Average length 27.3 ft.

Analysis of cost:	
Pipe, 27.3 ft. @ $0.0391	$ 1.07
Saddle complete	.50
Lead connection complete	1.56
Service cock	.45
Service box	.94
Labor	2.50
	$7.02
10% teaming and miscellaneous	.70
	$7.72

¾-in. Average length 30.1 ft.

Analysis of cost:	
Pipe, 30.1 ft. @ $0.0450	$ 1.35
Saddle complete	.50
Lead connection complete	2.23
Service cock	.58
Service box	.94
Labor	2.50
	$ 8.10
10% teaming and miscellaneous	.81
	$8.91

1-in. Average length 25.7 ft.

Analysis of cost:	
Pipe, 25.7 ft. @ $0.648	$ 1.67
Saddle complete	.50
Lead connection	3.10
Service cock	1.80
Service box	.94
Labor	2.50
	$10.51
10% teaming and miscellaneous	1.05
	$11.56

2-in. Average length 28.5 ft.

Analysis of cost:	
Pipe, 28.5 ft. @ $0.1377	$ 3.92
Saddle complete	.60
Lead connection	12.60
Service cock	7.50
Service box	.94
Labor	2.50
	$28.06
10% teaming and miscellaneous	2.81
	$30.87

3-in. Average length 45.5 ft.

Analysis of cost:	
Pipe, 45.5 ft. @ $0.288	$13.10
Saddle complete	.60
Service cock	7.50
Lead connection complete	16.00
Service box	.94
Labor	2.50
	$40.64
10% teaming and miscellaneous	4.06
	$44.70

4-in. Average length 24.4 ft.

Analysis of cost:	
Pipe, 24.4 ft. @ $0.436	$10.64
Saddle complete	.60
Lead connection complete	20.00
Service cock	7.50
Service box	.94
Labor	2.50
	$42.18
10% teaming and miscellaneous	4.22
	$46.40

6-in. Average length 29.5 ft.

Analysis of cost:	
Pipe, 29.5 ft. @ $0.804	$23.60
Saddle complete	.75
Lead connection complete	25.00
Service cock	11.29
Service box	.94
Labor	2.50
	$64.08
10% teaming and miscellaneous	6.41
	$70.49

Good Engineering in Solving the Emergency Water Supply Problem of the Panama Pacific International Exposition.

(Staff Abstract.)

The initial water supply plans of the Department of Works of the Panama-Pacific International Exposition contemplated that the Spring Valley Water Co., the water company which serves the city of San Francisco, would deliver to the Exposition from 2,000,000 to 3,250,000 gals. of water per day. However, at a late date the water company found that it could not bring into the city an additional supply to serve the Exposition as well as the needs of the city during the Exposition period. Consequently the Department of Works of the Exposition was suddenly confronted with the necessity for obtaining water from other sources and this condition did not manifest itself until after the water distribution system had been installed within the grounds based upon receiving water from the Spring Valley Water Co. The system of supply and purification works then installed comprises some ingenious features and is here described from a paper by E. C. Eaton, in charge of the Department of Works of the Exposition.

Negotiations conducted with the United States Government resulted in securing the excess water available over and above their needs, from their source of supply, Lobos Creek, the excess being estimated at 800,000 gals. per day, and it was decided to obtain the balance of the water required from wells in the Richmond District.

The Richmond District drainage area adjoins the Lobos Creek, area, from which latter the Government has pumped 2,000,000 gals per day continuously for the past five years, and the Lobos Creek District has a drainage area of five square miles. The drainage of the Richmond District is 2¾ square miles, from which no appreciable amount of water is taken, and it was therefore considered safe to assume that at least 1,100,000 gals. per day could be counted upon as a continuous supply from this district. The source of supply in this district is derived from the ground absorption of rains, occurring generally from December to March, and owing to the nature of the soil and to the fact that the district is not as yet thickly built up, amount to from 40 per cent to 50 per cent of the rainfall.

The principal difficulty anticipated was to develop a successful method of getting the water out of the ground, as the sand is very fine and uniform, having an effective size of .18 mm. and a uniformity coefficient of 1.55, and wells in this district had been pronounced a failure by those trying them, as they sanded up very quickly. For this reason a sump 200 ft. long by 14 ft. wide by 30 ft. deep was first constructed in Golden Gate Park, consisting of a 3-in. timber sheeting in the sides of which 100 infiltration screens were placed. Not as much water as was hoped for was obtained from this sump, as only 175 gals. per minute, or 250,000 gals. per day can be depended upon from this source.

Attention was next given to wells, and a well consisting of two concentric casings, 16-in. and 20-in. diameter respectively, was driven to a depth of 80 ft., with a gravel filling between the casings of a size running from rice to pea size. On testing this well it showed up very well, giving 186 gals. per minute with a drawdown in the water surface of 11 ft., and 256 gals. per minute with a drawdown of 17 ft., and very little sand discharged in the water. On the strength of this four other wells were driven, having an average depth of 83 ft. The water from the five wells all discharges into one main pipe line and then is discharged into one end of a draw water flume which is 12 ft. 6 ins. wide, 7 ft. high and 60 ft. long. From this flume water can be taken at any point desired to give a greater or less period of coagulation.

Unfortunately the behavior of the first test well did not prove to be indicative of what could be obtained from the others, as they rapidly sanded up when over 50 gals. per minute was pumped from them for any appreciable time. On attempting to draw, say, 100 gals. per minute or more from these wells they would hold up for several hours (10 or 12) when the ground for a radius of 5 ft. around the well would suddenly drop down 2 or 3 ft. and the well rapidly sand up to the pump runners. This was probably due to a cavern having been formed around the well casing by the gradual drawing out of small quantities of sand, which finally broke down and allowed the sand to flow quickly through the perforations in the casing and the intervening gravel space. It was thought that by filling in with a fine gravel where the caving occurred this would finally work down alongside the casing and hold back the fine material. As it would have been expensive to draw the pumps when a well sanded up, a small air lift was used, consisting of a 1¼-inch. discharge pipe and a ½-in. air pipe lowered into the 2-in. space between the pump and the well casing. This proved entirely satisfactory and cleaned out a well that had sanded up for 30 or 40 ft. in less than three hours.

After over two months' perseverance along these lines with no improvement, it was decided to drill a new well with a different gravel filling, and accordingly a few simple experiments were made to determine a suitable filling, with the result that a naturally graded beach gravel, coming from the Bay Shore about 20 miles south of San Francisco, was chosen, having an effective size of .42 mm. and a uniformity coefficient of 2.18. The tests for a gravel filler consisted of taking two plates about 12 ins. square having a number of slotted perforations and filling between with the size of gravel to be tested. The whole was then enclosed in a watertight box and a quantity of the ordinary sand, comprising the soil in the district, placed above the topmost plate. Above this sand water under varying pressures was applied. The nature of the water after it had passed through the plates was noted; that is, whether sand was being carried with it, and the velocity of water through the perforations calculated. The best results were obtained with the above mentioned gravel, together with a burred perforation in the casings not over 1/32 in. wide and giving a velocity of water through the perforations, at the capacity of the well, of 0.5 ft. per second.

The new well consisted of two casings, 16-in. and 22-in., with the special gravel filling between, and was sunk through sand to a clay stratum in four days to a depth of 60 ft. by means of an hydraulic ejector, at a cost of $236, of which $166 was for casing and material. On a test this gave 250 gals. per minute—the full capacity of the pump used, with no sand whatever in the discharged water. There is very little doubt but that the well is good for 300 gals. per minute continuously.

In case the method of drilling the well may be of interest, I will describe it in a little more detail: The well casing was forced down in the ordinary method by means of two 24-ft. logs weighted to give a maximum of five tons pressure on the casing, but instead of using the ordinary method of removing the sand by means of a cylinder containing a foot valve, the sand was removed by means of a water jet pump made up from standard piping. This was a considerable saving in time and labor, as two men drilled a well 60 ft. deep in this class of material in four days without difficulty. This well was drilled by the Exposition company at a cost of $3.89 per foot depth. The contractor's price for drilling the first well was $7.50 per foot depth, showing the considerable saving effected in this class of material by using the hydraulic process. This resulted in the overhauling of the four other wells, and accordingly a third casing was introduced with a 1-in. intervening space between it and the old inner casing, which was filled with the same grade of gravel as was used in the new well. No further sand trouble has been experienced, nor is any anticipated. The third casing was put in after it was found that even a 20-ton pull would not draw the original inner casing, and because it was impossible to remove the gravel originally placed between the first two casings.

An early estimate of the available average yield to supply the Exposition was made, as follows:

	Gals. per day.
Sump in Golden Gate Park	350,000
Wells—5 wells at 260,000 gals. per day capacity of the yield per day × 2¾ times	650,000
Spring Valley Water Co.	150,000
Wells on Exposition grounds	150,000
Excess government water available from Lobos Creek	800,000
	2,100,000

The wells in the Exposition grounds have since been shut down, and not as much water as was hoped for can be counted on from the Government excess supply. The source of supply in the Richmond District has proven the cheapest. The average daily quantities used from the various sources for the month of August were as follows:

	Gals. per day.
Sump and wells in Golden Gate Park	1,153,800
Spring Valley Water Co.	61,900
Wells in the Exposition grounds	....
Excess government water from Lobos Creek area	479,900
Total	1,695,600

As an additional insurance against any failure of the water supply during the heavy months of September and October, use was obtained of two city wells that were drilled in this district, during the summer, in which we installed an air lift pumping system, which insured an additional supply of 360,000 gals. per day in case of emergency.

Analyses of the water from the Richmond District wells showed a fairly good drinking water, but both sanitary and bacterial analyses showed that the water should be carefully watched and for this reason a filtration plant was decided upon. The whole system as designed consists of a sump and five wells, delivering water to a filtration plant; a main pumping plant pumping the filtered water a distance of 19,300 ft. to a reservoir of 2,500,000 gals. capacity at an elevation of 365 ft. and a gravity pipe line 5,000 ft. in length, to the Exposition grounds.

FILTRATION PLANT.

Owing to the temporary nature of the plant, a timber flume structure was decided upon, but the plant in everything except appearance embodies all the latest and some new features in the rapid-sand type of filter, combined with extreme simplicity. The water discharged from the wells and sump is received at one end of a long raw water flume of such dimensions that at the full capacity of the plant, 1,600,000 gals. per day, a period of 45 minutes elapses before the water reaches the far end, at which end it is discharged into the filters. The principle of the rapid-sand filter embodies the use of a coagulant, such as aluminum sulphate, being introduced into the water and forming a floc on the surface of the sand, allowing the sand to be worked at a high rate—125,000,000 gals. per acre sand surface per day, as against 2,500,000 gals. per acre per day in the slow-sand type of filter in which no coagulant is used. Over this raw water flume is run lengthwise a 1¼-in. pipe having distributing girds branching from it every 12 ft. by means of which the coagulant solution may be applied at any desired point by the opening of a valve, to allow the proper period for the floc partially to form in the water and to be deposited on the sand surface. The aluminum sulphate of the required strength is mixed in tanks and flows through graduated orifices in exact proportion to the amount of water flowing in the flume, and is regulated by means of a simple differential equipment, worked by floats on each side of a submerged orifice, through which the water from the sources of supply flows. The filters are three in number, each having an area of 183 sq. ft. sand surface, and a capacity of over 500,000 gals. per day per filter.

The collector system, by means of which the water is collected uniformly after passing through the sand, is very simple and entirely effective, and is a design especially developed by Prof. Charles Gilman Hyde of the University of California, and consists of an especially tapered header in the bottom of the filter, from which, at 6-in. intervals, 2½-in. lateral pipes run crosswise over the bottom of the filter on the under side of which 5/16-in. diameter holes are drilled on 3-in. centers. Over these lateral pipes four graded layers of gravel were placed, running from 2-in. to rice size, and above this a 26-in. layer of filter sand, over which provision was made for a 30-in. head of water. The most important feature contributing to the success of the plant was, of course, the sand, and we were especially fortunate in locating a sand of suitable size and uniformity within 60 miles of San Francisco. This sand is known as Lapis sand and has an effective size of .35 mm. and a uniformity coefficient of 1.5. The filtered water, after passing through the sand, discharges through an effluent controller in the shape of a specially constructed float valve, into the clear water reservoir, where as an additional precaution, it is given a chlorine dose at the rate of 3 lbs. of chlorine per 1,000,000 gals. of water filtered. The filters become clogged up from 8 to 12 hours, due to the collection of coagulant and impurities on the surface of the sand, so that the loss of head in the sand is increased from 1.7 ft. with clean sand, to 6 or 7 ft., at which point the filters are washed.

The older type of sand-wash, namely, agitation of the sand, by means of air or mechanical rakes, has been discarded in favor of the newer method of employing a high velocity rate of washwater, with no additional method of scrubbing the sand. In this method a reverse current of filtered water at a rate of 15 gals. per square foot sand surface per minute is forced up through the sand by means of a 10-in. centrifugal pump. The dirty water is collected over the surface of the sand by means of V-shaped wooden troughs and carried away by a 10-in. drain pipe to a slough nearby. It is believed that a saving of 2,700 gals. per wash has been effected by using this method.

The costs of water for the month of August were as follows:

Cost per 1,000 gals.—pumping from deep wells:	Cts.
Power	.846
Operators and superintendence	.607
Repairs to pumps	.047
Oil, grease and miscellaneous	.017
	1.517
Cost per 1,000 gals.—filtering and treating water:	
Al. sulphate	.250
Chlorine	.056
Washwater	.045
Operators and superintendence	.623
	.974
Cost of pumping to main reservoir:	
Power	3.3
Operators and superintendence	.631
Oil, waste and miscellaneous	.004
	3.935
Total cost of water, per 1,000 gals	6.426

The efficiency of the filters, as determined by analyses made by the Board of Health at frequent intervals, has been very satisfactory, the filters yielding an effluent with a bacterial count of not over 12 per c.c.

DISCUSSION BY CHARLES GILMAN HYDE.

The speaker does not know of any time when wells which have sanded up so badly as have these wells, which were apparently absolutely doomed to failure, have been regenerated and rejuvenated so that they have become very efficient as a source of supply. That was done by applying technical principles to a practical problem, and what Mr. Eaton did was to get out that type of sand and gravel, grade the material, which, when placed between the two casings of the well, would be just fine enough so that the natural material outside the casing would not percolate through or pass into the gravel and, on the other hand, the gravel would be of such a nature that it would allow the water to pass and would not clog up, due to the fact that the sand was against the outside ring of the material.

There is one other very interesting feature about this plant and that is in regard to the coagulation of the water as it passes through a coagulating basin or chamber, which antecedes the filter. It was arranged to have 45 minutes displacement in that chamber, if the plant was working at its rated capacity. However, the demand varies from 600,000 gals. to 1,600,000 gals., so that the storage period for the 600,000-gal. rate would be 2.7 times 45 minutes and there would be an economic loss of the coagulant. So the very clever scheme was devised of putting in these coagulent ribs so that when the plant is working at a lower than its rated capacity, the proper time always is had for coagulation without losing any coagulant. It is the first time, so far as I know, that this principle has been applied with a basin of this sort which is designed properly, namely, the length being several times the breadth and with reasonable depth.

ACKNOWLEDGMENT.

From a paper by E. C. Eaton, in charge Department of Works, Panama-Pacific International Exposition, before the League of California Municipalities.

BRIDGES

Design Features of the Dewey Suspension Bridge Across the Grand River, Near Dewey, Utah.

(Staff Article.)

The Dewey Bridge, which is to span the Grand River, near Dewey, Utah, is a stiffened suspension highway structure of somewhat unusual design. The span of the cables is 650 ft., the deflection at the center varies from 55 to 58 ft., the length of the roadway is 520 ft., and the width of the roadway 10 ft. The stiffening trusses are spaced 10 ft. 6 ins. on centers and have a depth, back to back of angles, of 10 ft. 4 ins. At a distance of about 140 ft. from the south bank of the river there is an abrupt sandstone cliff rising to a height of about 70 ft. above the level of the river bank. The north bank of the river is solid sandstone and is at about the same elevation as the south bank. At the south end the cables are supported on a concrete pier located at the top of the sandstone cliff, while at the north end they are supported on a 65-ft. steel tower and are anchored into the sandstone bank, the length of the anchor span being about 160 ft. Figure 1 shows a general plan and elevation of the bridge and indicates the topographical conditions at the site. By referring to Fig. 1 it will be noted that the roadway at the south end deflects around the sandstone cliff, the bridge ending at a point 130 ft. from the south cable support. At this end of the bridge there is a stiffening portal extending from a supporting concrete pier to the cables, a vertical distance of 30.7 ft. As shown in Fig. 1 (a) auxiliary wind bracing cables are provided at each end of the bridge. These cables are attached to the lower chords of the stiffening trusses, at points 180 ft. from the ends of the

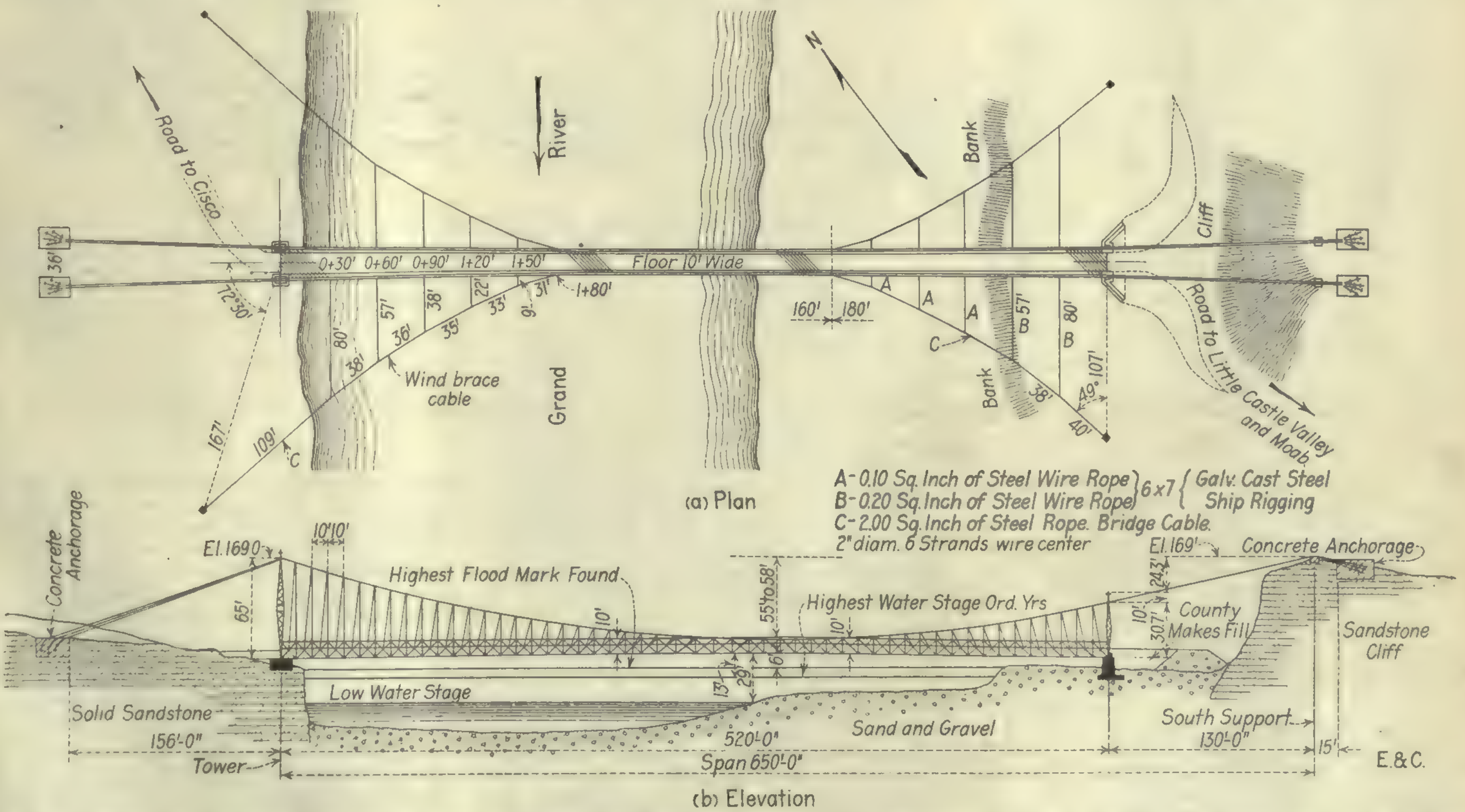


Fig. 1. Plan and Elevation of Suspension Highway Bridge Near Dewey, Utah, Showing General Design Features and Topography at Site.

bridge; and, deflecting laterally at intermediate connecting cables, end in anchor blocks located on the river banks. The bridge is further stiffened by means of a system of bracing in the plane of the lower chord of the stiffening truss.

SHEARS AND MOMENTS.

The stiffening truss is hinged at the center of its span, each segment having a length of 260 ft. The maximum positive and negative shear diagrams for the half span and for one side of the bridge are shown in Fig. 2 (a); the maximum positive and negative moment diagrams for the half span and for one side of the bridge are shown in Fig. 2 (b); and the wind stresses in the auxiliary wind bracing cables are given in Fig. 2 (c). A wind pressure of 140 lbs. per linear foot was assumed. As shown in Fig. 2 (c) the wind bracing cables are attached to the lower chords of the stiffening cables at points 80 ft. distant from the center of the 520-ft. span. As the stiffening truss is hinged at the center, the bracing in the plane of the lower chord in the 80-ft. sections of the trusses (between the hinge and the points of attachment of the wind bracing cables) is designed to resist the wind pressure acting as a cantilever about the points of attachment of the wind bracing cables. The floor system is assumed to resist 20 lbs. per linear foot of this wind load.

CABLES.

Main Cables.—Each stiffening truss is supported by three 2¾-in. diameter cables, these cables being parallel, not twisted. Each cable consists of six strands and a wire center, each strand comprising 19 wires. These cables have a span of 650 ft. and a deflection, when the bridge is fully loaded, of about 58 ft. The cables are standard galvanized steel bridge cables with wires having an elastic limit of 80,000 lbs. per square inch and a breaking strength of 180,000 lbs. per square inch. The cables are to be coated with a non-corrosive asphaltic or tar coating, with a melting point not lower than 150° F.

Wind Bracing Cables.—The four wind bracing cables are each 2 ins. in diameter and consist of six strands and a wire center. The lateral ties marked "A" (Fig. 2 c), which connect these wind bracing cables to the stiffening truss, each have a section of 0.10 sq. in., while those marked "B" each have a section of 0.20 sq. in.

Hangers.—The stiffening truss is connected to the cables by means of a hanger at each lower chord panel point and at the intersection of the two web members in each panel as shown in Fig. 6. The same quality of steel is used for the hangers as for the cables, and each hanger is fitted with a turnbuckle providing an adjustment of 3 ins. The hangers are provided with a protective coating similar to that used for the cables.

ANCHORAGE FOR CABLES.

The main cables are anchored at each end into the solid limestone as shown in Fig. 3. As noted in this drawing a hole is excavated in the limestone 5 ft. wide, 14 ft. long and at least 6 ft. deep. This hole is filled to a depth of 4 ft. with 1:3:6 concrete, into which there is embedded the anchor detailed in Fig. 3. This plate and channel anchor is in turn anchored by means of 2-in. bolts grouted into holes extending 10 ft. into the solid limestone.

The wind bracing cables on the north bank are anchored by passing each through a block of concrete, 3 ft. wide by 3 ft. 6 ins. long by 2 ft. thick, and continuing the cable into a vertical hole drilled 10 ft. into the solid rock, where it is grouted. In passing through the concrete block the cable is bent to a radius of 2 ft. over a plate embedded in the concrete. The wind bracing cables on the south bank are anchored in a different manner. Here each cable passes over a reinforced concrete pier extending about 6 ft. above the ground, and is anchored, by means of channels embedded in a block of concrete, the latter being buried to a depth of 15 ft.

TOWERS FOR MAIN CABLES.

At the north end of the bridge the main cables pass over a steel tower having an extreme height of 75 ft. The cables rest in sockets placed at a height of 65 ft. above the tower base. The tower is hinged at the base and rests on cast steel shoes, the latter being supported on a concrete base. Figure 4 (a) shows the general design features of this tower. The tower legs are spaced 23 ft. 8 ins. on centers, each leg consisting of two 15-in. 33-lb. channels.

As shown in Fig. 1 (b) a stiffening portal is provided at the south end of the bridge. This portal is similar in design to the tower shown in Fig. 4. Its total height is 40.7 ft., and the height of the cradle supports for the cables is 30.7 ft. This portal is designed to resist an upward or downward force of 35,000 lbs.

A reinforced concrete pier takes the place of the tower at the south end of the cable span. Details of this pier are shown in Fig. 5.

STIFFENING TRUSSES AND FLOOR SYSTEM.

The stiffening trusses are designed to resist the shears and moments shown in Fig. 2. Both chords of these trusses are subjected to reversals of stress. The sections were therefore designed for the larger stress plus one-half the smaller one. As both diagonal web members are inserted in each panel of the truss each member was designed to provide for one-half the shear in the panel. The connections, however, were designed to resist the stresses caused by the entire shear.

As has been noted, the stiffening truss is hinged at the center, dividing it into two 260-ft. trusses. Figure 6 (a) is an elevation of a panel of the stiffening truss and Fig. 6 (b) is a cross section of it. It will be noted that the 12-in. 31½-lb. floorbeams are riveted to gusset plates located at the intersections of the web members in each panel. The tops of these floorbeams are thus 4 ft. 6 ins. above the bottom of the lower chords. It will be noted by referring to Fig. 6 that the stiffening trusses are connected to the main cables at the lower chord panel points and also at the intersection of the web members in each panel. Tension members are designed for a stress of 16,000 lbs. per square inch and compression members for a stress of 19,000-100 l/r, or not to exceed 14,000 lbs. per square inch. For main

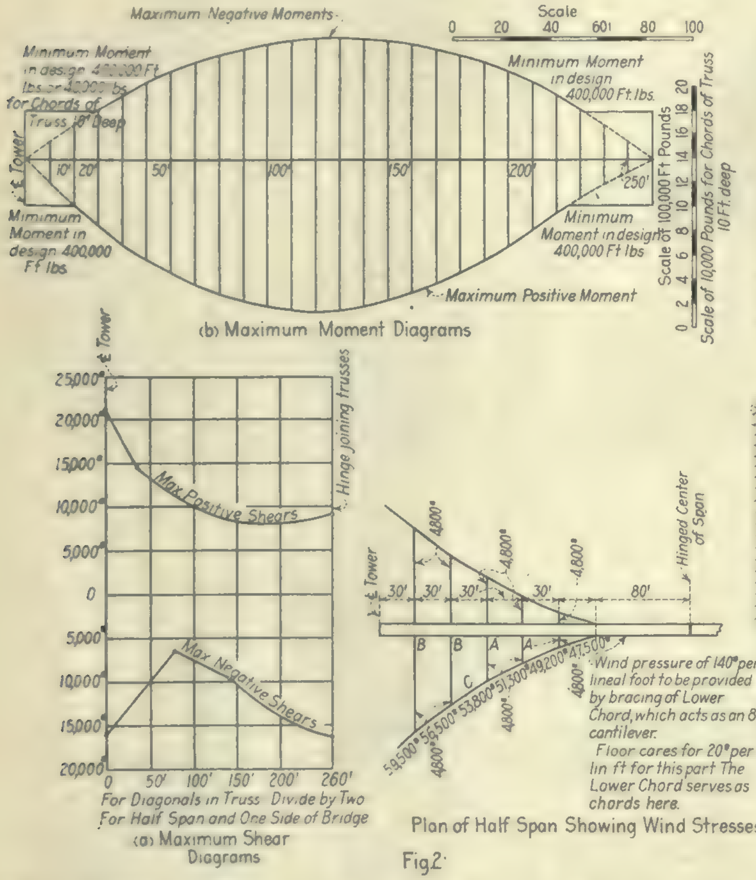


Fig 2

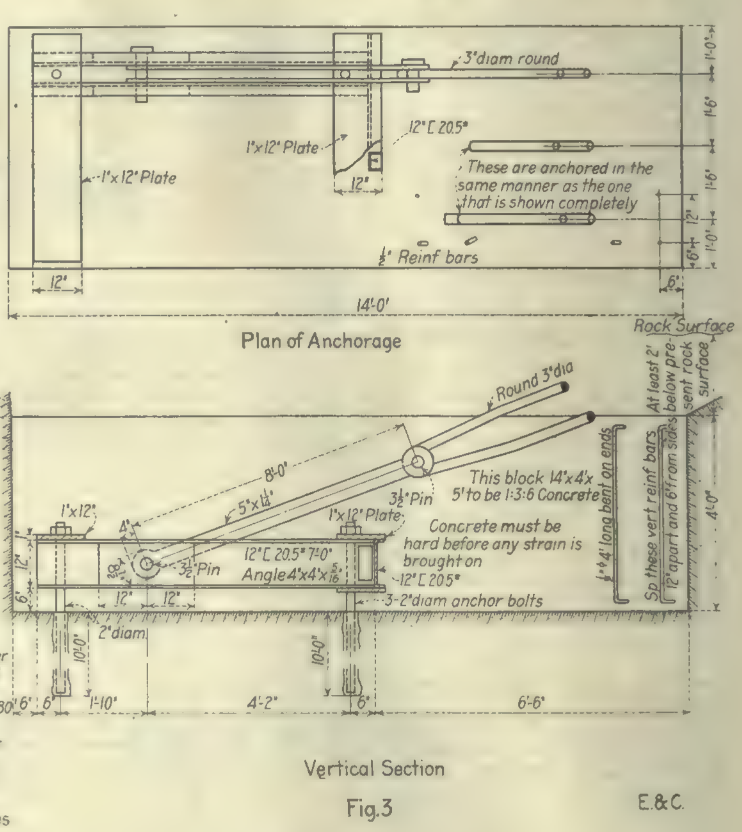


Fig. 3

Fig. 2. Maximum Moment and Shear Diagrams for Stiffening Truss of Dewey Suspension Bridge. Fig. 3. Details of Anchorage for Main Cables.

members l/r does not exceed 120 and for secondary members it does not exceed 160.

Six lines of 3 x 14-in. x 22-ft. Oregon fir stringers are used. As the floorbeams are spaced 10 ft. on centers, these stringers extend over two panels and lap 1 ft. at each end, where they are spiked together. Bridging is used over every other I-beam to give lateral stiffness. The flooring consists of two layers of 2 x 8-in. Oregon fir lumber, laid diagonally and securely nailed together. A hand railing consisting to two lines of 2 x 4-in. lumber is provided for each truss, as shown in Fig. 6 (b).

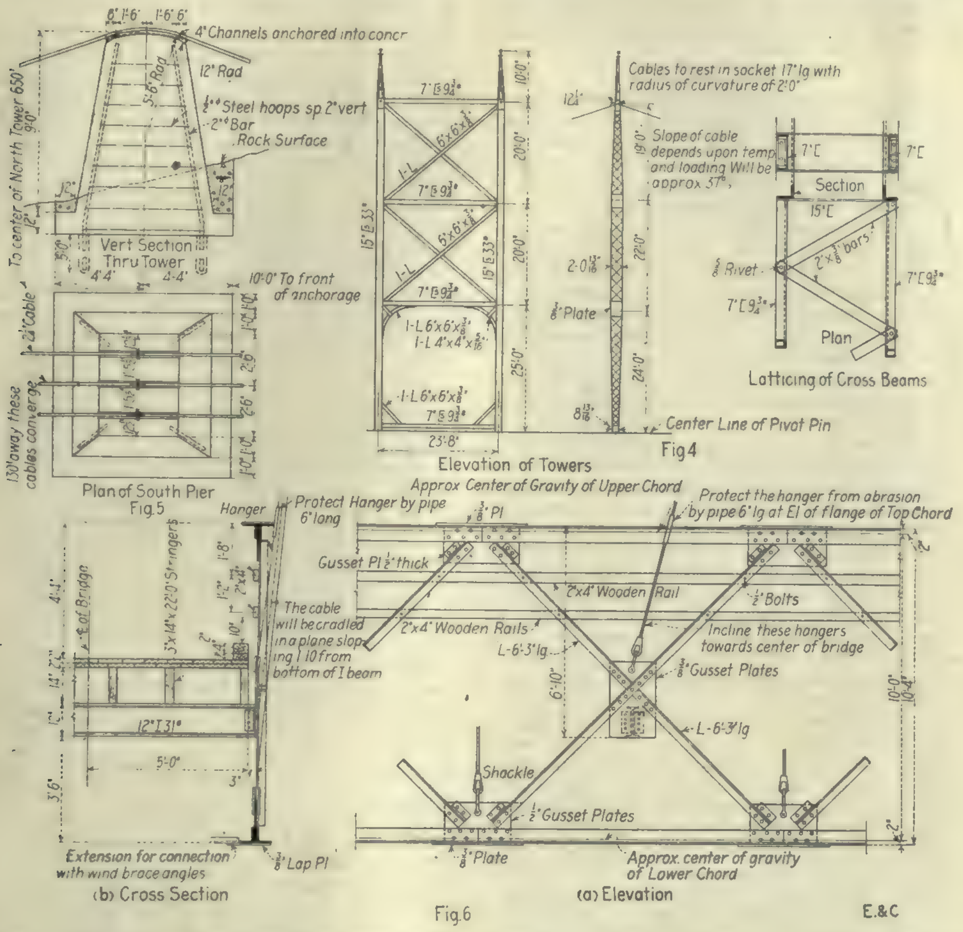

4" Channels anchored into concr
12" Rad
½" Steel hoops sp 2" vert
2" Bar
Rock Surface
Vert Section Thru Tower
10'0" To front of anchorage
To center of North Tower 650'
130' away these cables converge
Plan of South Pier
Fig. 5
Elevation of Towers
Cables to rest in socket 17" lg with radius of curvature of 2'0"
Slope of cable depends upon temp and loading Will be approx 57°
Section
Plan
Latticing of Cross Beams
Center Line of Pivot Pin
Fig 4
Approx Center of Gravity of Upper Chord
Protect Hanger by pipe 6" long
Protect the hanger from abrasion by pipe 6" lg at El of flange of Top Chord
Hanger
Gusset Pl ½" thick
2"x4" Wooden Rail
2"x4" Wooden Rails
½" Bolts
Incline these hangers towards center of bridge
⅜" Gusset Plates
The cable will be cradled in a plane sloping 1 10 from bottom of I beam
Shackle
½" Gusset Plates
⅜" Plate
⅜" Lap Pl
Approx. center of gravity of Lower Chord
Extension for connection with wind brace angles
(b) Cross Section
(a) Elevation
Fig. 6
E.&C

Fig. 4. Side and End Elevations and Lacing Detail of Steel Tower at North End of Dewey Suspension Bridge. Fig. 5. Plan and Elevation of Reinforced Concrete Pier Supporting Cables at South Bank of River. Fig. 6. Elevation and Cross Section of Typical Panel of Stiffening Truss.

PERSONNEL.

The bridge was designed by Horace W. Shelby, Consulting Engineer, Salt Lake City, Utah.

The Development of Commercial Alloy Steels.

(Staff Abstract.)

This paper treats of the development and use commercially of alloy steels. In it no attempt has been made to cover the strictly crucible steels.

The oldest alloy steels of which we can find record are an ingot of prehistoric times, analyzing 1.20 per cent carbon, 1.60 per cent silicon, unearthed near Nancy, and a tool containing a small percentage of nickel, removed in 1837 from the Cheops Pyramid. Also the Damascus steel of Toledo contained tungsten, nickel and manganese. There is no evidence that these steels were intentionally alloyed, but were the result, probably, of a combination of different element-bearing ores. During the eighteenth century great advances were made in metallurgy, although the opinions on the subject were vague. The effects of phosphorus, sulphur, bismuth, tin, antimony and arsenic in iron were known about 1740.

It was not, however, until the first half of the nineteenth century, and then only after ordinary carbon steel composition had been determined by Reaumur, that the first intentional experiments to alloy metals with iron were undertaken. In 1812 Hassenfratz, under orders from Napoleon, completed his work on the effects of cobalt on iron. The effects of titanium, chromium and tungsten were also known about this time.

SILICON AND MANGANESE.

Knowledge of silicon and manganese as alloys was limited up to 1880, although Gautier in 1876 had made observations regarding the hardening properties of manganese. R. H. Hadfield in the year 1880 began probably the first thorough research in the metallurgy of steel regarding silicon and manganese. As a result he published works of vital importance for the development of steel with these elements. Hadfield justly designates the year 1888 as the beginning of a thorough knowledge of alloy steels, when quite a number of such steels were produced in large tonnages and the use of silicon and manganese for the improvement of the physical and magnetic qualities was made practical.

CHROMIUM AND NICKEL STEELS.

The founder of the chromium steel industry in America was Julius Baur of New York, who, after receiving letters patent for the manufacture of chrome steel, formed a company in 1869 which soon marketed its product with success. In Europe chrome steels were first produced by Holtzer & Co., Unieux, France. In 1870 they manufactured chrome steel armor-piercing shells and armor plate containing about 2 per cent chrome. Soon thereafter Hadfield began the manufacture of chrome steel in England, and in 1882 furnished chrome steel shells to the English Government which penetrated 8-in. wrought iron plates.

The development from this time on was quite rapid and chrome steel was introduced largely for safe work, jail work and other lines somewhat related to its original uses. The modern manufacture of this steel has broadened it beyond these uses and a large tonnage is now annually used by the ball and roller bearing industry. It is also used extensively in tool manufacturing lines and for other purposes where intense hardness is essential.

From 1822, when Stodart and Faraday at Sheffield published their experiments on the alloying of nickel and iron, up to 1885, when a pure ferro-nickel was brought out, nickel steel, on account of its expense, was not developed to any great extent. While during this period Wolf, Fairbairn, Therber, Bessemer, and others, carried on extensive and valuable investigations, contributing to the development of this steel, it nevertheless remained for James Riley, then of Glasgow, to demonstrate by practical tests the advantages of alloying nickel with steel. Mr. Riley's paper on this subject, read before the Iron and Steel Institute of Great Britain in 1889, gave an impetus to the introduction of nickel steel in a commercial way.

The advantages of nickel steel in ordnance led to its use in the manufacture of guns of heavy caliber. The fact that the propeller shafts of the gigantic double-screw express steamer Deutschland, launched in 1889, were made of nickel steel is evidence of the remarkable progress made in the manufacture of this steel and the recognized advantages in its use.

Nickel steel is now used extensively in automobile construction for parts such as frames, gears, shafts, and its utility in fields of structural fabrication, engine building, ship building, and many kindred lines too numerous to mention, is established and increasing.

VANADIUM IN STEEL.

In 1803 Del Rio, professor of mineralogy in the City of Mexico, isolated this element and called it eurythronium. However, it was not until 1830 that Sefstrom, a Swedish investigator, succeeded in attributing the superior properties of some of their soft irons to this wonderful element, and gave it its present name.

The manner of the use of vanadium and its effect became known no sooner than 1900 through Arnold, who demonstrated a method of using it in a commercial way. Further investigations as to the action of vanadium in steel have been carried on by Nicolardot, Guillet, Putz, and others. With its marked affinity for numerous elements it was found in minute contents combined with the various minerals universally.

Owing to its enormous cost, which in 1895 exceeded $10,000 per pound, very little was done with it as a steel alloy, but a vast deposit was unearthed in South America in 1905 and its cost was thus soon brought within reach of the commercial consumer.

Its property as a scavenger in cleansing steel of its impurities other than phosphorus and sulphur, and the dynamic qualities, together with the superior static results obtained when used in conjunction with chrome, created a demand for this alloy which has been remarkable. The Swedish irons used as a base for high-grade crucible steels owe their virtues to this element. One of the first extensive uses synthetically, however, was in conjunction with high speed steels whose cutting properties were trebled and even quadrupled thereby.

The automobile, locomotive and high speed engines, with their demands for anti-fatigue material, opened a wide field for this product. It was this demand that caused the entry of the open-hearth and electric furnaces into the manufacture of this alloy steel.

About 1907 chrome-vanadium steel was first successfully made in the open-hearth furnace in commercial quantities. The consumption of vanadium as an alloy has steadily grown so that today it is used in combination with practically all other alloys, and in crucible, electric and open-hearth practice.

RECENT DEVELOPMENTS.

The use of alloys in the manufacture of steel was effected in a commercial way about 1880. The demands of a steel to meet the use of more powerful explosives was the first influence toward the use of alloys and resulted in the introduction of nickel and chromium in steel for ordnance work. In their infancy these steels were made and alloyed in the crucible, and it was from the crucible mills with their ultra-expensive practice that the consumer obtained his supply. Later the demand increased so tremendously that the open-hearth and electric furnaces were drafted into service, the former turning out an excellent product at a very much decreased cost owing to the tonnage involved, and the latter rivaling the crucible for purity and with its costs also decreased as against the crucible practice. This was due to the charge of tons in the open-hearth and electric as against the crucible's charge in pounds.

During the past decade wonderful strides have been made in the development of alloy steels of high physical properties. Such developments were brought about largely by the severe and exacting requirements of automobile manufacturers, as with the introduction of motor vehicles it became necessary to economize in space and weight, and to meet these requirements metallurgists turned their attention to the development of steels of greater efficiency. This resulted in the adoption of practically standard analyses, by which small percentages of the standard alloying elements, vanadium, chromium, nickel, tungsten, etc., introduced into the metal increased its strength, toughness, hardness and other physical properties sufficiently to meet the exacting conditions. In addition to the alloy steels containing the above mentioned elements, another class was developed by adding abnormal quantities of the essential impurities, silicon, manganese, or both, either with or without the aforesaid alloying elements. The production of satisfactory manganese, silicon and silico-manganese steels is now commercial.

MACHINABILITY OF ALLOY STEELS.

Some consumers specify alloy steels which must be made to analysis, heat treated to certain required physical results, and then either cold drawn or turned and polished, so that the consumer has only to use the steel as furnished by the steel manufacturer in its finished form. This demands of the steel maker not only heat-treating facilities but equipment for producing steel with the highest possible finish.

The problem which is now confronting the steel maker more and more is the machinability of steels capable of possessing high physical properties. Marvelous developments in tool steels, due to the improvement of the present-day high speed steels, has caused a proportionate increase in the efficiency of machine tools which means a "speeded up" production inconceivable ten years ago. The writer believes that the efficiency in improving machinable steels has not kept pace with the improvements in tool steels and machine tools. This is not entirely to be blamed upon the steel maker, as much steel is furnished in a green state, or the operations performed upon the steel before machining being thermal in nature destroy its production efficiency unless this structure is returned to its proper status. There is a large field for investigation as to the various mill operations to obtain a commercial practice which will deliver steel to the consumer in a uniformly machinable condition.

A few years ago, and even to date, a steel which was difficult to machine was "annealed." The peculiar characteristics of the steel were not investigated, but the steel was treated in a more or less superficial way and heated "somewhere in the neighborhood of 1500° F. and cooled in a slow heat conducting medium," which sufficed to obtain more or less uncertain results for the customer. Inasmuch as we are living in a day of special steels and each steel is indeed a deep study in itself, the problem of machinability becomes not that of a mere annealing (which in some cases is sufficient, however) but a scientific research of the metal through its many operations from ingot to bar. Casting, breaking down, rolling and principally finishing temperatures, all must be looked into with utmost care. These details must be not only ascertained but duplicated day in and day out in order to reach the ideal condition. Thus when each grade of steel is intentionally, and not more or less accidentally, made a consistent machining proposition, will the production which is sought be attained.

THE SPECIFICATIONS.

The question of chemical and physical specifications is an important one to the steel maker. It has been the habit of consumers when buying their materials to specify both chemical and physical properties, and in a good many instances properties that are conflicting and inconsistent. It has been our experience, and no doubt that of all the other makers of steel, to receive orders on which certain chemical limits that are commercially possible are outlined, and then physical results demanded that are absolutely impossible with the prescribed analysis.

In some cases the ductility factors, elongation and reduction are specified at percentages that cannot be met with the high elastic limit required. In others the hardness (placed either at a maximum to obtain machining qualities, or at a minimum to assure the elastic limit being up to specifications) is entirely inconsistent with the tensile strength and elastic limit. These discrepancies are in a good measure due to the steel makers themselves because only a few years ago the data at hand on alloy steels were obtained through tests in which the type of steel was the only variable, little consideration being given to section when recommending a steel for a prescribed purpose.

A standard test piece which has been heat treated after machining, as we all know, will show percentages of elongation and reduction which cannot be obtained with a test piece machined from a heat-treated part of greater section. Also a treatment which will produce certain properties upon a test piece treated after machining will not suffice for the heavier section. Because of the inconsistency of imposing physical specifications based on a standard test specimen heat treated, as against a specimen cut from a larger section after heat treatment, steel manufacturers have often found difficulty in meeting the requirements demanded.

Physical specifications should be drawn up in accordance with the results which should be obtained from tests taken from the full section in question. Data are often given out by steel manufacturers as to physical properties of steel without specifying the section from which the tests are made, which is thereby misleading.

PROPER ELASTIC LIMIT.

Again, concerns have been impressed with the virtues of some type of alloy steel by reason of its exceptionally high physical properties, and assume, for instance, that a steel which is stated to show 200,000 lbs. per square inch elastic limit must necessarily be better than one which shows only 150,000 lbs., ignoring entirely the purpose for which the steel is to be used. In reality the lower elastic with greater ductility may, for a particular purpose, serve to better advantage than the higher elastic and lower ductility, both results, however, being obtained from the same steel by different thermal manipulation.

The various types of alloy steels each have distinct properties for a constant elastic limit. The elastic limit is the working feature in all parts because after determining the stresses and by adding a factor of safety there is obtained a gross stress which must be resisted, and this resistance must in all cases be exceeded by the elastic limit. The type of steel then to be selected should be determined by the nature of the stresses and not the amount, for it is possible to obtain equal elastic limits in several of the alloy steels that are made today; for instance, where an alternating stress will cause a chrome-nickel steel to fail a chrome-vanadium steel will serve satisfactorily, even though it is treated to show no greater strength. This is due to its superior dynamic properties.

The consumer should, when specifying steel, arrive at the grade through the nature of the stresses, the elastic limit by the amount of the same, and be content with the tension, reduction, hardness, etc., which that particular type of steel must necessarily possess with a certain elastic limit.

PROSPECTIVE.

The manufacture of alloy steel tube stock has received great impetus in this country since the war began. In fact, many consumers in this country have learned that a high grade product of alloy steels can be obtained from the American steel makers. Steels which were formerly purchased abroad are now being produced by American manufacturers with satisfactory results. Therefore, the American steel maker, as well as the maker of finished articles heretofore imported, can hope to retain this trade, it having been fully demonstrated that American steels are equal in quality to the foreign steels.

The railroads have been far less active in the adoption of alloy steels than the automobile manufacturers, although during the past few years there has been on their part a greater realization of the merits of alloy steels effecting greater safety when operating at high speeds. The saving in weight in construction is a factor that the railroads cannot well overlook, as during the past few years the trend has been to tremendously increase the size of locomotives. This cannot be done without a decided increase in weight unless an alloy steel is used.

The first obstacle in securing a more universal acceptance of alloy steel by the railroads has been the lack of preparedness on their part to properly heat treat. The writer wishes to make himself clear on this point in particular, namely, that an alloy steel without heat treatment is but little better than a carbon steel, and in some cases more dangerous. Sound business principles should prompt the user to heat treat in order to obtain the maximum efficiency for which the consumer pays the additional cost for alloy above carbon steel. Proper heat treatment will in many alloy steels approximately double the static strength and will at the same time produce a higher degree of ductility. Railroad shops as a rule are woefully lacking in proper equipment for heat treatment, and until they provide furnaces of close and uniform operation and control, dependable heat measuring apparatus, suitable quenching facilities and mechanical methods of handling the material, it will be impossible for them to realize to the fullest extent the degree of superiority of the alloy steels over the carbon steels.

The steel maker can furnish the axles, side rods, and other forgings, heat treated and rough turned, finished or ready for finishing, but he can only furnish such parts which are not in the course of manufacture subjected afterward to any hot work, and parts where no greater hardness than is consistent with good machining is essential. A proper heat-treating equipment would be of great service to the railroads also in the rebuilding or repairing their present rolling stock with durable alloy steels.

FUTURE OF ALLOY STEELS.

The writer predicts that the next few years will show a greatly increased demand for alloy steels from the manufacturers of railroad equipment, machine tools, engines, mining machinery, farm tractors, aeroplanes, etc. Alloy steels will also occupy a larger field in marine construction, particularly in submarine work.

The aeroplane manufacturers are already calling for the highest grade of electric furnace alloy steels. If we review the wonderful development of aeroplanes in the last few years we can readily get a better idea of the greater possibilities in the future.

The field for the development of the tractor engine offers one of the attractive American manufacturing possibilities. The successful development of tractor engines in a large measure will depend on the increased use of alloy steels so that the tractor may be lighter in weight and stronger in construction.

Many other manufacturers have up to this time overlooked the great possibilities in the use of alloy steels in their products. There is a wide field for development.

GENERAL CONCLUSIONS.

The experience of alloy steel makers during the past seven years shows a steadily decreasing cost of production and a decreasing selling price due to many changes in manufacturing methods. Some mills which are now specializing in alloy steels have developed as the result of their experience methods of manufacture which are quite dissimilar in many phases to the manufacture of common steels. The waste product has been greatly reduced, this having been accomplished by the reclaiming of material which was formerly rejected. Heretofore the practice was to discard a very large percentage of the heat which resulted in high cost of production. Economical methods put into effect resulted in a higher quality of steel and a better practice. While chipping, grinding and reclamation of steel in other ways entail a higher cost per ton for the making of the steel, they have resulted in ultimate decreased cost and cleaner billets, producing not only a greater yield of bars but a finished material free from defects and imperfections. This is beneficial not only to the consumer but also to the manufacturer, who, by conscientiously cleaning his stock, is assured that the material will remain sold and give satisfaction.

Citing my company for example, rejections by the trade during the past seven years have declined very materially; that is, from 5 to 10 per cent seven years ago until during the past few years average rejections have been less than 0.5 per cent.

Lower costs are due also to decrease in cost of some of the alloys, as, for instance, ferro-vanadium, and to lower cost in heat treating, because of the greater amount being treated, together with improved design in furnaces to facilitate handling the stock. Lower selling prices will generally result in the further expansion of tonnage.

THE ELECTRIC FURNACE.

The perfection of the electric furnace for steel melting has enabled the manufacturer to duplicate by this method many steels which were formerly made in the crucible, and at a reduced cost. There is a large opportunity for introduction of such steels for use where the excessive cost of machining necessitates an absolute minimum of rejection, and which steels cannot be made successfully in the open-hearth furnace. This is especially applicable to parts where under rigid inspection minute defects cause rejections.

The advancement made in the manufacture of alloy steels in recent years is a tribute to the steel makers and speaks for the progress, the increased efficiency and years of hard work on the part of the steel manufacturer necessary to accomplish this result. From one point of view this remarkable efficiency of practice is a greater achievement than some of the metallurgical successes in the field of alloy steels. It is a homely story of human effort which is only fully appreciated by the steel manufacturer.

ACKNOWLEDGMENT.

The foregoing paper was presented before the Cleveland meeting of the American Iron and Steel Institute by Edgar D. Rogers, general sales manager, United Steel Co.

Cost of Drilling Anchor Bolt Holes for Quebec Bridge.

(Staff Article.)

The following is a detailed statement of the cost, for labor and material, of drilling the anchor bolt holes for the Quebec Bridge. The holes were drilled with a "Calyx" core drill, the diameter of the drill being 4½ ins. and that of the core 3⅜ ins. The number of holes drilled was 176, and the number of linear feet drilled 800, or an average of about 4.6 ft. per hole. The holes were drilled through solid granite. The costs given include every item except power for operating the drills, the drills being driven by a 5-hp., alternating-current, electric motor. It will be noted, from the following data, that the cost of drilling, including equipment but excluding power, was $2.50 per linear foot.

LABOR.	
Dougherty, at north shore	$ 263.60
White, at north shore	238.25
Brown, at north shore	16.50
Mooney, at north shore	51.80
Raymond, at north shore	72.10
Dougherty, at south shore	291.80
White, at south shore	285.40
Total labor	$1,219.45
Traveling expenses, Dougherty	40.22
Total	$1,259.67
MATERIAL.	
Calyx shot drill	$ 450.00
Belting, 12 ft. 3 ins.	1.76
Shot, 2,000 lbs.	100.00
Express on shot	3.00
Drill spindle, 4 ft. x 6 ins. long, one	22.85
Shot feed complete, one	4.50
4-in. shot bits, eighteen	117.00
1-in. stop cocks, two	1.86
4-in. core barrel plug, one	15.50
4-in. x 2-ft. core barrels, two	16.00
16-ft. 3 in. betting and rivets	9.53
Total material	$ 742.00
Total labor and material	$2,001.67

SEWERAGE AND SANITATION

Recent Results of Experiments on the Purification of Sewage by Aeration in the Presence of Activated Sludge, at the University of Illinois.

Contributed by Edward Bartow, Director, and F. W. Mohlman, Assistant Chemist, State Water Survey, University of Illinois, Urbana.

Since reporting the results of our preliminary work (see ENGINEERING AND CONTRACTING, April 7, 1915) experiments on the purification of sewage by aeration in the presence of activated sludge have been conducted on a larger scale. Four reinforced concrete tanks have been completed and put in operation. These tanks operating on the fill and draw system (see the accompanying cut for design details) are designed for studying in a comparative manner the amount of air required, the best method for distributing the air, the time required for purification, and the quantity and quality of activated sludge formed.

The tanks are located in the basement of the University power plant. The room is not affected by heat from the boilers and conditions are similar to those which would be obtained by housing a plant.

It was very easy to tap the city of Champaign main sewer which passes underneath the coal hopper of the power plant. The sewage is pumped to the tanks by a 2 HP. centrifugal pump run by a direct connected motor.

Each tank is 3 ft. 2 ins. square, having an area of 10 sq. ft. Each tank is 8 ft. 5 ins. in depth above 1⅛ in. Filtros plates which are used for diffusing the air. In two tanks there are nine plates, each 12 ins. square, covering the entire floor. In the third tank there are three plates, covering one-third the area of the floor, forming the bottom of a central trough. The remainder of the bottom slopes to the plates at an angle of 45°. In the fourth tank is a single plate in the center covering one-ninth the area with the bottom sloping to it at an angle of 45° from all sides. Below the plates is an air space 4 ins. deep. A pet cock is provided to relieve the air pressure when draining the tank and to prevent air bubbles from rising and stirring up the sludge. The air obtained from the University compressed air plant at a pressure of 80 lbs. is reduced by a pressure reducing valve to 8 lbs. and is further regulated by a hand operated valve before passing through meters on each tank. The pressure under which it enters the tank is sufficient only to overcome the pressure of the sewage, equivalent to about 8 ins. of mercury or a little less than 4 lbs. per square inch.

Two outlets for the effluent are respectively 2 ft. 6 ins. and 5 ft. 7 ins. above the porous plates. A tank can be filled in six minutes and drained to the lower outlet in eight minutes.

Experience has shown that a lower outlet connected to a floating outlet would be preferable. A fixed outlet is objectionable because sludge is at times drawn out with the effluent. In fact, no accurate data have been obtained concerning the quantity of sludge formed, because we have been unable to determine how much has been lost with the effluent. In order to prevent this loss, a floating outlet made of 2-in. pipe connected together with loose joints, has been placed in tank C. The effluent flows to the outlet through a screen of copper wire of about 16 mesh, which is fastened on both sides of an iron frame one foot square. With this arrangement no sludge has been lost and we expect to obtain accurate data concerning the amount of sludge formed from the sewage.

The amount of sludge must be determined by weight on the dry basis, for it has been noted that its volume and rate of settling varies with the amount of air applied. If an unusually large amount of air has been applied, the sludge will settle more slowly and will occupy a much greater volume even after prolonged settlement, than it does when less air has been applied.

Building Up of Sludge.—If, in accordance with previous practice, activated sludge is built up by complete nitrification of each portion of sewage added, it would require several weeks to put a plant in operation.

In order to obtain sludge more quickly the English investigators have used sludge from sprinkling filters. At Milwaukee, Imhoff tank sludge has been aerated until it is aerobic and similar to activated sludge. Such a source of sludge would not be available in many places, especially at newly installed plants. We have attempted to shorten the period of sludge formation.

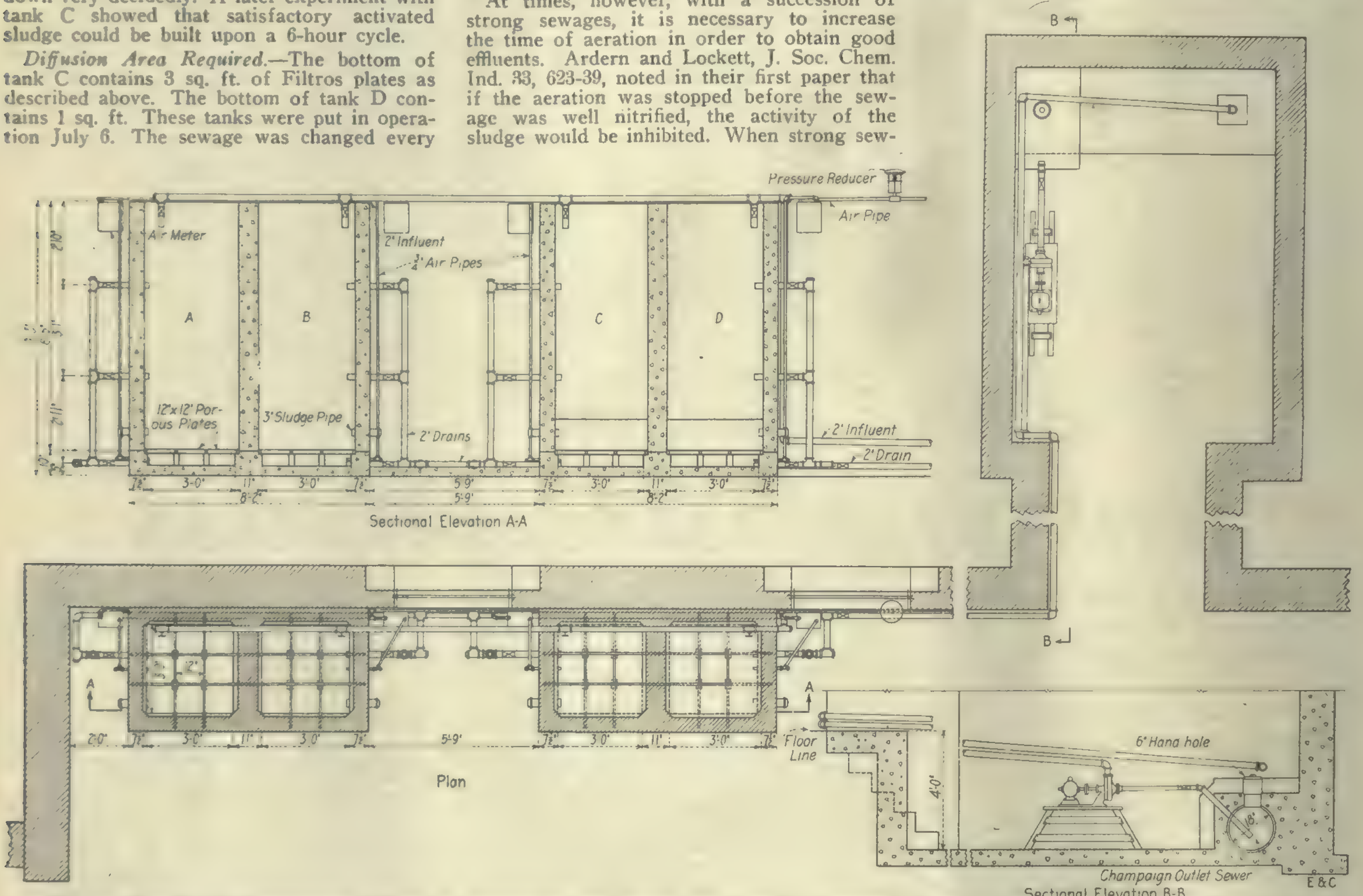
Tanks A and B were filled with the same kind of sewage on May 5, 1915. The sewage in tank A was aerated continuously. The sewage in tank B was aerated 23 hours, allowed to settle, the supernatant liquid withdrawn and refilled with fresh sewage in one hour. This cycle was repeated daily. Determinations of the amount of sludge and of the degree of purification were made daily.

At the end of 10 days, after one hour's settling in Imhoff cones, 1 per cent of the volume in tank A consisted of sludge while about 10 per cent of the volume in tank B was sludge. The effluents from tank A, which had been aerated 10 days, and from tank B, which had been aerated one day, were equally stable, while that from tank B was clearer.

Tank B was continued in operation, changing the sewage every 24 hours, until, after 15 days, nitrification was complete. Then the sewage was changed every 12 hours; nitrification was again complete after 8 days, then the sewage was changed every 6 hours. Many of the effluents with the 6-hour cycle were putrescible and it is necessary at intervals to aerate for longer periods. This comparison indicates, however, that sludge may be satisfactorily activated by changing the sewage before nitrification is completed, and that the sewage may be changed at frequent intervals.

Tank A was, therefore, cleaned and fresh sewage added every 12 hours. Stable effluents were obtained in 7 days; complete nitrification occurred in 18 days, after which the sewage was changed every 6 hours. The effluents obtained from the tanks during this 6-hour cycle were not all stable, yet the average improvement was so great that the conclusion is reached that activated sludge may be built up by changing sewage at frequent intervals without complete nitrification of each dose of fresh sewage. A considerable degree of purification is also obtained from the beginning of the operation, and the time for building up adequate sludge for the process is cut down very decidedly. A later experiment with tank C showed that satisfactory activated sludge could be built upon a 6-hour cycle.

Diffusion Area Required.—The bottom of tank C contains 3 sq. ft. of Filtros plates as described above. The bottom of tank D contains 1 sq. ft. These tanks were put in operation July 6. The sewage was changed every six hours. There was a noticeable difference in the working of these tanks. Tank C gave some stable effluents after 5 days. Tank D did not give stable effluents in 18 days. The sludge from C was of good appearance, while that from D was not as flocculent and at times had a septic odor. During the comparative experiment an average of 450 cu. ft. of air per 400 gals. of sewage were used with tank C and of 360 cu. ft. of air per 400 gals. of sewage with tank D. The amount of air given tank D was always sufficient to keep the sludge mixed with the sewage. In fact, the sewage in tank D was agitated much more violently than that in tank C. We have concluded that 1 sq. ft. of Filtros plate per 10 sq. ft. of floor area is hardly sufficient. Of the four tanks, tank C with 3 sq. ft. of Filtros plate per 10 sq. ft. of floor area, has given the best results.



Design Details of Experimental Plant at University of Illinois for Testing Activated Sludge Process of Sewage Treatment.

We have noted that it is quite essential that the plates be as nearly as possible at the same level. A variation of ¼ in. in level will cause uneven air distribution. The distribution seems to become more uniform the longer the plates are used.

Quality of Effluents.—The quality of the effluents has usually depended more on the strength of the raw sewage than upon any other variable. The tanks, when operating on a 6-hour cycle, were filled at 9 a. m., 3 p. m., 9 p. m. and 3 a. m. The strength of the raw sewage, estimated by the free ammonia values, averages for the 9 a. m. sewage between 20 and 35 parts per million, for the 3 a. m. sewage between 3 and 12 p. p. m. Nearly all of the 3 a. m. sewages have given stable effluents, but the strong morning sewages have quite frequently given putrescible effluents. Unless the sludge is in good condition and well nitrified, a strong sewage cannot always be purified in 4½ hours even by increasing the air to 800 cu. ft. per 400 gals. In the normal working of the plant the sludge will usually regain its "activity" if 800 cu. ft. of air is applied for several periods after the strong sewage has been added.

At times, however, with a succession of strong sewages, it is necessary to increase the time of aeration in order to obtain good effluents. Ardern and Lockett, J. Soc. Chem. Ind. 33, 623-39, noted in their first paper that if the aeration was stopped before the sewage was well nitrified, the activity of the sludge would be inhibited. When strong sewages are to be treated a definite cycle of operation cannot be established without provision for longer aeration of the sewage or separate aeration of the sludge. In order to keep the sludge in its most active state, complete nitrification of each sewage is necessary. Effluents are usually stable if 50 per cent of the free ammonia is removed, and 2 to 3 p. p. m. of nitrogen as nitrates is present. A completely nitrified effluent is neither necessary nor economical.

The greatest efficiency in air consumption will be obtained when enough air is used to make the sewage non-putrescible and to keep the sludge activated. The operation of the plant during six months has suggested the advisability of studying more carefully such other features of the process as the amount of sludge formed, the building up of nitrogen in the sludge and the composition of the effluent gases.

Excavation on the Panama Canal in the seven days ending at 6 a. m., Nov. 2, amounted to 257,029 cu. yds., of which 236,549 cu. yds. were from the Culebra slides. In addition, 8,700 cu. yds. were rehandled.

Data and Discussion on the Value of Activated Sludge as a Fertilizer.

Activated sludge is an essential material and an important product in a new method of sewage disposal, which was first described by Ardern and Locket. See Jour. of Soc. of Chem. Ind. 33, 523-39; 1122-4 (1914).

At present, September, 1915, experimental plants are being operated at Baltimore, Md.; Chicago, Ill.; Cleveland, O.; Houston, Tex.; Milwaukee, Wis.; New York City; Regina, Saskatchewan; Urbana, Ill.; and Washington, D. C. At Baltimore a modified Imhoff tank is to be operated with continuous flow. At Milwaukee both fill and draw and continuous flow processes are being operated on an experimental scale, and a 2,000,000-gal. plant is under construction. At Cleveland a 1,000,000-gal. plant is to be built. At Urbana an experimental plant of 6,000 gals. capacity is being operated on the fill and draw system.

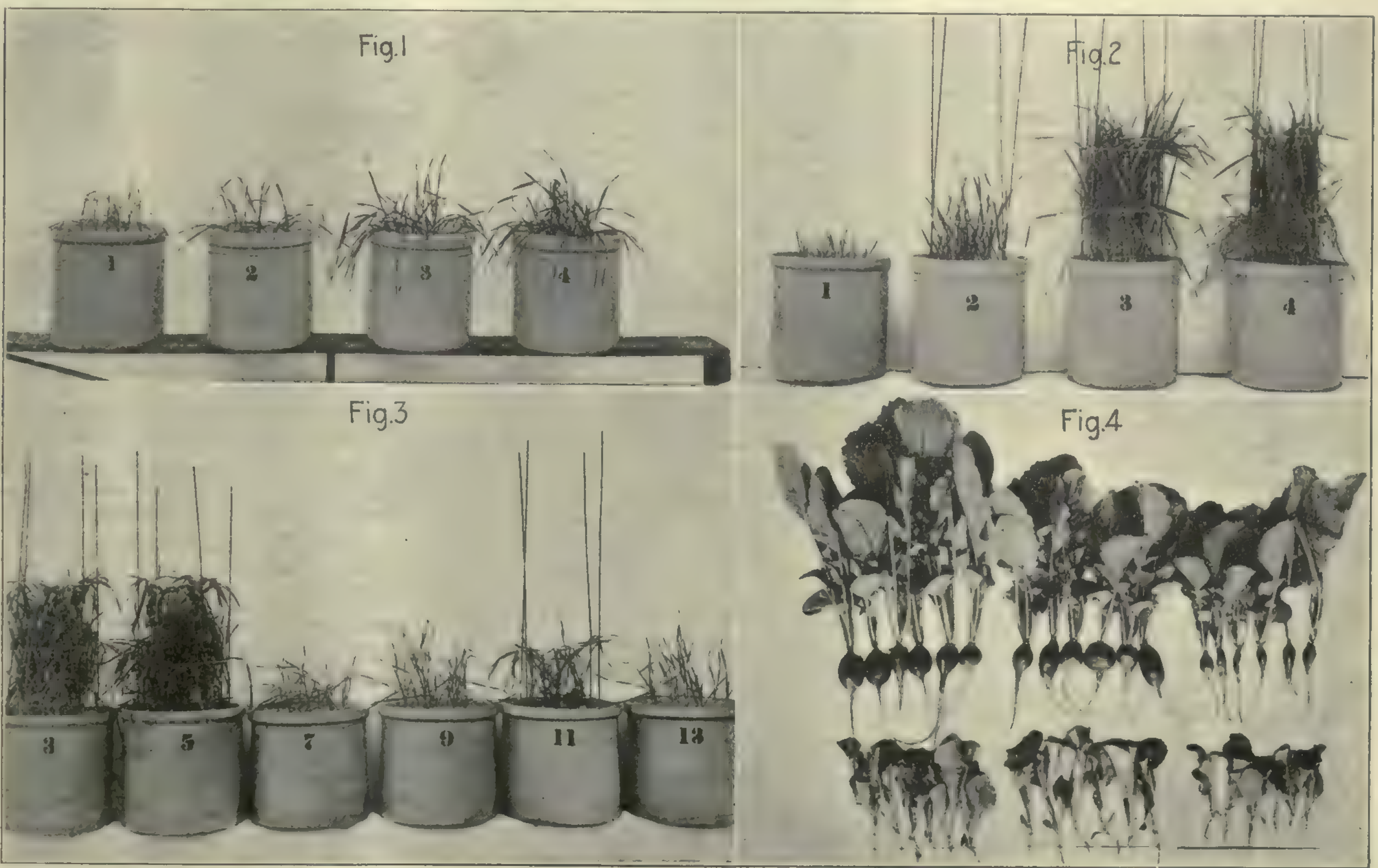
As in other sewage disposal processes, the ultimate disposal of the sludge is of great importance. Near the seaboard it is possible to carry this sludge out to sea, but in the interior, the problem of sludge disposal is often very serious.

In the experimental plant at the University of Illinois in Urbana, we have tried to study all phases of the process (see ENGINEERING AND CONTRACTING of April 7, 1915, and this issue), and have paid especial attention to the sludge.

The amounts of sludge formed and its chemical composition evidently vary with the concentration of the sewage, and with temperature conditions. The sewage treated in the experimental plant during rainy weather contains large amounts of diluting water, which reduces the amount of sludge per unit of water. The diluting water carries considerable dirt from the streets which reduces the nitrogen content of the sludge obtained. Also during warm weather, bacteriological action is more rapid, and apparently the amount of sludge is considerably reduced.

The sludge obtained in the process is flocculent, resembling a freshly formed precipitate of ferrous-ferric hydroxide. It separates easily from the clarified water, and after one hour's settling contains from 96 to 98 per cent of moisture. On further standing, about one-half of this water can be removed. The remaining material can be dried by filter pressing or by drying on beds of sand and evaporating over steam baths.

Experiments with the worms found in the wet sludge (ENGINEERING AND CONTRACTING, April 7, 1915), have proved that they are not essential to the purification process. Nitrifying bacteria, and bacteria which have the power of destroying organic matter, have been isolated from the sludge. The nitrifying bacteria alone will not purify sterile sewage. A combination of the nitrifying bacteria with the other varieties will purify sterile sewage very satisfactorily.



Figs. 1-4. Illustrations of Value of Activated Sewage Sludge as a Fertilizer in Pot Cultures of Wheat and Gardening Experiments with Radishes and Lettuce. Experiments Made at the University of Illinois by the Experts of the Illinois State Water Survey.

Fig. 1. Pot Cultures of Wheat 23 Days After Planting. Each pot contains pure white sand to which the same amount of plant foods except nitrogen have been added. No. 3 contains 20 g. dried activated sludge. No. 4 contains the same amount extracted with ligroin. No. 2 contains an equivalent of nitrogen from dried blood, and No. 1 contains no nitrogen. Fig. 2. Pot Cultures of Wheat 63 Days After Planting. Each pot contains pure white sand to which the same amount of plant foods except nitrogen have been added. No. 3 contains 20 g. dried activated sludge. No. 4 contains the same amount extracted with ligroin. No. 2 contains an equivalent of nitrogen from dried blood, and No. 1 contains no nitrogen. Fig. 3. Second Series of Pot Cultures of Wheat 35 Days After Planting. Each pot contains pure white sand to which the same amount of plant foods except nitrogen have been added. No. 3 contains 20 g. dried activated sludge. No. 5 contains 20 g. of dried activated sludge from which other soluble matter has been removed. No. 7 contains the nitrogen equivalent from sodium nitrate. No. 9 contains the nitrogen equivalent from ammonium sulphate. No. 11 contains the nitrogen equivalent from gluten meal. No. 13 contains the nitrogen equivalent from dried blood. Fig. 4. Gardening Experiment 38 Days After Planting. Radishes—From left to right, six radishes fertilized with extracted sludge, six radishes fertilized with sludge, six radishes unfertilized. Lettuce—Six heads fertilized with extracted sludge, six heads fertilized with sludge; six heads unfertilized.

The disposal of the sludge can be most easily accomplished if it has manurial value. That activated sludge has manurial value is shown by its chemical composition, by its reaction with various soils, and by its effect on the growth of plants. Specimens of sludge obtained at the experimental plant have varied in nitrogen content from 3.5 to 6.4 per cent. The lower values were obtained during periods of high water. Street wash was getting into the sanitary sewers and since no grit chamber was provided to remove the grit, the nitrogen value of the sludge was greatly lowered. The tests of the fertilizer value have been made on the richer specimens which were first obtained.

Through the courtesy of Mr. Paul Rudnick, Chief Chemist, Armour & Co., Chicago, the availability, according to alkaline permanganate method as used by the New England states was shown to be below 50 per cent (44.7%) and the sludge would be classed as an inferior ammoniate, but the availability according to the neutral permanganate method which has been adopted by the southeastern states was shown to be above 85 per cent (89.0%) and would therefore be classed as satisfactory.

Tests have been made by Professor C. B. Lipman, according to a method described by Lipman and Burgess (see Univ. of Calif. Bull. 251, 1915) in which a fertilizer and a soil are incubated for a month. The amount of nitrogen changed into nitrate is then determined. This amount is an index of the availability of the nitrogen with respect to the soil used. The results obtained were reported by Professor Lipman as follows:

The activated sludge used contained 6.2 per cent total nitrogen and no nitrate. The 100 grams of soil in every case contained nitrate as follows:

	Milligram nitrogen.
Anaheim soil	1.0
Davis soil	.3
Oakley soil	.1

The amounts of nitrate produced in one month's incubation from the soil's own nitrogen and from the nitrogen of the sludge mixed with the soil in the ratio of one part of sludge per hundred of soil is as follows:

	Milligrams nitrate produced.
Anaheim, without sludge	6
Anaheim, with sludge	10
Davis soil, without sludge	4.2
Davis soil, with sludge	14
Oakley soil, without sludge	2.2
Oakley soil, with sludge	4

The Davis soil is the best nitrifying soil of the three, especially for high grade organic material. Anaheim is next, and the Oakley by far the poorest. Indeed, the last named does not nitrify in a period of a month in the incubator the nitrogen of dried blood at all.

These figures indicate that the general tendency is to make available the nitrogen of sludge in type soils at about the same rate that nitrogen is transformed into nitrate in such organic, nitrogenous fertilizers as fish guano. While it seems to hold a medium position, it nevertheless resembles very much more closely in its general characteristics, so far as available nitrogen is concerned, the so-called high grade organic nitrogenous fertilizers, dried blood and high grade tankage, etc., rather than the low grade nitrogenous fertilizers, steamed bone meal, cotton seed meal, garbage tankage, etc.

Although the chemical tests and the nitrification tests with soils indicate that the activated sludge has a high fertilizer value, the final test must be its effect on plant growth. Pot cultures, using wheat, were started in March, 1915, (see ENGINEERING AND CONTRACTING of April 7, 1915), under the general direction of Prof. C. G. Hopkins and with the assistance of Mr. J. C. Anderson. The contents of the pots in which the wheat was planted were as given in Table I.

Each pot contained an equivalent of 5 tons per acre of dolomite, ½ ton per acre of bone meal, and 500 lbs. per acre of potassium sulphate.

Pot 1, the check pot, contained only 60 milligrams of nitrogen which were added in the bone meal. This small amount was without significance since the same amount was

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added to the other pots. Pot 2 contained an equivalent of 120 lbs. of nitrogen per acre added in the form of dried blood. Pots 3 and 4 contained an equivalent of 120 lbs. of nitrogen in the form of dried activated sludge (one ton of sludge) per acre. Following is an analysis of the sludge used:

TABLE I.—CONTENTS OF POTS USED IN WHEAT CULTURE.

Pot number	1 Grams.	2 Grams.	3 Grams.	4 Grams.
(1) White sand	19,820	19,820	18,820	19,820
(2) Dolomite	60	60	60	60
(3) Bone meal	6	6	6	6
(4) Potassium sulphate	3	3	3	3
(5) Activated sludge	0	0	20	0
(6) Extracted sludge	0	0	0	20
(7) Dried blood	0	8.61	0	0

	Per cent.
Total nitrogen	6.3
Phosphorous (P_2O_5)	2.69
Ether soluble (3 hrs. extraction)	4.00
Ether soluble (16 hrs. extraction)	11.8

Thirty wheat seeds were planted, 2 seeds in each of 15 holes, in each pot. In four days the plants were up in each pot and in 10 days were 5 ins. high. At the end of 18 days the plants were thinned to 15 of the best in each pot, in most cases leaving one plant to each hole. In 20 days from date of planting there was a marked showing in favor of the plants in pots 3 and 4. In 23 days the plants in pots 3 and 4 (see Fig. 1) were growing far ahead of 1 and 2.

TABLE II.—AMOUNTS OF WHEAT AND STRAW OBTAINED IN THE FIRST SERIES.

Pot number	1	2	3	4
No. of heads	14	15	22	23
No. of seeds	85	189	491	518
Weight of seeds	2.38 g.	5.29 g.	13.748 g.	14.504 g.
Bushels per acre (calculated)	6.2	13.6	35.9	37.7
Average length of stalk	19.4 in.	23 in.	35.4 in.	36.1 in.
Weight of straw	2.25 g.	8.25 g.	26.75 g.	26.21 g.
Tons per acre (calculated)	0.18	0.68	2.25	2.18

The plants in pot 2 fertilized with the same amount of nitrogen grew much slower than those in pots 3 and 4. The reason for the poor showing of the plants in pot 2 is not known.

In 30 days a slight brown mold appeared on the larger plants, which may have been due to the dark, damp weather. Powdered sulphur was used to fight it.

During the fifth and sixth weeks the plants in the pots fertilized with the sludge, which had grown fully three times as large in height and in the amount of foliage as those in the pot fertilized with dried blood, began to yellow. About half of the foliage died, leaving two healthy stalks to each plant. The plants possibly grew so fast, at first, that all the foliage which had started could not develop. The remaining stalks immediately grew stronger and of a deeper blue green color. After nine weeks the plants were strong and healthy. (See Fig. 2.)

In 14 weeks the plants in pots 3 and 4 began to head and in 15 weeks there were about 20 good heads in each. The plants in pot 1 were very weak, while those in pot 2 were just beginning to develop heads.

When it was first noticed that the plants fertilized with sludge were growing much better than those fertilized with dried blood, in order to confirm the results, a second series of pot cultures was started. In this series the sludge was compared with dried blood, nitrate of soda, ammonium sulphate and gluten meal. This series contained 14 pots, 2 check pots, 6 containing nitrogen equivalent to an application of 20 grams of sludge, and 6 containing nitrogen equivalent to 30 grams of sludge. The plants in this series grew faster than those in the first because of better weather. They showed exactly the same characteristics that the plants in the other series showed. The plants fertilized with sludge were the best. The results confirmed the results obtained in the first series. At the end of five weeks striking differences were noticeable. (See Fig. 3.) The pots containing the equivalent of 30 grams of sludge gave no better results than those with an equivalent of 20 grams.

When the wheat matured it was carefully harvested and calculations made to determine the yield per acre. The results are shown in Table II.

The control series gave results corresponding to those of the first series.

The surprisingly rapid growth of the wheat fertilized by the sludge must be due for the most part to nitrogen present in a very available form. It may be due in part to the phosphorus (2.69 per cent) which is present in the sludge. At the time of making the pot cultures we did not consider the phosphorus, since it was present in such a small quantity. The growth may be due in part to the organic matter present in the sludge, since the sand used contains no organic matter. The cause of the molding of the leaves has not yet been determined. It was quite noticeable that the mold appeared chiefly on the leaves of rapid growing plants. In the first series it attacked only plants fertilized with sludge. In the second series it also attacked the plants fertilized with gluten meal. The rapid growing leaves are naturally more tender than those which grow slowly and consequently are more easily attacked by mold spores. The mold evidently does not come from the sludge because the extracted sludge surely would be sterile, and plants fertilized with it showed the same mold. Plants fertilized with gluten meal also had the mold.

The sludge causes such a rapid growth of wheat that it should be valuable to truck gardeners, to rush the spring crops. To test its value to the market gardener, three plots each 2 ft. by 3 ft. were laid out in a field. One plot was not fertilized, one was fertilized with an equivalent to 126 lbs. of nitrogen, one ton of sludge per acre, and the third with an equivalent of extracted sludge. On April 24, 1915, two rows of radishes and lettuce were planted in each of the three plots. The plants in the plot where the extracted sludge was used, came up first, a little ahead of those in the plat where the unextracted sludge was used. At the end of two weeks the lettuce and radishes of the treated plots appeared to be twice the size of those in the untreated plot. At the end of four weeks the plants were thinned. The roots of the radishes from the treated plots were already red and quite rounded near the tops, while those from the untreated plots had not yet started to swell and had not become red. The lettuce plants from the treated plots were nearly twice as large as those from the untreated plots.

On June 1, 38 days after planting, the six best plants of lettuce and radishes were taken from each plot. (See Fig. 4.)

The difference in sizes were very marked, as shown by Table III.

The increase in weight, due to the sludge, is 40 per cent in the lettuce, and of 150 per cent in the radishes. The radishes from the sludge pots when cut open and eaten were found to be very crisp and solid, and to have a good flavor. They were weighed.

TABLE III.—COMPARISON OF THE LETTUCE AND RADISHES FROM UNFERTILIZED AND FERTILIZED PLOTS.

Plot.	Treatment.	Wt. of lettuce.	Wt. of radishes.
1	None	4.5 g.	23.4 g.
2	Sludge	6.3 g.	63.0 g.
3	Extracted sludge	6.8 g.	68.0 g.

These pot cultures and gardening experiments show that the nitrogen in "activated sludge" is in a very available form and that activated sludge is valuable as a fertilizer.

ACKNOWLEDGMENT.

A paper presented at the 51st meeting of the American Chemical Society, Seattle, Wash., by Edward Bartow, Director, and W. D. Hatfield, Assistant Bacteriologist, State Water Survey, University of Illinois.

First Annual Meeting Iowa Section American Water Works Association.

The first annual meeting of the Iowa Section of the American Water Works Association will occur Friday and Saturday, December 3 and 4, at the State University of Iowa. From 10 a. m. Friday until 12 m. Saturday the program indicates continued rapid firing at some of the water works problems of Iowa. A special feature, of unusual interest because of the close connection between sewage disposal and the purity of water supplies, will be the illustrated paper Friday evening on "The Latest Method of Sewage Disposal," by Dr. Edward Bartow, Director of the State Water Survey of Illinois. The Iowa Section is extending to all interested city officials, water works men, engineers, and friends a cordial invitation to attend its sessions.

The Lighter Side of Engineering and Contracting

The Little Sheep Was to Blame.

BIG RILEY, of Clapp, Nostrom & Riley, owns a few thousand acre farm. One day not long ago when he was sitting on the front porch of the farm house, wondering what was going on in South Canal St., a tramp came along and asked for a job. "I'm from Chicago," said the wayfarer. "I've never been in the country before and I thought I'd like to work on a farm." "From Chi," said Riley. "What's happened to Canal St. since yesterday? You bet I'll give you a job. Go and drive those sheep into the pen and then come back here and my foreman will tell you what to do next." The man went away and in about three hours came back to the porch. He was wet with perspiration and so tired he could hardly stand up. "What the deuce is the matter with you," inquired Riley, "have you been all this time getting those sheep into the pen?" The man leaned weakly against the post. "Sure, I have," he replied. "I had the devil of a time with a little sheep." "Lamb," said Riley, in surprise, "there wasn't any lambs with that flock." "Come out and see," insisted the man. They went to the pen, which was enclosed by a high, close wire fence. Darting wildly around the enclosure was a big jack rabbit. The man pointed at it. "There," said he, "that's the little sheep that gave me all the trouble. I chased him more'n 17 miles before I could get him in."

Where He Lit.

ONE of the foremen on a second track job on the Erie had his home in a nearby town. He came to work each morning on an express train, which slowed down sufficiently for him to drop off safely. One day, however, the engineer forgot to slow down and the train dashed through the cut at about 60 miles per hour. The contractor noticed this and remarked to his superintendent that they would have to get along without Danny for a while. Somewhat to their surprise a much battered looking figure showed up on the job. "Great guns," said the super, "where did you get off?" Danny turned stiffly and pointed with a trembling hand to the right of way as he said, "All along there."

Branding Bees.

FRANK Gilbreth, the efficiency expert, who recently made a trip through the fighting zone of Europe, brought back this story. An old Scotch farmer came up to a government official and asked him what he should do in case of an invasion by the Germans. The official told him. "An hae I reely tae dae this wi the beestes?" said the old fellow at the finish. The official informed him that the law was: "All live stock of every description must be branded and driven inland." "Weel, weel," said the Scotchman. "I'm thinkin' I'll hae a devil o' a job wi ma bees."

Uncalled for Profanity.

"THE man who could not tell a lie" must have been near kin to a transitman who tarried with us for a brief season some years ago. We were running through heavy timber and dense underbrush and the trail cut by the bushwhackers like other straight and narrow ways was oft beset with pitfalls. One day as our hero with his transit came down one of the leafy aisles, en route to the next turn, his foot slipped and a nearby pine received some awful punishment. He got slowly and painfully to his feet, noted the bent circle, broken compass box, and other ailments of the transit, then muttered hoarsely, "Oh Shoot on the Luck." H. T. J., Salt Lake City, Utah.

His Salary Was Raised.

SOME 25 years ago a promoter, whom many persons think was the original Col. Mulberry Sellers, was trying to build a railroad with hot air. A rotund gentleman, called by common consent the major, had sat around in the promoter's office for several months, supposedly acting as general bookkeeper, and with the expectation of becoming the auditor of the railroad when it got on its feet. Col. Mulberry, having been east in pursuit of funds, pay days being unknown meanwhile, at last appeared with an engineer sent out by some prospective investors to make a report on the project. Before the Colonel got away again, the Major cornered him and begged for lucre. "For God's sake, Colonel, let me have just a little money," pleaded the prospective auditor. "It's winter and the hotel is about to turn me out on account of the unpaid board bill." "Major," says the Colonel, "it really grieves me more than you can think that I can't let you have even $5; but I've got to go back east with the engineer and of course I've got to travel first class and I've only got a $20 bill to go on and how I'm going to get there God only knows. But I've got to make 'er someway. But I appreciate greatly what you've done for me (the Major hadn't done a blame thing, for the Colonel hadn't even got around to buy him a set of books to keep)—and from now on I'm going to raise your salary $25 per month." E. K. B. Seymour, Mo.

The Joy of Rediscovery.

NOT the least interesting characteristic of the well-known human race is its bent for and joy in the rediscovery of old truths. Thus, as said Tom Reed, one of the greatest charms of the redoubtable T. R. is "his enthusiasm over his own discovery of the Ten Commandments." A few decades ago the public service corporations said: "The public be damned." Now they say: "The public be pleased." The latest development along this line is the Harmony Special Train on the Santa Fe. The officials of the road ride along the line making frequent stops to meet the people. "We tell them our troubles and listen to theirs," says President Ripley. Perhaps the wise old psalmist had the same thing in mind when he wrote: "The man who would have friends must show himself friendly."

Expected Too Much.

W. H. McCADDEN, of Memphis, Tenn., secretary of the Roach, Mannigan Paving Co., spends much of his time visiting the various jobs of his company. One time not long ago he was in a small city where the leading hotel was not exactly on a par with the La Salle of Chicago. Along toward midnight a couple of mice began a desperate combat in McCadden's rooms. He stood it for a while and then called up the clerk. "Huh," said the clerk, "a mouse fight; what room you got?" McCadden told him, and then clerk inquired, "What are you paying for it?" "Two dollars," was the reply. "Well," said the clerk, "what do you expect for $2—a bull fight?"—and then he hung up the receiver.

Why Sam Didn't Get the Water.

IN a Southern State some months ago the chief engineer ordered Sam, a coal black negro, to go down to the creek and get some good water to use for cooking; water fit to drink. Sam departed with a pail in each hand.

Soon; hatless, empty handed, breathless and almost white, Sam, panting, stood before the engineer.

"Why, what's the matter, Sam?"

"Boss! Thar's an alligator down thar. Clare to goodness! Looking right at me, wif his mouth wide open."

"Sam, you go on back and get that water. That alligator is just as scared of you as you are of him."

"Lordy, Boss! If that 'gator is half as scarred of me as I is of him I just know that water ain't fittin to drink."—E. F. K., Topeka, Kas.

Revising the Motto.

A RECENT visitor at the Panama Canal brings back the interesting information that the motto, "Life is one d— thing after another," adorning the wall of Major Goethal's office, now reads, "Life is one d— slide after another."

Skinner Mulvey says: I'm going to swear off drinking. Hereafter I won't take a drink except when I am alone or with somebody. It's going to be a cold winter. I know it because my red flannels are thicker than usual.

CURRENT NEWS

The Doings of the Week.

The weekly trade reviews of the commercial associations indicate that business expansion is now near a record. Commercial transactions for the past week were at a volume not heretofore exceeded. Bank clearings were 20 per cent in excess of those for the corresponding week of last year and well above the total in 1913. The railroads continued to show net gains in earnings. October reports for the Union Pacific disclosed a net increase of $836,000 for the month; the Santa Fe System gained $136,000. One important feature of the week was the organization by the National City Bank and its associates of a $50,000,000 company for the development of enterprises in foreign countries. The Baltimore & Ohio R. R. completed the sale of $60,000,000 of refunding and general mortgage bonds. This is the largest issue of American railroad bonds announced for some time. Of more significance, perhaps, is the tentative sale by the Atchison, Topeka & Santa Fe Ry. of 100,000 shares of preferred stock. In the construction field there has been considerable activity despite the lateness of the season. Several large jobs for private concerns were placed under contract and a few big public improvements came up for advertising for bids. A considerable amount of municipal work is projected for letting early next year. In the Metropoltan District of New York there was a general stiffening of prices of building materials. In the steel and iron trade there was a notable accumulation of forward work at the furnaces, rolling mills and allied branches. *The Iron Age* prices for finished iron and steel, and for sheets, nails and wire for the week ending Nov. 24 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Nov. 24. Cts.	Nov. 17. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.859	1.759
Iron bars, Pittsburgh........	1.65	1.60
Iron bars, Chicago...........	1.60	1.50
Steel bars, Pittsburgh.......	1.70	1.70
Steel bars, New York........	1.869	1.869
Tank plates, Pittsburgh......	1.90	1.70
Tank plates, New York......	2.169	1.869
Beams, etc., Pittsburgh......	1.70	1.60
Beams, etc., New York......	1.869	1.769
Skelp, grooved steel, P'gh....	1.70	1.60
Skelp, sheared steel, P'gh....	1.80	1.70
Steel hoops, Pittsburgh......	1.75	1.75
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.40	2.25
Galv. sheets, No. 28, P'gh....	4.25	4.00
Wire nails, Pittsburgh......	1.90	1.90
Cut nails, Pittsburgh........	1.85	1.80
Fence wire, base, P'gh......	1.75	1.75
Barb wire, galv., P'gh........	2.75	2.75

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.70 cts. to 1.90 cts.

Railways.—Conditions in the railway field are more encouraging at present than they have been for months. While no large construction jobs appear to be slated to come in the immediate future, there are good indications that the railroads are seriously considering undertaking a considerable amount of work. The sale by the Baltimore & Ohio of $60,000,000 of 5 per cent refunding and general mortgage gold bonds and the tentative sale by the Santa Fe System of 100,000 shares of stock indicate a decided improvement in the demand for railway securities. Part of the Baltimore & Ohio issue will be used to retire $40,000,000 of notes and the remainder will go for improvements under way or contemplated. The New York, New Haven & Hartford R. R. will start construction shortly on a $2,500,000 bridge. This company also placed orders last week for $3,000,000 worth of equipment. The contracts let recently include the following: List & Gifford Construction Co., Kansas City, Mo., lowering grade and filling trestle on White River branch of Iron Mountain R. R.; Read Construction Co., Hazleton, Pa., construction of Cumberland & Manchester Ry. in Kentucky; J. W. McMurray Contracting Co., Kansas City, Mo., 4,000 ft. of revetment for Frisco R. R.; L. J. Smith Construction Co., Kansas City, Mo., reconstruction of 23 miles of Gulf & Interstate R. R. in Texas for Santa Fe System.

Roads and Streets.—The principal road letting of the week appears to be that of Road District No. 1 of Clarksville, Tex. This district is calling for bids for a system of highways estimated to cost $300,000. The State Highway Commissioner of Washington opens bids Dec. 20 on road construction to cost about $120,000. The city of Ontario, Cal., is asking proposals on about 55,000 sq. yds. of concrete pavement. Pittsburg, Kan., awarded a $35,176 repaving contract, and Huntington Beach., Cal., let work to cost $81,481. Bids were opened Nov. 23 by the city of Philadelphia, Pa., for street work to cost over $300,000. Mason City, Ia., will let contracts next month for street improvements to cost about $500,000. Bids will be asked about Jan. 1 by Freeholders of Sussex County, New Jersey, on a $85,000 road job.

Bridges.—Several large private bridge developments will be placed under construction in the near future. Chief of these is a $2,500,000 structure to be erected over the Thames River at New London, Conn., for the New York, New Haven & Hartford R. R. The Metropolitan Park Commission of Boston, Mass., awarded contract for $117,000 reinforced concrete bridge and approaches.

Drainage and Irrigation.—Drainage District No. 2 of Robstown, Tex., is calling for bids on 90 miles of main ditch and laterals requiring about 1,150,000 cu. yds. of excavation. The Cement Products Co., Spencer, Ia., was awarded a $59,780 contract for constructing County Ditch No. 28. Bids were opened by U. S. Reclamation Service on 162,000 cu. yds. of excavation for the Leaburg Canal and 54,000 cu. yds. for the San Elivario Canal. Contracts will be let about April 1 for a $81,000 drainage job in Sac County, Iowa.

Water Works.—Lakeland, Fla., is calling for bids for additions to its water works and electric systems; Galveston, Tex., opens proposals Dec. 9 for laying 9,100 ft. of submerged water main; Ridgefield, Wash., is asking proposals for constructing water works. East Liverpool, O., awarded a $52,900 contract for superstructures for new pumping station and filter plant; Lynn, Mass., let contract for superstructure of its Ipswich River pumping station. Oshkosh, Wis., will ask bids on filtration plant to cost $120,000; Marin Municipal Water District of San Rafael, Cal., will start work next month on its main pipe line tunnel.

Sewerage.—Mason City, Ia., opens bids Jan. 6 on a 1,000,000 gal. sewage disposal plant; Ridgefield Park, N. J., is asking proposals on about 18,000 ft. of vitrified clay pipe sewer; Baltimore, Md., is calling for bids on 8,500 ft. of 8 in. to 12 in. vitrified pipe seyer. Frazer & Buchenal, New York City were awarded contract at $259,012 for tunnel sewer for Borough of Manhattan. Vincennes, Ind., will let contract about Jan. 1 for sewers to cost $123,700.

Rivers and Harbors.—Important pier developments for railroads have been placed under contract recently. The Baltimore & Ohio R. R. awarded a contract for a $1,500,000 coal pier at Curtis Bay, near Baltimore, Md.; the Duluth & Iron Range R. R. awarded the contract for a new ore dock at Two Harbors, Minn. The Norfolk & Western R. R. will ask bids this month for the construction of two coastwise piers at Lambert's Point, near Norfolk, Va. The American Dredging Co., Philadelphia, Pa., at 8.9 cts. was low bidder on 800,000 cu. yds. of dredging in Delaware River for U. S. Government and the Home Dredging Co., Mobile., Ala., at 8.875 cts. was low bidder on 2,780,000 cu. yds. of dredging. The Great Lakes Dredge & Dock Co., Cleveland, O., at about $60,000, was low bidder on 800,000 cu. yds. of dredging in Cleveland Harbor.

Bidders' Mistakes.

A western contractor is a sorrier and wiser man. He bid on a sewer job and because he wanted it very badly he put much time and labor into the preparation of his estimate. When the proposals were opened it was found that he was the low bidder. The other totals were so close to his that he felt sure that he had not underestimated the work. But he had made one little mistake—he had neglected to sign his proposal. As a consequence the contractor, through sheer carelessness, lost a very desirable piece of work. Occurrences like this do not happen frequently. Nevertheless there hardly is a letting where there are not some irregularities in the bids. Some of these are of minor importance, and if the officials in charge are liberal-minded, do not affect the award of the contract. Others, however, are sufficient to cause the throwing out of the bid. At a recent letting there was an unusual number of failures to comply with the bidding conditions. One would-be bidder failed to get in his proposal at the specified time and so it was not considered. Two other contractors did not comply with the requirements regarding the amount of the certified check. Another failed to enclose this guaranty with his bid. Of the 15 proposals received seven did not comply with the conditions laid down in the instructions to bidders. And all of these mistakes could have been prevented.

Luck.

A cyclone swooped down some three weeks ago on a small city in Kansas and left a trail of wreckage behind it. A contractor was engaged at the time on a paving job. His equipment included a $5,000 gravel pumping and washing plant and a $15,000 portable asphalt plant. The storm passed directly between the two plants, blowing down the stack from the mixer and ripping off about 40 ft. of pipe from the gravel outfit, but otherwise causing no damage. This little incident is cited merely to show that even a contractor sometimes has good luck. It also indicates that it is a good plan to provide for all unforeseen contingencies. This contractor carried no tordado insurance. A lucky chance, only, saved him from considerable loss.

Taking Bids in Winter.

The officials of a Wisconsin town are using good judgment in handling the preliminaries for the installation of a water works. They are asking bids now with the understanding that construction shall be started in the spring as early as weather conditions will permit. Furthermore, it is specified the pipe must be delivered during the month of January. This eliminates possibilities of delays in delivery, and it also undoubtedly will result in securing lower prices on the materials. By letting the work at this time better prices on the construction likewise will be obtained. Melrose, Wis., is 18 miles from a railroad but its officials know the opportune time for taking bids on a construction job.

BRIDGE CONSTRUCTION IN IROQUOIS COUNTY, ILL.

Bids Asked on 7 Structures to Cost About $29,000.

Steel and Reinforced Concrete and Reconstruction.

A bridge letting of interest to contractors specializing in smaller undertakings of this kind is being advertised by the State Highway Department of Illinois. Bids on seven jobs calling for an estimated expenditure of about $29,000 will be opened on Dec. 15 by Benj. Jordan, County Superintendent of Highways, Watseka, Ill.

Five contracts call for the construction of reinforced concrete bridges, one contract for the reconstruction of a bridge, and one contract for a reinforced concrete bridge or for a steel bridge. Details of the letting are given in Table I.

TABLE I.—DETAILS OF BRIDGE LETTING TO BE HELD DEC. 15, AT WATSEKA, ILL.

Name.	Township.	Span, ft.	Roadway, ft.	Height over all, ft.	Total concrete, cu. yds.	Reinforcing steel, lbs.	Estimated cost.
No. 12 Bridge	Artesia	60	18	17	204.1	33,670	$3,430
No. 41 Bridge	Stockland	50	18	18	182.2	25,062	2,790
Brown Hill	Loda	16	24	11	81.4	4,030	1,070
Tower	Belmont	50	16	20	192.6	25,754	2,800
No. 137 Bridge*	Belmont	..	..	..	.....	......	5,990
No. 17 Knuth	Loda	50	18	15	143.6	23,922	2,510
Centennial	Douglas	60†	18	24	658.2	71,390	10,410
Centennial‡	Douglas	120	18	24	244	15,000	7,560

*Reconstruction; includes one creosoted timber abutment and one reinforced concrete abutment, two steel I-beam approach spans, etc. †Two 60-ft. spans. ‡Alternate on steel bridge with reinforced concrete abutments.

No. 12 bridge will be a reinforced concrete structure and will replace a steel structure 76 ft. long and 16 ft. wide. The high water flow at the site is 8 ft. deep; low water is 1 ft. deep. The excavation is in clay and will extend 5 ft. below stream bed for foundations. Buckley, the nearest station, is 1¼ miles from the work. Sand and stone are reported available f. o. b. Buckley at $1.15 per ton.

No. 41 bridge will be a reinforced concrete structure. There is no existing bridge at the site. The nearest railroad station, Stockdale, is 3½ miles from the work. The high water flow is 12 ft. deep; low water 1 ft. deep. The excavation will extend 4 ft. below stream bed for foundations. Sand and stone are reported available f. o. b. Stockland at 90 cts. per ton.

The Brown Hill bridge will be a reinforced concrete structure and will replace a 14-ft. steel bridge, having brick floor and brick abutments. The average depth of excavation is 10 ft. in loam and will extend about 4 ft. below stream bed to clay foundations. High water flow is 5 ft. deep; low water, dry. Loda, the nearest railroad station, is 2 miles from the site. Sand and gravel are reported available f. o. b. station at $1.25 per ton.

The Tower bridge will be a reinforced concrete structure. The present bridge is wood, 45-ft. span, with wood abutments. High water flow at the site is 13 ft. deep; low water, 3 ft. deep. The average depth of excavation is 14 ft. in loam and clay and will extend about 4 ft. below stream bed to blue clay foundations. The nearest railroad station, Woodland, is 1 mile from the work. Sand and gravel are reported available at the station at $1.25 per cubic yard.

Bridge No. 137 is located between Belmont and Milford Townships, and is to be reconstructed. The work includes the construction of one creosoted timber abutment and one reinforced concrete abutment, the construction of two steel I-beam approach spans, furnishing and placing new steel joists on present 119-ft. steel span, and reflooring entire bridge with creosoted plank. Woodland, the nearest railroad station, is 2½ miles from the work. Sand and gravel are reported available f. o. b. this station at $1 per ton. The average depth of excavation for the new reinforced concrete abutment is 15 ft. in loam to extend 1 ft. below stream bed to clay or sand. Piles may be required.

No. 17 Knuth bridge will be a reinforced concrete structure. The present bridge is a 50-ft. span, 16-ft. roadway, steel structure. The high water flow at the site is 7 ft. deep; low water 2 in. deep. The excavation is in clay and will extend 5 ft. below stream bed for foundations. The nearest railroad station is Buckley, 3 miles from the work. Sand and stone are reported available f. o. b. Buckley at $1.15 per ton.

Bids on the Centennial bridge will be received on alternate plans for either a reinforced concrete bridge or a steel bridge on reinforced concrete abutments. The present bridge is an iron truss of 84-ft. span. The nearest railroad station, Leonard, is 2 miles from the work. Sand and gravel are reported available f. o. b. station at $1.15 per ton. Green timber for falsework is reported available near the bridge site. High water flow is 18 ft. deep; low water flow 1 ft. deep. The average depth of excavation is 11½ ft. in loam and is to extend about 4 ft. below stream bed to clay or sand. Piles probably will be required.

A $285,000 Irrigation Development, San Joaquin County, Cal.

Detail plans and specifications are now being prepared for a $285,000 irrigation development in San Joaquin County, California. The work will be done for the West Side Irrigation District. This district was formed under the Wright Act in accordance with plans prepared by W. G. Hunter, Civil Engineer, Stockton, Cal., and approved by the State Engineer. The vote for the formation of the district was 79 to 11. A bond election to take action on the issuance of $285,000 of 6 per cent securities will be held in February. The bonds will run for 40 years, the principal being paid up during the last 20 years. The district contains 11,600 acres.

The water will be taken from Old River near Bethany Ferry by an open ditch about ½ mile in length and will then be pumped through two wooden stave pipe lines to two main canals and thence will be distributed by gravity to the high point of each 160-acre subdivision.

The pumping plant will be housed in a reinforced concrete building and will consist of one 12-in. pump, three 14-in. pumps, two 16-in. pumps and an 18-in. pump. All these will be driven by direct connected electric motors. The 12-in. pump will supply water to low acreage near the pumping plant. The three 14-in. pumps will furnish water to a 48-in. pipe line 6,600 ft. long. The other three pumps will supply a 54-in. pipe line 13,000 ft. in length.

The intake is about 75 miles above salt water, and the elevation of the water in river at lowest stage is zero or sea level. The tidal action is about 2 ft. The pumping plant will be at an elevation of about 20 ft., so as to be above flood water in case the river levee breaks. One canal will be at an elevation of 52 ft. and the other at 105 ft.

There is an unlimited supply in Old River due to backwater from the San Joaquin and Sacramento Rivers. The maximum demand for the system will be 110 cu. ft. per second. The first cost of the irrigation will be $24 per acre and the annual cost for the first 20 years will be $3.35 per acre for interest, maintenance and operation. When renewals and paying off of principal is allowed for the total annual cost will be about $5 per acre. W. G. Hunter, Stockton, Cal., is the engineer. C. E. Grunsky, San Francisco, Cal., was consulting engineer on the preliminary work.

CONCRETE ROADS IN ARKANSAS.

A 28½-Mile Letting in Mississippi County.

245,000 Cu. Yds. Earth Excavation—159,280 Sq. Yds. Concrete Pavement.

A large amount of concrete road construction is to be undertaken in Arkansas. This work, for the most part, will be financed by road improvement districts in the various counties. One of the first lettings for this type of highway will be held by the Osceola and Little River Road Improvement District No. 1 of Mississippi County, Arkansas. This letting covers 28½ miles of highway and calls for the laying of over 159,000 sq. yds. of concrete.

The letting is divided into four sections as follows: Section 1, Road No. 1, 4 miles; Road No. 2, 3 miles. Section 2, Road No. 1, 3.25 miles; Road No. 3, 2 miles; Road No. 4, 3 miles. Section 3, Road No. 1, 6.75 miles. Section No. 4, Road No. 1, 1.25 miles; Road No. 5, 2.25 miles; Road No. 6, 3 miles. The approximate quantities in each section are as follows:

	Sec. 1.	Sec. 2.	Sec. 3.	Sec. 4.
Road, miles	7	8.25	6.75	6.50
Earth excavation to be placed in embankment, cu. yds.	42,506	67,096	38,866	48,594
Earth excavation not to be placed in embankment, cu. yds.	13,671	26,812	3,887	4,378
Shoulders, silica or crushed stone, sq. yds.	15,840	29,040	23,760	22,880
Concrete paving, sq. yds.	45,760	43,560	35,640	34,320
Steel bridges	3	3	1	2

The roads will have a graded top width of 30 ft., where center fills are less than 1½ ft. and in cuts, and a top width of 22 ft. where the center fills are more than 1½ ft. Along all center fills of more than 1½ ft. a berm of 4 ft. will be left between the ditches and road bed with a slope of 1 in. in 1 ft. towards the ditch.

The concrete pavement will be 9 ft. wide on narrow gage roads with a depth of 7 in. at the center and 6 in. at the side. On broad gage roads the concrete will be 15 ft. wide, 8 ins. deep at the center and 6 ins. deep at the side. Transverse joists will be perpendicular to the surface, spaced 30 ft. apart and will be not less than ¼ in. nor more than ⅜ in. in thickness. The joints will be protected by soft steel protection plates 2½ in. in depth and 3/16 in. in average thickness. The joint filler will consist of prepared felt or similar material ¼ in. thick. Shoulders of silica or crushed stone 3 ft. in width will be constructed on each side of the concrete pavement.

The fine aggregate for the concrete will consist of clean washed sand free from lignite. The coarse aggregate will be washed gravel or crushed stone. The coarse aggregate will pass a 1½ in. round opening and be retained by ¼ in. opening. The concrete will be a 2:3:6 mix.

Pride & Fairley, Osceola, are engineers for the Osceola and Little River Improvement District No. 1. Bids for the construction of the 28½ miles of road will be opened at 2 p. m., Dec. 1, at the Court House, Osceola, by the Commissioners of the District. The successful bidder must begin work within 30 days after the contract is let and complete it by Jan. 1, 1917.

A $2,500,000 Railroad Bridge.

The directors of the New York, New Haven & Hartford R. R. have authorized the construction of a $2,500,000 bridge over the Thames River at New London, Conn. Plans for the structure have been prepared by the engineering department of the railroad and it is understood contracts will be let in the near future. The present bridge was built in 1888-89 at a cost of about $1,300,000 and will be presented to the State of Connecticut for use as a highway bridge.

The new bridge, which will be located about 200 ft. upstream from the old structure, will be a five-span structure with electrically operated bascule lift span. There will be three spans of 330 ft., one of 212 ft., and one of 185 ft. There also will be two approaches of 1,300 ft. and 1,600 ft. The substructure will be constructed to carry four tracks, but the superstructure at first will be built for only two tracks. The piers will be of concrete with masonry facing between high and low water. The construction will require about 48,000 cu. yds. of concrete and 5,000 tons of steel.

A 900,000 Cu. Yd. Dredging Contract, New Jersey.

A 900,000 cu. yd. dredging job on the Atlantic Coast is being advertised by the U. S. War Department. The work calls for excavation in Newark Bay and Passaic River, N. J. The Passaic River is tidal and navigable from Newark Bay to the city of Passaic, a distance of 15 miles. There is deep water leading up to the locality of the work in Newark Bay. The depth of water over the area to be dredged varies from about 14 ft. to 20 ft. at mean low water. The mean range of tides is about 5 ft. The location is sheltered and the tidal currents are moderate. The duration of the working season is about 10 months. Except at the bridge draws the area to be improved has been dredged previously to a depth of 20 ft. at mean low water, and to a width of 300 ft. The area to be dredged is crossed by three railroad bridges and one highway bridge, the width of the draw openings being 82½, 97, 100 and 100 ft., respectively.

The work to be done consists in dredging for restoring the channel and completing it, beginning at deep water in Newark Bay and proceeding toward Jackson St., Newark, a distance of about 8 miles. The depth of channel to be obtained is 21 ft. at mean low water, and the bottom width is 300 ft.

The total estimated quantity is about 765,000 cu. yds. place measurement or 900,000 cu. yds. scow measurement. The material is believed to be mainly mud, sand, clay, gravel and some old piles and riprap in the waterways of the drawbridges. The maximum distance for disposal of excavated material (if towed to sea) is about 34 miles. The average distance will be about 30 miles.

Bids for dredging in Newark Bay and Passaic River will be received until noon, Dec. 14, by the U. S. Engineer, Room 802, Army Bldg., 39 Whitehall St., New York City.

Flood Prevention at Erie, Pa.

The City Council of Erie has adopted formally the plan recommended by Farley Gannett, consulting engineer, Harrisburg, Pa., for the prevention of flood damage on Mill Creek in Erie. The plan adopted is for a large reinforced concrete conduit about 12,500 ft. long throughout the city. The alignment follows closely the present course of the stream, but by reason of three material cut-offs, reduces the length about 1,300 ft. Through one portion of the city the new line diverts from the old one for about four blocks, but passes through ground from which buildings and structures were removed by the flood. The conduit will be horseshoe shaped, 22 ft. wide by 18 ft. high, inside dimensions. The capacity of the conduit will be 12,000 cu. ft. per second, which is somewhat in excess of the volume of water during the peak of the flood of Aug. 3, last. The total cost of the work will approximate $900,000, and a resolution has been introduced into the City Council for the appropriation of funds for the first year's work. This money will be raised by the sale of bonds which can be issued by the City Council without vote of the people.

Small Drainage Jobs in Kansas.

A considerable number of small drainage jobs will come up for letting in Kansas early next year. Most of the undertakings require a comparatively small amount of excavation and are suitable for light dry land excavators or drag lines. District No. 1 of Salina County probably will let contracts in January for work estimated to cost $18,000. This will require about 80,000 cu. yds. of excavation and will include 3,000 ft. of open ditch with 13 ft. base, 1 to 1 slopes, and 8-ft. berm; 20,240 ft. of ditch with 8-ft. base, 1 to 1 slopes and 8-ft. berm, and 3,000 ft. of ditch with 6-ft. base, 1 to 1 slopes and 6-ft. berm. On the improvement there are no obstructions to interfere with a mechanical excavator and it is believed that a medium sized drag line would be best suited for the work, as part of the ditch must be wasted entirely on one side. The cut ranges from 2 ft. to 8 ft., with an average of 4 ft. The soil ranges from heavy loam to a medium heavy gumbo and works very well under ordinary conditions. The nearest railroad station is Solomon, which is 3 miles from point of beginning work. There also is an unloading station on the Rock Island R. R., 1½ miles from the ditch.

Contracts may be let in January for constructing six cutoffs on Rock Creek in the Delaware River District. These will have 12-ft. base, a depth of 14 ft., 20-ft. berm, and will require a total of about 31,000 cu. yds. of excavation. The work is suitable for dry land excavators or teams. Newman on the Union Pacific R. R. is 4 miles from the improvement. Other work is contemplated by the district and it is hoped to let this at the same time with the cutoffs.

Contracts may be let in February for a small job in Chase County. This calls for about 2 miles of open ditch requiring 70,000 cu. yds. of excavation. The ditch will have a 16-ft. base and an average depth of 9 ft. The estimated cost is about $10,000. The work is about 4 miles distant from Strong City, Kan., the nearest railroad station. The ditching is suitable for drag line or light type of dry land excavator. The plans for the above development are in charge of H. B. Walker, State Drainage Engineer, Manhattan, Kan.

NEWS LETTERS

St. Louis Items.

The List & Gifford Construction Co. of Kansas City secured the contract for lowering grade and filling trestle on the White River branch of the Iron Mountain R. R. in Arkansas. There is approximately 232,000 yds. of grading and 3,000 yds. of concrete in this job. List informs us that they are going to move two shovels on this work, one that they have had idle at Edwardsville and another one at Cairo, Ill.

Another electric line for Madison County, Illinois, is under consideration. The Edwardsville Business Men's Association on Nov. 24th heard reports on the subject and considerable progress was evidenced. The line is to run from Edwardsville to Marine, and Highland, having a length of 19 miles. The Commercial clubs of Marine and Highland have lined up the business men for the proposition, and the residents of the country are so eager for an interurban that indications are much of the right of way will be procured at nominal cost. The line is proposed as a feeder to the Illinois Traction System.

V. E. Funkhauser passed through St. Louis on his way to Cape Girardeau, Mo. Funkhauser is going to Superintend the J. W. McMurray Contracting Co. job on the Frisco R. R. at that point. This work has been shut down on account of high water all summer.

Bids were opened Nov. 19th by the Board of Public Service for the construction of a children's building to replace the present House of Detention. The bid of the John Hill Construction Co., $65,747, was the lowest of 16. The cost of the structure will be

The Alton Board of Trade is considering a proposition for launching a propaganda in Madison County, Illinois, looking to a bond issue for a large sum of money to be used in building hard roads over the county. A meeting will be held Monday evening, at which the members of the Good Roads Committee of the Alton Board of Trade will decide the scope of a proposed campaign for good roads.

Harry G. Halleck of the Halleck & Thom Construction Co., Little Rock, Ark., was here several days making preparations to get started on their drag line work at Corning, Ark., and Osceola, Ark.

The L. J. Smith Construction Co. of Kansas City were awarded the contract for grading 23 miles of new road by the Gulf & Interstate R. R. Co., a part of the Gulf & Santa Fe R. R. in Texas.

The Mississippi River Commission, of which Col. C. McD. Townsend is president, met on Nov. 18th in the steamer Mississippi at the foot of Olive street for the semi-annual tour of inspection. The Commission will meet with drainage and levee boards at various points on the Mississippi between here and New Orleans, for conference on river conditions. All members of the Commission were present.

The J. W. McMurray Contracting Co. of Kansas City were awarded contract for putting in 4,000 ft. of revetment work on Red River above Arthur City, Texas, by the Frisco R. R. Co.

Workmen have been employed on night and day shifts to get the Alton steel mill in shape for a resumption of work Jan. 1. The steel mill has been idle for more than a year. The plant is being remodeled.

Jack and Dan Hickey of the Hickey Bros., were with us several days last week. They have a good steam shovel and concrete plant idle. 901 Miley Ave., Indianapolis, Ind., will catch them.

Elmer Gant, McClure, Ill., has 15,000 yds. of short haul, wheeler and grader work to sublet.

Conferences are being held between the Board of Local Improvements of East St. Louis, Mayor Mollman and the railroads for the discussion of plans for repairing the Broadway viaduct over Cahokia Creek. There are rotted timbers and cracked concrete in the viaduct. All electric cars from downtown East St. Louis going to St. Louis pass over the viaduct.

The Bates & Roger Construction Co. are increasing their plant at Maysville, Ky. Added quite a number of Austrians on to this job during the past two weeks.

Pat Hannon stole away from his office in the Boatman's Bank Bldg. one day last week, came down as far as Walnut Street, dropped in at No. 612 to look over the new Labor Office and Contractors' Headquarters that Koenig built during the summer. Pat admired the shower bath immensely, promising to come in and make use of it often. Pat also gave the writer a quiet tip that he would be back on a big job shortly and has us guessing where it is going to be.

A permit was issued to the Riverview Club to erect a three-story clubhouse at 10592 Riverview drive, above the Waterworks plant at the Chain of Rocks. The contract has been awarded to the Gilsonite Construction Co., which will erect the building. The club is a new organization composed of motor-boat owners, hydroaeroplane navigators, lovers of aquatic sports and motorists. The building will be near the river front and will be completed before spring.

L. H. Mummert of the Central Labor Bureau, Cincinnati, was in town the other day. Mummert reports a good labor business during the past year and is making Cincinnati one of the big labor towns of the Ohio Valley. Contractors when in Cincinnati are invited to call at his office, 408 W. Fourth St., and make themselves at home. Mummert will post you on what is going on and coming up in his neighborhood.

J. M. Floesch passed through St. Louis the other day on his way from Rochester, N. Y., to his big Little River Drainage job below Cape Girardeau, Mo. They have seven big drag lines at work on this job day and night and are piling up big estimates.

A. B. Koenig.

PERSONALS

Mr. F. F. Flynt has resigned as city engineer of Maryville, Mo., being succeeded by Mr. U. S. Wright.

Messrs. Robert James Love and James Verne Richards announce a partnership to be known as Love & Richards for the practice of architecture with offices at 116 South Michigan avenue, Chicago.

Mr. A. A. Kurzejka is appointed chief carpenter of the Iowa & Minnesota Division of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Minneapolis. He succeeds Mr. Michael Caton, who has resigned because of ill health

Mr. J. C. Lord has been appointed superintendent of water works at Fort Worth, Texas. Mr. Lord was formerly general manager for the Fort Worth Light & Power Co., holding that position for 21 years, from 1890 to 1911. Later he was in the employ of the city of Fort Worth for a year and a half, during which time he completed the Lake Worth dam.

Mr. L. J. Hotchkiss has opened an office in the Monadnock building, Chicago, for a civil engineering and contractors' consulting practice, specializing in bridge design, foundations, etc., and in assisting contractors on quantity surveys and estimates, plant layout and temporary structures such as cofferdams, falsework, forms, etc. Mr. Hotchkiss has been with the Bates & Rogers Construction Co. of Chicago for two years past. He was formerly connected with the Chicago, Burlington & Quincy Railroad as designer, assistant engineer and finally assistant bridge engineer. From 1912-13 he was superintendent for The Foundation Company of New York.

Mr. Ralph H. Stearns has been appointed assistant engineer of the Water-Supply Board of Providence, R. I., and will be employed in the design of additional water supply facilities including a large reservoir and tunnel. Mr. Stearns was connected with the Boston Transit Commission in 1902-7. He then became assistant engineer on design for the New York City Board of Water Supply, and held that position until 1912 when he became designing engineer for the Board of Water Commissioners at Hartford, Conn., having charge of the design of all the water supply structures, including the Nepaug reservoir. For the past year he has been with Frederic P. Stearns, consulting engineer.

Mr. W. H. Perkinson has been appointed superintendent of water, sewer and lighting systems for the city of Durant, Okla. Mr. Perkinson was superintendent of water works and sewers for that city during 1907 and 1908. He held the same position at Ada, Okla., during 1910-11 and in 1912 was with the Denison, Texas, city water department. During the year 1913 he was connected with the East Chicago and Indiana Harbor water department at East Chicago, Ind., as inspector. Since that time he has been engaged in sewer construction, mostly in Oklahoma. Mr. Perkinson has thus had eight years of practical experience in the operation of municipal plants and is well qualified for the position which he now takes.

A "Division of Engineering" has been established at the University of Texas with Dr. F. E. Giesecke, professor of architecture, as the head. There has also been created the Division of Economic Geology with Dr. J. A. Udden at the head and a Division of Chemistry, with Dr. E. P. Schoch in charge. These are all sub-divisions of the Bureau of Economic Geology and Technology, whose former director, Dr. Phillips, has recently accepted the presidency of the Colorado School of Mines, and was succeeded by Dr. Udden. The new Division of Engineering will conduct work along the lines of the engineering experiment stations. Professor Bryant is in the School of Civil Engineering in charge of testing laboratories, and Professor Weaver is ranking instructor in Mechanical Engineering. Dr. Giesecke, who will have the leadership in this work, was connected with the Agricultural & Mechanical College of Texas for 29 years, following 1883 as student and teacher, except for one year which he spent at the Massachusetts Institute of Technology and one at the Royal Engineering School in Berlin. Since 1912 he has been head of the School of Architecture at the University of Texas. Dr. Giesecke is a member of the American Society of Civil Engineers.

Mr. Chester F. Gailer, formerly assistant chief engineer of the United Railways & Electric Co. of Baltimore, Md., has been appointed chief engineer for the Atlantic Welding Co., New York City, in which position he will have charge of the manufacture and installation of automatic arc welded rail joints of which he is the inventor. Prior to his connection with the Baltimore company mentioned, Mr. Gailer held the position of roadmaster of the Connecticut Co., Hartford, Conn. He was at one time assistant engineer with the Goldschmidt Thermit Co., and also held various other engineering positions, including that of chief engineer for the Binghamton Railway Co., Binghamton, N. Y., and chief engineer for the Rutland Railway, Light & Power Co., Rutland, Vt.

Mr. Thornton W. Price has opened offices in the Woolworth building, New York City, for the practice of structural and mechanical engineering, specializing in the design of mill and office buildings, bridges, handling equipment, etc. Mr. Price graduated in civil engineering from the University of Pennsylvania in 1911. But prior to that he had been engaged in engineering work as draftsman and checker of structural steel at the Pencoyd plant of the American Bridge Co. From June, 1911, to September, 1913, he was designing engineer for that company, working on the Woolworth building and Hell Gate bridge in New York. Since the latter date he has been in responsible charge of work on the Panama coaling stations with the Berger Point Iron Works, Bayonne, N. J.

Mr. James Forgie, consulting engineer of New York City, has been awarded a Telford Gold Medal by the Institution of Civil Engineers (Great Britain) in recognition of his paper on "The Laxaxalpam Aqueduct Tunnels in Mexico," and of his achievement in engineering the subject of that paper. Very few men in this country have received this honor. Among them are Col. W. H. Harts, William Barclay Parsons, W. J. Wilgus, and J. V. Davies. Mr. Forgie has been for many years prominently identified with the solution of rapid transit problems in cities, notably in New York, the Pennsylvania railroad tunnels and the Hudson and Manhattan tunnels under the Hudson rivers, and is an authority on tunneling and construction work of a subaqueous character. He is a member of the American Society of Civil Engineers as well as the British institution.

OBITUARIES

Charles G. Carpenter, superintendent of the Milwaukee city parks, died in that city Nov. 15, aged 57. Mr. Carpenter was a civil engineering graduate of the University of Wisconsin, and followed that profession for a time, being for five years connected with the city engineering department of Omaha, Neb. He entered the landscape gardening field in 1900, and for 11 years had held the position at Milwaukee.

Thomas E. Jones, contractor of Wilkes-Barre, Pa., died at his home in that city, Nov. 10. Mr. Jones started out as a rock contractor, his first big job being the sinking of the Pettebone shaft and the deepening the Avondale shaft of the Lackawanna coal mines. He also held the contract for building the Sing Sing aqueduct for the New York City water supply. He later went into the building field and erected many of the large structures in the vicinity of Wilkes-Barre.

C. D. Campbell, a drainage contractor of Lincoln, Neb., was shot by a robber in the streets of Omaha, and died from the results November 19. Mr. Campbell had just completed a drainage job at Logan, Iowa. He was contractor on the Oak Creek drainage district work, and on the conduit which carries off the flood waters of Antelope Creek. He was 50 years of age and had been in business in Lincoln for some years.

NEW CATALOGUES

Tests.—Paper, 8½x11 ins.; 30 pp. The Berger Manufacturing Co., Canton, Ohio.

Illustrates and describes in a technical way the unofficial and official tests on Berger's metal lumber pressed steel construction. To be reviewed later.

Corrosion Preventives.—Paper, 8x10 ins.; 48 pp. American Bitumastic Enamels Co., 17 Battery Place, New York City.

"Recent Achievements in the Prevention of Corrosion." Booklet No. 10. Report of the study of corrosion prevention and the application of Bitumastic solution and enamel and their efficacy. To be reviewed later.

CATALOGUE REVIEWS

Waterproofing and Protective Coatings.—Paper, 8½x11 ins., 32 pp.; The Trus-Con Laboratories, Detroit, Mich.

The Trus-Con Laboratories have sent us a copy of the "Architects' Hand Book of Specifications for Waterproofings, Dampproofings and Technical Paint Products." This publication contains 30 complete specifications covering the use of waterproofings and protective coatings. These are printed on separate sheets and are held in a loose leaf binder, thus permitting the addition of new sheets which the company proposes to issue from time to time, covering special and unusual conditions.

The specifications of course all call for the use of Trus-Con products, and a description of the particular material adapted for each purpose is printed on the back of the specification sheet. Nevertheless the book should greatly interest the architect or builder who has problems of waterproofing, metal or masonry protection, dustless flooring and similar matters to meet. Specific instructions for the preparation of the surface and application of the material are given. The book is carefully indexed, thus permitting the reader to find at a glance the specification covering his particular problem. The list includes waterproofing and dampproofing of stucco, plaster, massed concrete, exterior and interior masonry, foundations under earth, dustproofing cement floors, floor hardener, protective steel coatings under various conditions, etc. A request to the firm on business stationery will procure a copy.

INDUSTRIAL NOTES

The Lehigh Portland Cement Co. has appointed Harold M. Scott as assistant secretary and B. H. Rader as western sales manager.

The American Car & Ship Hardware Manufacturing Co., manufacturers of brass and bronze bushings and bearings, castings of all kinds, aluminum, etc., with general offices and works at New Castle, Pa., is making large additions to its present plant in order to take care of the greatly increased demand made upon them. The addition will almost double their present output.

On Nov. 12 and 13 the sales engineers of the Blaw Steel Construction Co. held their annual convention in Pittsburgh. The men met Friday morning at the works at Hoboken, Pa., and made an inspection of the plant. A number of new devices were shown and the men were entertained at luncheon in the dining room of the Blaw plant. In the evening a banquet was held at the Concordia Club, where 63 men assembled. A feature was a play in which the various members of the Blaw organization were imitated. This was along the lines of the annual meeting of the Gridiron Club in Washington. Following this, the convention re-convened for serious work on Saturday. Some very interesting tests were made of the workings of the various Blaw products.

RAILWAYS

PROSPECTIVE WORK.

Alabama:

Tuscaloosa, Ala.—It is reported here Illinois Central R. R. has purchased Alabama, Tennessee & Northern R. R., and will extend the line 30 miles to Tuscaloosa.

California:

Patterson, Cal.—Patterson & Western R. R. Co. has secured last 35 miles of right-of-way, proposed line from Patterson to Manganese and Quicksilver Mines. It is reported construction will be started shortly.

San Francisco, Cal.—U. S. Government proposes to extend Belt Line R. R., now operated by State, from present terminus at Fort Mason to general warehouses in Presidio Military Reservation.

Georgia:

Savannah, Ga.—Savannah & Northwestern Ry. is reported to be planning construction in near future of 44-mile line from St. Clair to Warrenton.

Indiana:

Indianapolis, Ind. — Cincinnati, Indianapolis & Western R. R., B. A. Worthington, President, will expend about $2,000,000 for equipment and betterments. Latter include strengthening of bridges and expenditure of $500,000 for track elevation work in Indianapolis. This company will take over and operate local division of Cincinnati, Hamilton & Dayton Ry.

Kentucky:

Central City, Ky.—Kentucky, Midland R. R., M. M. Wheeler, General Manager, Central City, contemplates extending its line to Earlington and Dawson.

New York:

Oneonta, N. Y.—Proposition is under consideration to construct electric railway from this place to Davenport and on through South Wooster and Charlotteville to Summit.

Oklahoma:

Henryetta, Okla.—Henryetta, Oklahoma & Western Ry. Co. has established office here and has started surveys for its proposed line. It is reported that construction will be started shortly.

Oregon:

Corvallis, Ore.—Southern Pacific R. R. is reported contemplating electrifying its line between Whiteson and Corvallis, 48 miles.

Roseburg, Ore.—Roseburg & Eastern R. R. has secured over 75 per cent of right-of-way for its projected railroad and construction may be started in early spring.

Pennsylvania:

Connellsville, Pa.—It is reported that construction on Chartiers Southern R. R. will be resumed at once and the line pushed to completion. Grading was completed last year and several bridges were constructed. This is a Pennsylvania R. R. project and will form a branch line from Van Eman to Marianna.

Coatesville, Pa.—Reading Ry. is reported to contemplate expenditure of $250,000, for improvements on its Wilmington & Northern branch near this place. Work includes enlargement of yards, and building of new siding.

South Dakota:

Huron, S. D.—It is reported here that construction on the Duluth, Huron & Southern Ry. will be started within a short time. G. W. Morrow, president of the Huron Investment & Construction Co., is vice-president of the railroad.

Texas:

Marlin, Tex.—Temple-Marlin Interurban Promotion Co. has been organized and will continue surveys and securing right-of-way for proposed electric railway between the two places mentioned. W. A. Patrick, Marlin, is interested.

Utah:

Salt Lake City, Utah.—San Pedro, Los Angeles & Salt Lake R. R. will have surveys made early this spring for new line into Uinta Basin. Reconnaissance surveys of three routes have already been made.

West Virginia:

Huntington, W. Va.—It is reported here that contracts for constructing 12 miles of line for Pond Fork Ry. Co. will be let early in January. The line will run along Pond Fork of Little River, and will open up coalfields. The railway is a subsidiary of the Chesapeake & Ohio R. R.

Wisconsin:

Green Bay, Wis.—Green Bay & Eastern Ry. Co. has been granted patent for construction of railroad from Green Bay through Manitowoc to Sheboygan, 70 miles. Capital stock is $50,000. Chas. Frazier, Manitowoc, Wis.; Rude Stockinger, Manitowoc, and R. P. Mattern, Milwaukee, Wis., are among the incorporators.

Mexico:

City of Mexico, Mex.—The present national government is reported to have under consideration plans for the early construction of several thousand miles of road. A considerable proportion of this work will be carried out in Northern Mexico.

BIDS OPENED; CONTRACTS LET

Arkansas:

Little Rock, Ark.—List & Gifford Construction Co., Kansas City, Mo., has been awarded contract for lowering grade and filling trestles on White River Branch of Iron Mountain R. R. Work involves about 232,000 cu. yds. of grading and 3,000 cu. yds. of concrete.

Illinois:

Pekin, Ill.—Fred Schaefer, Jr., Pekin, has been awarded contract by Big Four R. R. for straightening ditch requiring about 25,000 cu. yds. of earth excavation.

Kentucky:

Barbourville, Ky.—Read Construction Co., Philadelphia, Pa., and Hazleton, Pa., has been awarded general contract for construction and track laying of Cumberland & Manchester R. R., from connection with Louisville & Nashville R. R. at Barbourville to Manchester, Ky.

Texas:

Galveston, Tex.—L. J. Smith Construction Co., Kansas City, Mo., has been awarded contract for reconstruction of 23 miles of Gulf & Interstate R. R., for Santa Fe system.

Arthur City, Tex.—J. W. McMurray Contracting Co., Kansas City, Mo., has been awarded contract by Frisco R. R. for 4,000 ft. of revetment work on Red River, above Arthur City.

ROADS STREETS

BIDS ASKED.

California:

Ontario, Cal.—Until 7:30 p. m., Dec. 6, by R. O. Brackenridge, City Clerk, for about 252,000 sq. ft. of concrete paving on A St. and Bon View Ave. and for about 259,000 sq. ft. of concrete paving with concrete box culverts on east roadway of Euclid Ave.

Florida:

Pensacola, Fla.—Until 7 p. m., Dec. 7, by W. C. Barrineau, Chairman County Commissioners, for furnishing one or more trailers for road work, to be of 3 to 5 yds. capacity, regulating dump doors, reversible, steel tired wheels.

Indiana:

Salem, Ind.—Until Dec. 6 by I. H. Rutherford, County Auditor, for about 2½ miles of road in Washington Township.

Winamac, Ind.—Until noon, Dec. 6, by W. E. Munchenburg, County Auditor, for gravel road.

Franklin, Ind.—Until 2 p. m., Dec. 6, by H. L. Knox, County Auditor, for gravel road in Union and Franklin Townships.

New Albany, Ind.—Until 10 a. m., Dec. 6, by J. G. Miller, County Auditor, for 3 miles of roads in New Albany Township.

Delphi, Ind.—Until noon, Dec. 7, by M. G. Haun, County Auditor, for system of roads in Fay Township.

Mount Vernon, Ind.—Until 2 p. m., Dec. 7, by J. R. Haines, County Auditor, for gravel road in Bechel and Point Townships.

Spencer, Ind.—Until 2 p. m., Dec. 7, by County Auditor for sand, stone and river gravel road in Jefferson Township.

Bloomfield, Ind.—Until 2 p. m., Dec. 7, by Geo. E. Kidd, County Auditor, for macadam road in Fairplay and Grand Townships.

La Fayette, Ind.—Until 10 a. m., Dec. 8, by G. W. Baxter, County Auditor, for 2 miles of gravel road on line between Lawrence and Sheffield Townships.

Greenfield, Ind.—Until 10 a. m., Dec. 10, by Lawrence Wood, County Auditor, for 6 miles of road on Hancock-Shelby County line.

Anderson, Ind.—Until 10 a. m., Dec. 10, by County Auditor for 9 concrete roads and 12 gravel roads.

Brookville, Ind.—Until 1 p. m., Dec. 6, by V. G. Reifel, County Auditor, for road in Blooming Grove Twp.

Shoals, Ind.—Until noon, Dec. 6, by L. D. Haga, County Auditor, for road in Halbert Center and Perry Twp.

Minnesota:

St. Paul, Minn.—Until 10:30 a. m., Dec. 13, by Aug. Hohenstein, City Purchasing Agent, for grading and otherwise improving Edgecomb Road, West Seventh St. to Lexington Ave.

Pine City, Minn.—Until Dec. 10 by W. H. Hamilton, County Auditor, for construction of Elwell Road. Total estimated cost is about $50,000.

St. Paul, Minn.—Until 10:30 a. m., Dec. 13, by Aug. Hohenstein, City Purchasing Agent, for grading and otherwise improving Oxford St., Rondo to Thomas Sts.; curbing Edmund St., Lexington Ave. to Dunlap St., and grading, etc., Oxford St., Iglehart Ave. to Rondo St.

New Jersey:

Newark, N. J.—Until 3:15 p. m., Dec. 9, by E. R. Sherrerd, Chief Engineer, Street and Water Commissioners, for 2,500 sq. yds. asphalt pavement on Read St.

Hackensack, N. J.—Until Dec. 3 by County Freeholders for several contracts for grading and macadamizing.

New York:

New York, N. Y.—Until 11 a. m., Dec. 9, by L. H. Tounds, President, Borough of Brooklyn, for 52,800-gal. capacity steel tank for storage of liquid asphalt at Municipal Asphalt Plant.

New York, N. Y.—Until 10 a. m., Dec. 6, by R. A. C. Smith, Commissioner of Docks, for repairing about 2,000 sq. yds. of asphalt pavement on Marginal St. and pier, Northeast and Harlem Rivers.

Tuckahoe, N. Y.—Until 8 p. m., Dec. 6, by John Mathews, Town Superintendent of Highways, for improvement of California Road.

Texas:

Clarksville, Tex.—Until noon, Dec. 9, by Geo. Morrison, County Judge, for construction of system of highways, including bridges and culverts, for Road District No. 1. Contemplated expenditure is $300,000.

Houston, Tex.—Until 10 a. m., Dec. 13, by H. L. Washburn, County Auditor, for 5,000 cu. yds. of shell for road resurfacing.

Washington:

Olympia, Wash.—Until Dec. 20 by State Highway Commission for road work to cost about $120,000.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette   C. S. Hill   C. T. Murray   S. C. Hadden   C. W. Malcolm   C. R. Thomas

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Twenty Years Too Late.

A valued reader, Mr. Emile Low, M. Am. Soc. C. E., of Buffalo, N. Y., comments on our recent editorial on Systematic Recording of Engineering Discovery by Engineering Societies. He writes: "You are too late. I advocated this idea over twenty years ago." This confirms our belief that the idea is a good one. However we believe that, instead of the editor being too late, both he and Mr. Low are too early—Mr. Low by about forty years.

Has Street Cleaning Become a More Dangerous Occupation Than Police Duty?

This query is not facetious. It is propounded seriously in his annual report for 1914, by J. T. Fetherston, Commissioner of Street Cleaning of New York City. Indeed, the query is quoted verbatim from the report. The city served by Mr. Fetherston has 7,000 street cleaners and during 1914 there were killed 7 of these men and 938 were injured at their work. During the same period New York lost by death in performance of duty seven of its 10,000 policemen. That a policeman is more safe from danger of death in the eastern metropolis than is the man in white who cleans the litter from its streets is due to the harmlessness of the Gotham criminal as compared with the Gotham chauffeur. Of the seven white wings who died in service in 1914, four were run down by automobiles, a street car killed one and a runaway horse killed another. The seventh man fell off his cart. Seriously there is need for study of the conditions which surround the street cleaner at work; a record of one man killed or injured of every 7½ men employed is a record that warrants attention.

An Unwise Contention Between Good Roads Associations.

Dissension has arisen out of the Pan-American Road Congress. This congress, held in Oakland, Cal., last September, was one of many engineering congresses instigated and carried out by the Panama-Pacific Exposition. Primarily two associations composed the road congress—the American Road Builders' Association and the American Highway Association. The combination was effected and the meeting was financed on the understanding that the joint congress at Oakland should replace the usual separate annual conventions of the two associations. Now comes the American Road Builders' Association with the announcement of a convention to be held Feb. 28, 1916, at Pittsburgh, Pa., and herein is the root of the dissension.

To hold the Pittsburgh convention so soon after the congress at Oakland is felt by the critics of the action to be no more than postponement of the regular convention of 1915 and so a breach of faith. In defense the American Road Builders' Association asserts that the Pittsburgh meeting is merely a change of the association's annual convention date, a move long considered and just now decided on. Press notices are being sent out by both sides plentifully. Beyond these this journal pretends to no intimate knowledge of the circumstances which warrants it in sitting in judgment. It, and all others who are interested in successful organization study and promotion of improved roads, deplore any occasion calling for exhibition of partisanship.

There should not be two national road builders' organizations. The two now existing are not doing more to advance the work to which they are committed than one could do. They are simply dividing the membership and the money available for any work that can be done. They are putting an unnecessary burden of expense upon the exhibitor of road machinery. They are provocative of disputes and competition where there should be agreement and combination of effort.

The Designing of Details.

Structural steel is a material which has fully demonstrated its worth under the most exacting conditions. Its high tensile and compressive strength, coupled with its ability to yield considerably and thus prevent sudden failure, have resulted in its use for almost every conceivable structural purpose. That it still bears a "good reputation" is due not so much to its use in carefully planned and efficient designs as to its ability to do more than one should reasonably expect of it. The processes of manufacture, under rigid specifications, have been perfected to a degree sufficient to insure the trustworthiness of the commercial product in the form of standard rolled sections. Its uniformity and demonstrated strength in the form of rolled shapes have, in a measure, led many designers to give too little attention to the manner in which the separate sections are fabricated into composite members. The result has been that insufficient study has been given to this exceedingly important factor. In previous issues we have commented on the inadequate attention given to structural detailing and to the regrettable fact that, in general, the designing of details is considered more in the nature of mechanical trades-school work than as a very important branch of structural steel designing.

In this issue we are publishing an article pointing out and commenting on a collection of errors found by the author of the article in checking the structural plans of a building. The number of errors exhibited, and their diversified character, are greater than those who class themselves as structural engineers will be willing to concede can be found in any design made under their direction, *but* we ask that engineers carefully study the article in its entirety before expressing an opinion—or even making admissions to themselves. We believe that it will be generally conceded by experienced engineers, especially by chief draftsmen and managers of structural shops, that many of the errors here pointed out are common—very common. Especially do we recommend that those to whom is entrusted the teaching of structural engineering courses in our technical schools study the data with a view to emphasizing, to their students, the importance of "detail designing"—commonly referred to us "detailing."

That the efficiency of our past and present methods of producing finished structural designs is not highly satisfactory is becoming more generally recognized, but more than mere recognition of deficiency is necessary to correct a fault. So long as those in charge of structural shops—by their low rate of pay—and so long as engineers—by their apparent contempt for structural detailing—continue their present attitude toward this branch of designing, we can expect little improvement in methods and practices. We believe, however that the present is a propitious time for those in authority to take steps toward a more satisfactory solution of the problems presented in the production of finished structural designs.

The Amenities in Collecting Water Bills.

Consider the policemen of Chicago and Paris. In Chicago the brass-bound guardian of the law makes arrests in a rough and ready manner. He calls the wagon and throws the apprehended individual into it with slight consideration. He is a brisk wielder of the baton and night stick and feels that he has acted quite handsomely toward the arrested person if he refrains from "laying a stick av timber along his ear," as Mr. Dooley says. Injury to the feelings, at least, results from all arrests. Hereabouts the road of the transgressor is very hard—if he is arrested. On the other hand the gendarme of Paris, who makes arrests without fear or favor, does it in such a suave and polite manner that the arrested person feels that he has been made a mark of special distinction—that a favor has been shown him. However, this is a subject about which we do not wish to appear too well informed. Let us pass on to the safer subject of collecting delinquent water bills.

Reduced to its lowest and briefest terms the ordinary notice to a delinquent water taker reads as follows: "Sir: Your water bill is past due. Pay it at once or we will shut off the water and charge you $1 for turning it on again after you pay your bill. Y'rs, Water Dept." Again in brief terms, but employing polite usage the form becomes: "My Dear Sir: Your water bill is past due. We are sure that this has escaped your attention in the pressure of other business. Will you kindly favor us with a remittance as per the enclosed statement? Your early attention to this matter will spare us the performance of a disagreeable duty required by law. Very truly yours, Superintendent, Department of Water."

If the two notices serve equally well, which leaves the better impression with the water consumer? The second, of course. True, he is at fault in letting his bill run beyond the limit but that is small reason for using harsh and peremptory language in telling him that the water department knows his bill is due and unpaid. His good will is worth keeping.

In the illustration used in the first paragraph of this editorial which procedure is better calculated to uphold the majesty of the law? The second one, without a doubt. And so it is in notifying the utility bill delinquent of his delinquency. If he finds that the polite notice is "meant" he will pay just as promptly and without permanent resentment. His good will is worth keeping—in fact it is the best asset the utility has, regardless of the form of ownership.

In this issue we publish an article which shows the tactful manner in which delinquencies are handled by the Terre Haute Water Works Co. We commend it to the attention of all utility managers.

Grouting to Close Leaks and Solidify Rock in Tunnel Excavation.

A most notable example of grouting as a means of preparing water bearing rock for economic tunneling is presented in another column of this issue. In the Astoria Tunnel the conditions encountered and the extent of the grouting operations have no precedent in tunneling by grouting. The results were remarkably successful. The task was accomplished in the face of many obstacles. There is substantial warrant for the assertion that by no other means could the work have been so well accomplished. These statements present the case of grouting at the Astoria Tunnel. What altogether has been the record generally of tunnel grouting? A brief answer to this inquiry may perhaps be made as follows:

Grouting fissured or decomposed water bearing rock in excavating tunnel is perhaps the most difficult of all grouting operations, and the one concerning which the least information of a precise nature is available. Except rarely only a surmise of exact rock conditions is possible until they are disclosed by excavation. Also the usual small tunnel heading gives scant room for effective attack by grouting. The problem is in confined quarters to meet a condition unknown until encountered and then perhaps a few yards ahead to meet another condition entirely different. And finally these conditions have to be met often in floods of water. Therefore while grouting in all places calls more largely upon the native ingenuity of the engineer than most other construction processes in tunneling this call is intensified.

Based on experience at Astoria Tunnel, at the tunnels of the Catskill Aqueduct and at water supply tunnels at Buffalo, N. Y., the typical cases of grouting in tunnel excavation are: (1) Grouting individual water-bearing seams, and (2) grouting highly fissured and porous water-bearing zones or belts of rock. The first case permits of simple methods and certain results as compared with the second case. A particularly clean cut example of this truth is afforded by the records of grouting the Roundout Tunnel of the Catskill Aqueduct where there was an alternation of individual seams and of zones of porous rock. The main conclusions furnished by experience with the two conditions were: (1) An open seam reached by several grout-holes in such manner that there is free circulation between holes can be grouted perfectly; when this free circulation does not exist, the grouting is usually imperfect. (2) Grouting a porous, irregularly, highly-fissured rock is a tedious task of drilling and grouting successive stages of short holes with only partial closing of holes.

Scant room in small headings for effective attack by grouting combined with the succession of repeated drilling and grouting operations is a strong economic obstacle to grouting as a means of tunneling porous water-bearing rock. As stated in the account of grouting the Astoria Tunnel, horizontal grout holes cannot well be drilled much more than 20 ft. ahead; often half this distance is good work. Grouting a set of holes closes the rock not much farther ahead than the ends of the holes, so that after blasting a round or two, driving must cease until a new round of grout holes is drilled and they are injected. The delay to rapid progress by this alternation of tasks is obvious. Since closing of leaks is never complete and the leakage is cumulative there is need even with grouting of some pumping. It becomes an open question whether it is not more economical to provide pumping facilities for handling all the water and do away with the grouting process. From the records of grouting in the Catskill tunnel excavation, this seems to have been the conclusion reached by the contractors. It should be kept in mind that these remarks are applied only to cases where wide zones or a continuous run of porous wet rock are being penetrated.

Another practice having influence in grouting highly fissured porous rock like the strata at Roundout Tunnel is the limitations encountered by the necessity of keeping a sound cover in rear of the rock being grouted. At Roundout pressure at which grout could be injected was limited by danger of the face being burst off by back pressure of the grout. At Astoria Tunnel to prevent this same trouble and to give a tight and firm cover into which to fix the grouting nipples the face was reinforced by concrete buttresses. Obviously either of these contingencies can introduce obstacles to rapid excavation which make grouting economically impracticable.

In grouting individual seams the need for perfect filling of having a circulation from hole to hole has been mentioned. Practice discloses another influencing condition, which is the extent to which the seam is filled with sand or rock powder. Generally speaking it is impossible to secure far penetration of grout into a sand-packed seam. This statement is entirely true when only ordinary grouting pressures are employed. At the Hudson syphon or the Catskill Aqueduct, however, using a grouting pressure of 1,000 lbs. per square inch, sand filled seams were quite perfectly grouted.

One very conclusive teaching of all practice in grouting for tunnel excavation is that ample provision should be made for high pressures. They are needed, if not generally, always in starting injection to overcome frictional resistance, always when sand filled seams have to be grouted and in various other imaginable circumstances.

The main points just summarized indicate two facts rather clearly: First as a resort for meeting extraordinary water-bearing rock conditions as at the Astoria Tunnel grouting is a most useful process available to the tunnel builder; second, as a general method of combatting water in more ordinary wet rock tunneling grouting is of moderate economic worth.

BUILDINGS

Errors in Structural Steel Designing.

Contributed by Edward Godfrey, Pittsburgh, Pa.

Books have been written in a high key. They decant learnedly on higher structures, ellipses of stress, secondary stresses, influence lines, and many like things. The writer has made a study of structural failures. He has never seen the slightest evidence indicating that any of them have been due to the lack of the things mentioned in the second sentence of this article. He has seen wrecks without number, real and potential, that indicated failure on the part of the designer to apply ordinary horse sense in their design. This article is a collection of errors in design. The errors all occurred in one set of drawings, but they are not for this reason an exhibition of one or a few designers' peculiarities; they are common—very common. No single designer is responsible; the responsibility lies higher and broader. Designers cannot all be independent investigators. Most of them take for granted what they are taught and what they read in standard books, or they consider as non-essentials the things that are omitted in teachings and books. The writer would like to see serious study given by structural engineers to the errors pointed out in this article.

Figure 1 shows a 12-in. channel, with a span of 21 ft., curved, with an offset of 6 ins. The channel had ordinary end connections. When the designer was asked what would prevent this beam pivoting on the end connections and flopping down, he replied that "it was held at the middle by the 8-in. I-beam acting as a cantilever." This "cantilever" was connected with three rivets to a light hanger. To emphasize the fact that this is not a cantilever would seem to the writer to be superfluous, if it were not that he had the greatest difficulty in demonstrating this and like points to the designer. As a cantilever it would have the greatest bending moment at the hanger and in the hanger. The end connection is quite inadequate to take bending and the hanger is unsuited.

To remedy the error the channel was made straight, thus allowing the curve to be made in the plastering.

Figure 2 shows another sample of a curved beam which is even worse than the first. This beam was to carry a portion of floor and a wall. The designer marked this 10-in. channel to have "stiff connections," as if stiff connections would relieve the wrenching effect on the beams to which the channel is connected. A curved beam is in reality a cantilever, but here is a cantilever branching out of the side of a single beam. To remedy this a straight beam was introduced between the ends of the 10-in. channel and a cantilever from the corner of the quadrant, as indicated by the dotted lines.

Figure 3 shows another curved girder which is worse than either of the first two. This girder is 24 ins. deep and 23 ft. long. It has a sort of gallows connection at one end (of which more will be said later), and it rests on a wall at the other end. It supports a large area of floor overhanging the supports a distance of 7 ft. The beams shown dotted were added at the writer's suggestion.

Figure 4 shows a greater overhang than that to which attention was called in the last paragraph, but the gallows detail is at both ends. The designer stoutly maintained that this detail was good because the channels in the wall would take the bending. But what about the high unbraced wall? A cantilever must have a back anchor and a gallows frame must be "planted" firmly at its base. This is not stable on either basis. The cantilever has no back anchor and the gallows was simply connected to a wall beam at its base.

The practice of "losing" or ignoring the cantilever stress just where it reaches a maximum is very common. It is exemplified in a large number of these cases.

The remedy for this case was not a simple one. It required alterations in the architectural features of the building which allowed the introduction of support for the cantilever, in front of the wall line.

Figure 5 shows another example of failure to take care of cantilever stresses. The top flange stress was provided for by means of a plate across the beam, but the bottom flange stress was totally ignored. To remedy this error the writer introduced angles (shown dotted) to take the bottom flange compression.

Figure 6 shows a cantilever which is connected to a cross beam with 73 rivets ("A," "B," "C," "E"). *The bending moment of the cantilever must all be carried by the four rivets, "D," which could be put in the space of the palm of one's hand.*

Figure 7 shows a cantilever which is connected to a cross beam by 39 rivets. The four rivets, "A," take the bending moment into the 6-in. I-beam.

In Fig. 8, 25 rivets are used to connect the cantilever to the cross-beam. The *two rivets,* "B," take the bending moment into the 6-in. I-beam.

The last three cases are examples where excellent provision is made for cantilever stress up to a certain point—the point of maximum bending moment—and then the matter is dropped as though the cantilever stress had no existence whatever. In the example shown in Fig. 6 the top plate over the cross-beam was extended to connect with the inclined beam. In the examples shown in Figs. 7 and

8 it was recommended that a pair of 6-in. channels be substituted for the 6-in. beam, with suitable connections to take the bending.

Figure 9 shows a splice in a heavy 9-in. I-beam at a break. The splice was inadequate. In cases of beams on broken lines, such as this, the designer should use double channels, separated so as to permit the insertion of a splice plate as deep as or deeper than the channels themselves. Flange splices are not good where the plates are bent, hence the need of deep and thick web plates, with plenty of rivets to take the bending. This splice, however, was reinforced with heavy bent plates, since the bend was downward.

There were many examples of flange splices in broken beams, such as that shown in Fig. 9. Some of the beams were larger than this; some of them had bent plates developing the strength of twelve rivets. How any designer can imagine that the strength of twelve rivets can pass around the sharp corner of an 8x½-in. plate is a mystery. The bend in these beams was upward, so that the knuckle action would force the plate away from the beam in both the compression and the tension flanges.

Figure 10 illustrates a particularly bad case of "bends." Here a stress of 540,000 lbs. is expected to pass around a sharp corner in a very heavy chord. It is seen that there are but two or three rivets near the point where the upward resultant, "F," acts. These are totally inadequate to take that resultant. Apart from the inadequacy of these rivets to take that resultant there is the further fault that at the bend the cover plates and the horizontal legs of the angles will tend to bend upward under stress and throw their load on the vertical legs of the angles.

It would have been very easy to extend this gusset plate to the left about as far as it now reaches to the right of the bend. With this trifling expenditure the strength of the girder would have been enormously increased although the detail would not be ideal because of the large area of metal in the bent plates.

Figure 11 (a) shows how two heavy beams were hung across a girder. Here is a sharp bend, with the brittleness which it is liable to cause in the forging and a wide thin plate acting as a cantilever. The detail was changed to that shown in Fig (b).

Figure 12 is an astounding example of simplified detailing. This is a 15-in., 104-lb. I-beam, which is "some beam." The entire top flange was cut away merely to allow an easy connection for some small channels on a slope. This hardly needs comment. Beam flanges are useful not only near the middle of span but also near the ends to give stiffness. The top flange of a beam is especially useful near the ends of span.

Figure 13 shows how an 18-in. I-beam was cut away for convenience in detailing and its end connection made exceedingly weak. The supporting power of a girder is at its middle plane. The middle plane of this girder touches only the tip end of the 5-in. tongue of this 18-in. beam. The rivets are remote from this tip. The outstanding flange of an angle should not be required to carry a load. Seventy per cent of the web of this I-beam is cut away, leaving but little to take the shear. A sharp corner sheared out of a web means a possible incipient crack in that corner. This detail could not be much worse. The I-beam could have been extended and could have had a good web connection to the side of the girder.

Figure 14 resembles the preceding example. To remedy this defect a bent plate was used with four rivets in a line in the web of the channel, in place of two.

Figure 15 shows how a beam was hung under another beam. Such details are sometimes hard to avoid. The fault is not so much in the kind of detail as in the weakness of the connecting angles. These angles tend to bend and should be of metal thick enough to resist that bending. The lever arm for the force causing this bending is one-half of the gage, or 1¼ ins. The bending moment is 4,300×1¼=5,380 in.-lbs. On a plate 6¼x⅜ in. this gives an extreme fiber stress of about 37,000 lbs. per square inch. These angles ought to be of ⅝-in. thickness.

Figure 16 shows a hanger for a heavy I-beam. It is faulty in many respects. It is eccentric. The metal of the angle is about half cut and punched away in the section at "A." The rivets are very poorly placed to take the load. Four of these rivets could not possibly act until the other four had failed. This is indicated by the drawing. In a tension detail such as this all of the rivets which are expected to act in supporting load should be near the heel of the angle, and the metal of the angle should be thick.

Figure 17 shows another hanger which supports a considerable load. This is eccentric in every way that it is possible to make it. With an apparent strength of four rivets in tension it has in reality the strength of only two, and the pull on these is one-sided.

Figure 18 is an example of a post resting on a beam. No attempt whatever was made to bring the center of gravity of these posts over the center of the supporting beam, as they should be. In this case a large part of the section of the post is entirely off the flange of the beam. Some of the posts were not even milled but were ¼-in. from the surface of the beam and were connected to the beam with a little lug and a small group of eccentrically placed rivets.

Figure 19 illustrates the worst example of an eccentrically placed post. About 40 rivets were used in this heavy triangular brace and the whole connection could be swayed with a crowbar.

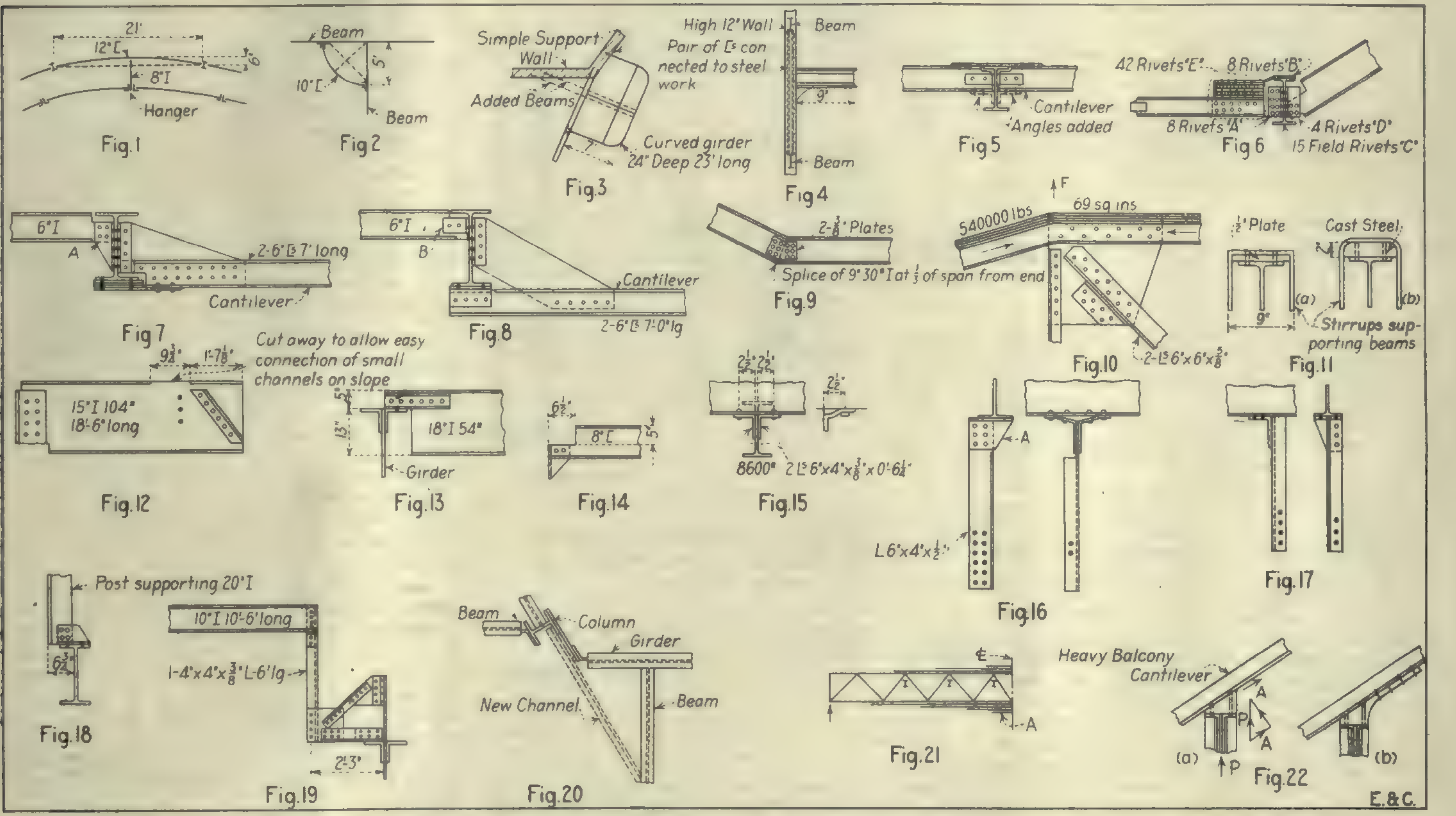
Figure 20 shows a very bad case of eccentric load on a column. The girder in this case was at a considerable distance from the column line, a plate being extended to meet it. The writer added the new channel which is shown dotted in the drawing, to take the bending moment.

In other cases where wall columns were eccentrically loaded their sections were reinforced with side angles and plates.

Figure 21 shows an error in the use of cover plates. The cover plate "A" reaches only half way across the panel of the girder. It is evident that the stress in this panel is constant for the entire panel. Reinforcement added for half of that distance is simply wasted.

Figure 22 (a) shows a heavy balcony cantilever, resting on a cross girder, the connection being made with a cast iron triangular block.

The reaction, *P*, of the cross girder is vertical. This has a large component, *A*, for which no provision was made. The crooked holes indicated would have to be gouged out to get a bolt through them, and bolts in such holes would be of little value. In any event four bolts would not be enough to take the component, *A*. The writer had cast steel blocks made, as indicated at Fig. 22 (b). These blocks could be riveted to the cantilever



Figs. 1-22. Examples of Errors Found in Checking Structural Steel Designs.

without danger of cracking the casting and the rivets would take all of the stress in a direction parallel to the flange of the cantilever.

Novel Method of Underpinning a Tenement Building in New York.

The following method was used to underpin a large tenement house at the southeast corner of Union St. and Fourth Ave., New York, in connection with adjacent subway construction. Here it was necessary not only to underpin the building but also to prevent the sliding out of material from under the building. The latter was accomplished by driving interlocking steel sheet piling between the building line and the subway:

A pier of the building was "caught up" on needle beams, one end resting on the floor of the cellar and the other on piles which were driven for a sewer. A small excavation was made, and 10-in. cylindrical steel piles were driven in 5-ft. sections, by means of a "goat" attached to a drop-hammer piledriver (see Fig. 1). After being driven to a depth of several feet below the sub-grade of the tunnel the piles were filled with concrete, and the pier then constructed on them. The work progressed on alternate piers, one at a time, until all were underpinned. The results were entirely satisfactory, and there was no appreciable settlement of the building.

The work was designed by S. M. Purdy and executed by the Barth S. Cronin Co. It was described in the Proceedings of the Brooklyn Engineers' Club.

Safe Practice in the Use of Crane Chains.

(Staff Abstract.)

It is indeed amazing to find the scant attention that the subject of the strength of chains has received from investigators in the field of strength of materials. One can readily obtain from almost any handbook a table of so-called safe loads, but the peculiar thing about these recommended safe loads is that when put to actual practice the chains are not safe, but fail, and fail frequently, hazarding the lives of the many workmen.

The peculiar thing about these chain failures is that the chain, after being subjected to a so-called safe load and safely resisting this loading repeatedly, suddenly fails under a loading seldom equal to, and more often much less than, the recommended loading. Furthermore, an examination of these sudden "pop" failures reveals that they are seldom due to a bad or burnt weld, nor to a section of the link that has been weakened by wear or abrasion; an examination generally shows the failures are due to a so-called crystallized link. This is certainly convincing evidence that something is radically wrong with our tables of so-called safe loads, as it is a well-established principle of the strength of materials that the extreme fibers of a material should infinitely resist imposed stresses within the elastic limit, making reasonable allowances for deterioration due to rust and abrasive wear.

What does this mean? It means that our problem of procuring safety in crane-chain practice is not one of purchasing well-made chains, of inspecting them regularly, and of restoring the fatigue of the .metal by annealing; but it is a matter of *preventing* this fatigue by subjecting the chain to a *proper* loading.

But what is this proper load? It is a load based upon a permissible working stress for the extreme fiber, and not on the ultimate breaking strength test of the chain. This necessitates the solution of the maximum extreme fiber stress that is developed in an elliptical-shaped ring, as in the case of a link of a chain supporting a load. This involves a theory which has received very meager attention in technical works. There seems to have been only one attempt to develop a formula for the fiber stress developed in an elliptical ring based on experiment and sound theory. The writer refers to a thesis on the strength of chain links, prepared under the direction of the University of Illinois Engineering Experiment Station, in 1907, in which the following formula has been developed for open links:

$$f=\frac{P}{0.4d^2}$$

Where f = extreme fiber stress in tension,
d = diameter of the stock,
P = load on the link.

In *Safety Engineering*, for August, 1915, and also in a recent bulletin on "Safe Loads" issued by the National Safety Council, the following safe loads for straight suspension for wrought iron, hand-made, short-link chains are recommended:

Size, in.	Safe load, lbs.	Ultimate, lbs.
½	2,400	18,000
⅝	4,000	27,000
¾	5,500	40,000
⅞	7,500	48,000
1	9,500	61,000

The writer has found by tests that these values are, on an average, about one-seventh of the ultimate breaking strength, and are in fact a trifle lower than the loads imposed in general practice in most plants.

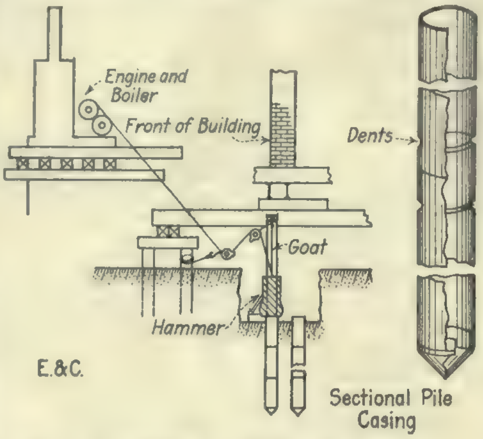


Fig. 1. Diagram Illustrating Manner of Driving Sectional Piles Beneath Existing Building.

It is interesting to note that with these recommended safe loads the following stresses in the extreme fiber are obtained, using the formula cited above:

Size, in.	Stress, lbs. per sq. in.
½	24,000
⅝	25,600
¾	24,500
⅞	25,000
1	23,700

Anyone familiar with the theory of the strength of materials can readily see what this means. It means that the extreme fiber will be stressed up to and in excess of the elastic limit in the case of an iron chain.

The writer has made repeated tensile tests on Norway or Swedish iron, which is about as pure as any commercial iron obtainable, and has never developed more than an average ultimate tensile strength of 44,000 lbs. per square inch and an average elastic limit (or drop of the beam) of 23,500 lbs. per square inch. This shows how such loading as exhibited produces stresses in excess of the elastic limit, notwithstanding the fact that the impact stresses due to mechanical braking in lowering the hoisted load, which are no doubt very severe under certain conditions, have been neglected. It is evident that this magnifies the danger in applying stresses which will destroy the resiliency of the metal.

This is without doubt the reason why chain links become brittle and fail. It is also the reason why the average user encountering such difficulties resorts to annealing as a remedy. No doubt this annealing often forestalls failure, not because the metal has been completely restored to its original physical qualities, but because it has been made tougher.

There has been much said of late both pro and con concerning the annealing of chains to restore the metal from its so-called crystallized condition to the original physical properties. The writer feels that the problem of whether or not to anneal chains and the proper annealing need not be considered at all, as it is evident from the foregoing exhibits that it will all be unnecessary if the chains are properly loaded.

It seems that most tables of safe loads have been based upon the ultimate strength of the chain developed by test. It may be argued that if a new chain tests at 40,000 lbs. it can be used at 10,000 lbs. and have a safety factor of 4. The reason why a chain tests higher than it figures is readily understood when it is shown that the fiber in an open link is subjected to a stress in straight tension and also one due to the bending moment

When the chain is pulled in a tensile test to the rupture point the failure is usually one in direct shear or tension, as the sides of the link have become straight and the bending stresses are not present, the distortion having taken place before the critical maximum point in the bending stresses occurs. It therefore can be seen that there are absolutely no grounds for basing the safe working load upon such a test.

The one point which the writer wishes to emphasize in this brief discussion is that we will not get maximum safety in chains by annealing—although annealing aids merely by prolonging the failure, due to toughening the metal. What must be done is to revise the present code of so-called safe loads and to base them on the rational basis of the permissible extreme fiber stress.

It is a hard proposition to convince an old shop hand that a ⅝-in. iron chain should be only worked to 1,600 lbs. in straight tension when he has been using it for loads of about 5,000 lbs., which he feels is perfectly safe because it has carried that load numerous times without failure. It is going to be hard to remedy this overloading of chains, as a big misunderstanding has taken deep hold of the average mechanic and user of chains, and why not? Have not the best handbooks and authorities recommended these loads?

In summarizing, the writer would recommend that, to procure maximum safety in crane-chain practice, the following points must be closely watched:

1. Decide upon the material desired—low carbon open-hearth steel or an iron as nearly free from impurities as possible. The writer believes a pure iron is preferable to steel, as it makes a better weld than steel; moreover, an iron link will stretch out to a lock more easily if overloaded, which serves as a telltale for inspection.
2. Prepare a rigid set of specifications covering the material, workmanship and tests desired.
3. Insist on a hand-made link, as the machine-made link is bent cold around less than twice its own diameter at a high speed, on an elliptical spindle. This sets up severe initial internal stresses of tension and compression in the outer and inner fiber of the link, respectively, which are sure to cause a weakened condition; while in the hand-made link this bending is made under a cherry-red heat which obviates such stresses; moreover, a much better lap weld is secured in a hand-made link.
4. Number each chain and keep a record of when it goes into service and of the length of service and class of work for which it is used. Inspection should be made daily by a competent and experienced person to detect any reduction of section due to wear, together with any deformation of links or visible flaws developed in the welds. This is somewhat tedious and expensive, but must be done, and done carefully, to insure safe operation.
5. Place the chains under a proper loading restriction.

ACKNOWLEDGMENT.

Paper presented before the recent meeting of National Safety Council at Philadelphia, Pa., by Earl B. Morgan, safety engineer, Commonwealth Steel Co.

ROADS AND STREETS

Methods and Results of Cost Recording on Pavement Work at St. Paul, Minn.

(Staff Abstract.)

At the beginning of the season of 1915 we had orders to pave streets with the following described materials:

	Sq. yds.
With asphalt (sheet)	23,438
With asphalt concrete	9,466
With creosote blocks	270,097
With brick	15,700
With sandstone blocks	1,312
Total	320,013

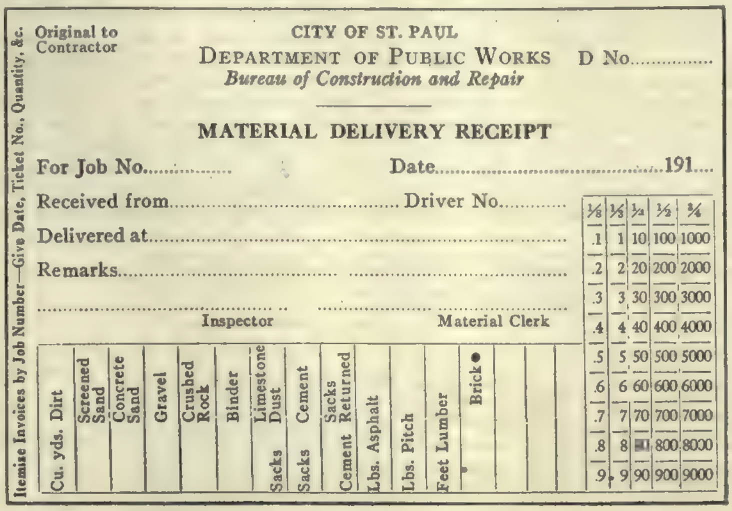
This was about 20 2-10 miles of pavement with roadway having an average width of 27 ft.

The organization consisted of two units, the first accounting and the second the construction.

The accounting was in charge of an engineer, who had for his assistants one bookkeeper, one chief timekeeper, street or job timekeeper, and material clerks. The engineer in charge looked after the placing and filling of orders for materials. He kept in systematic order a record of the purchases, the labor records and the plats showing the daily progress of the work.

The construction unit was organized as follows: One general foreman, street foreman, master mechanic, sub-foremen: one rough grading, one fine grading, concrete mixing and placing, block laying, etc.

General foreman in charge of all the work—His work primarily was to see that the street, sub-foreman and others were instructed how to go on with their work and if not capable, to either separate them from the service or transfer them to such line or kind of work that they were best able to do, to see that the foremen and others under him were at all times supplied with tools and material of the right kind and to make such transfers of men and materials to the several jobs as might be deemed necessary to get it well and cheaply done. He was supplied with a runabout automobile.



Itemise Invoices by Job Number—Give Date, Ticket No., Quantity, &c.

Original to Contractor

CITY OF ST. PAUL
DEPARTMENT OF PUBLIC WORKS D No..............
Bureau of Construction and Repair

MATERIAL DELIVERY RECEIPT

For Job No.............. Date..............................191....

Received from.............................. Driver No............

Delivered at..

Remarks.............................. ....

.... Inspector .... Material Clerk

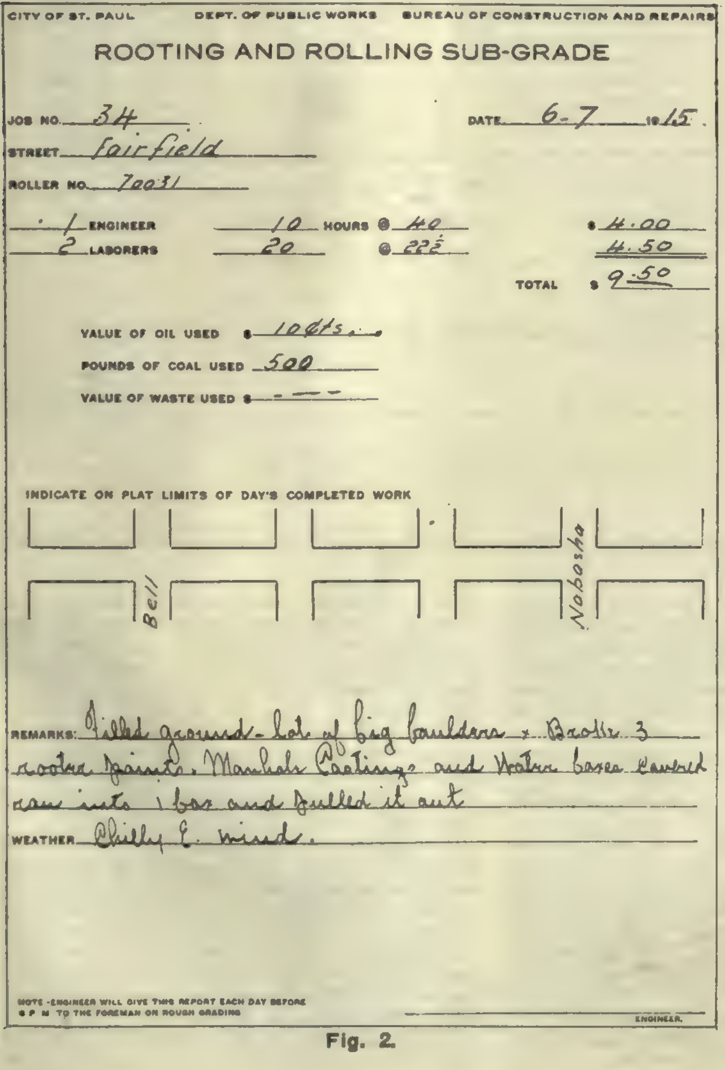
Cu. yds. Dirt	Screened Sand	Concrete Sand	Gravel	Crushed Rock	Binder	Sacks Limestone Dust	Sacks Cement	Cement Sacks Returned	Lbs. Asphalt	Lbs. Pitch	Feet Lumber	Brick			

⅛	⅓	¼	½	¾
.1	1	10	100	1000
.2	2	20	200	2000
.3	3	30	300	3000
.4	4	40	400	4000
.5	5	50	500	5000
.6	6	60	600	6000
.7	7	70	700	7000
.8	8	80	800	8000
.9	9	90	900	9000

Fig. 1.

Sub-foreman—His work was primarily to see that the street foremen and others under him attended to their work and were supplied at all times with the necessary help, tools and material, that the work done by them did not generally over-run the estimated cost, and make such transfers of men and materials to the several jobs as would permit all the work to be well and economically done.

A street foreman to take charge of the paving of one or more streets—His duties were to get the work done on the street or streets to which he was assigned, to employ the necessary assistants and labor and see that he had



CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

ROOTING AND ROLLING SUB-GRADE

JOB NO. 34 DATE 6-7 1915.

STREET Fairfield

ROLLER NO. 70031

1 ENGINEER	10 HOURS	@ 40		$ 4.00
2 LABORERS	20	@ 22½		4.50
			TOTAL	$ 9.50

VALUE OF OIL USED $ 10cts.

POUNDS OF COAL USED 500

VALUE OF WASTE USED $ ———

INDICATE ON PLAT LIMITS OF DAY'S COMPLETED WORK

Bell
Nobosha

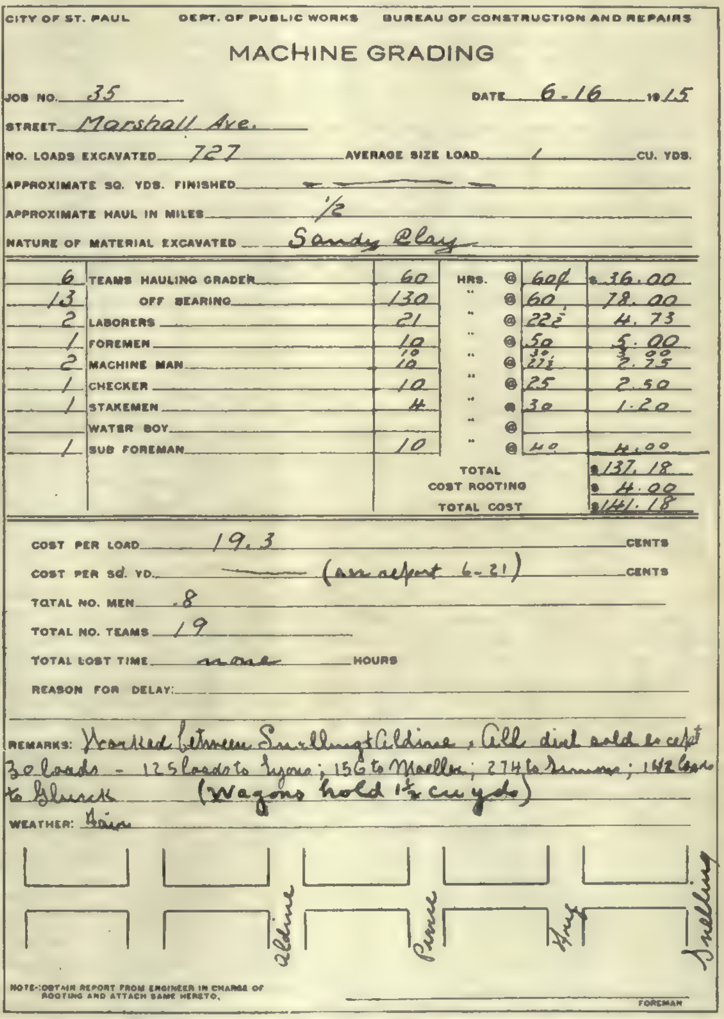
REMARKS: Filled ground - lot of big boulders & Broke 3 rooter points. Manhole Castings and Water boxes caused ran into 1 box and pulled it out

WEATHER Chilly E. wind.

NOTE—ENGINEER WILL GIVE THIS REPORT EACH DAY BEFORE 6 P. M. TO THE FOREMAN ON ROUGH GRADING

ENGINEER.

Fig. 2.



CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

MACHINE GRADING

JOB NO. 35 DATE 6-16 1915

STREET Marshall Ave.

NO. LOADS EXCAVATED 727 AVERAGE SIZE LOAD 1 CU. YDS.

APPROXIMATE SQ. YDS. FINISHED ———

APPROXIMATE HAUL IN MILES ½

NATURE OF MATERIAL EXCAVATED Sandy Clay

6	TEAMS HAULING GRADER	60	HRS. @	60¢	$ 36.00
13	OFF BEARING	130	" @	60	78.00
2	LABORERS	21	" @	22½	4.73
1	FOREMEN	10	" @	50	5.00
2	MACHINE MAN	10 10	" @	30 22½	3.00 2.75
1	CHECKER	10	" @	25	2.50
1	STAKEMEN	4	" @	30	1.20
	WATER BOY		" @		
1	SUB FOREMAN	10	" @	40	4.00
			TOTAL		$137.18
			COST ROOTING		$ 4.00
			TOTAL COST		$141.18

COST PER LOAD 19.3 CENTS

COST PER SQ. YD. ——— (see report 6-21) CENTS

TOTAL NO. MEN 8

TOTAL NO. TEAMS 19

TOTAL LOST TIME none HOURS

REASON FOR DELAY:

REMARKS: Worked between Snelling & Aldine. All dirt sold except 30 loads - 125 loads to Lyons; 156 to Mueller; 274 to Simmons; 142 loads to Glueck (Wagons hold 1½ cu yds)

WEATHER: Fair

NOTE—OBTAIN REPORT FROM ENGINEER IN CHARGE OF ROOTING AND ATTACH SAME HERETO.

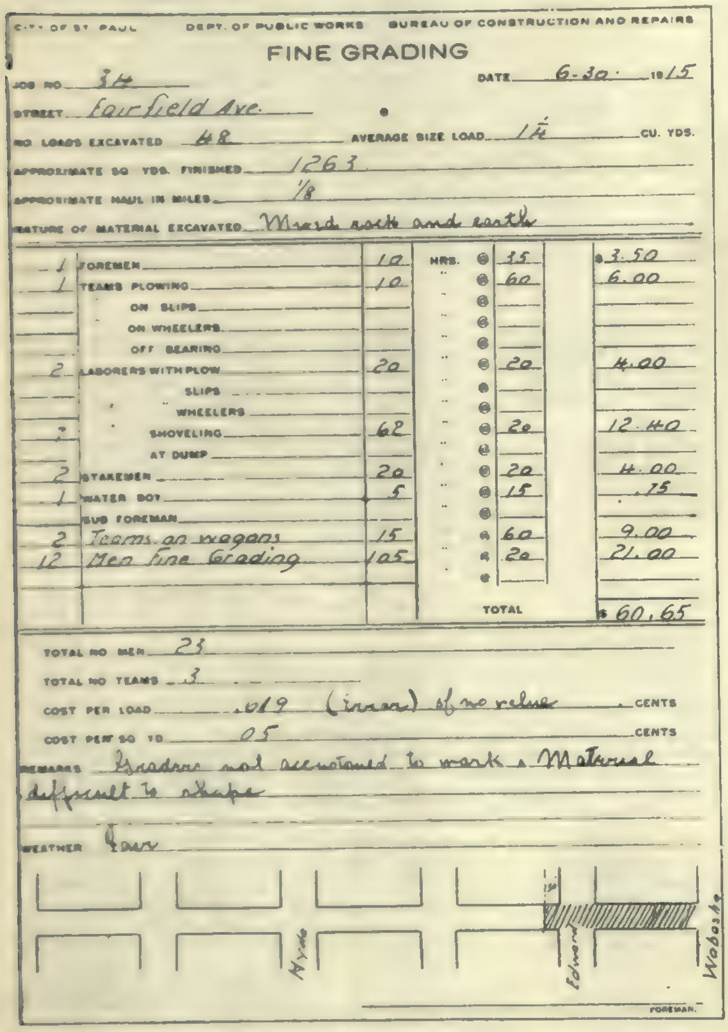
FOREMAN

Fig. 3.

at all times the necessary tools and materials and make a daily report to the superintendent of construction.

We had a master mechanic to look after the repairs and maintenance of tools; he was supplied with a motorcycle in order to get around on the various jobs, most of which were widely separated. On this motorcycle the master mechanic carried such tools as was deemed necessary for quick repairs.

One timekeeper and one material man for each street was appointed, whose duties were as follows: The timekeeper, to keep an accurate record of all the labor employed on the street and how employed, the total cost and the cost of each activity, to make out the payrolls (in duplicate) each day and bring same to the office, also material reports. The material man to receive all material, see that the quantity as called for on the delivery ticket was actually delivered and of the required quality, and see that it was placed as required by the foremen. His duties also were to turn in daily reports of all material received and used, the invoices on all goods or material delivered, and to give a receipt therefor, which was in duplicate. A sample page of the book for that purpose is shown by Fig. 1. These books were gotten up by the department in order to help do away with the danger of paying for material not actually delivered. The books were issued in series alphabetically and numerically. On one job the same series letter only would be used. Carbon paper was used to get copy. Right here I might say that this is the best position for a man to start in who has ambitions to be a foreman.



CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

FINE GRADING

JOB NO. 34 DATE 6-30 1915

STREET Fairfield Ave.

NO. LOADS EXCAVATED 48 AVERAGE SIZE LOAD 1¼ CU. YDS.

APPROXIMATE SQ. YDS. FINISHED 1263

APPROXIMATE HAUL IN MILES 1/8

NATURE OF MATERIAL EXCAVATED Mixed rock and earth

1	FOREMEN	10	HRS.	@	35	$3.50
1	TEAMS PLOWING	10	"	@	60	6.00
	" ON SLIPS		"	@		
	" ON WHEELERS		"	@		
	OFF BEARING		"	@		
2	LABORERS WITH PLOW	20	"	@	20	4.00
	" SLIPS		"	@		
	" " WHEELERS		"	@		
[illegible]	" SHOVELING	62	"	@	20	12.40
	AT DUMP		"	@		
2	STAKEMEN	20	"	@	20	4.00
1	WATER BOY	5	"	@	15	.75
	SUB FOREMAN		"	@		
2	Teams on wagons	15	"	@	60	9.00
12	Men Fine Grading	105	"	@	20	21.00
				@		
				TOTAL		$60.65

TOTAL NO. MEN 23

TOTAL NO. TEAMS 3

COST PER LOAD .019 ([illegible]) of no value CENTS

COST PER SQ. YD. .05 CENTS

REMARKS Graders not accustomed to work & Material difficult to shape

WEATHER Fair

FOREMAN.

Fig. 4.

For the purpose of keeping a close check on the sub-foreman's work as well as to check up the timekeepers and material men, every foreman was required to make a report on the forms furnished him for that purpose, and were taken up by the general foreman. Copies of the several forms in use during the season are shown by Figs. 2 to 8. These forms are filled out to show an average day's work and in one or more instance a maximum day's work at a minimum of cost. The necessity of such reports are obvious. It was no easy matter to get these reports in the beginning as most of the foremen never before were called upon to submit a written report of his day's work. It did not take the men who had to make these reports very long to see that for the first time at least in their lives they were in a fair way to get a square deal. Why? Because the record of their efficiency was, so to speak, in black and white, that their record was placed on file in the office and became a matter of public record. The keeping of the daily record had another strange advantage. It taught foremen who could do work cheaply the reason therefor, as you know there are quite as many foremen who can do work cheaply but don't know why as there are foremen who can do work cheaply or economically, if you please, and also know why. We expect, as a result of the foremen keeping their own daily efficiency record, provided someone else don't get them away from us, that we will be able, before another season is over, to get along with a less number of timekeepers and office help, in other words, we believe we can cut our overhead from 10 per cent to 5 per cent.

An examination of the reports will disclose what the foreman had to do in order to properly fill them out. I would suggest you look them over carefully. It is not claimed they are perfect, but I believe they will give us a good start toward getting a better understanding of each man's ability and of the work done.

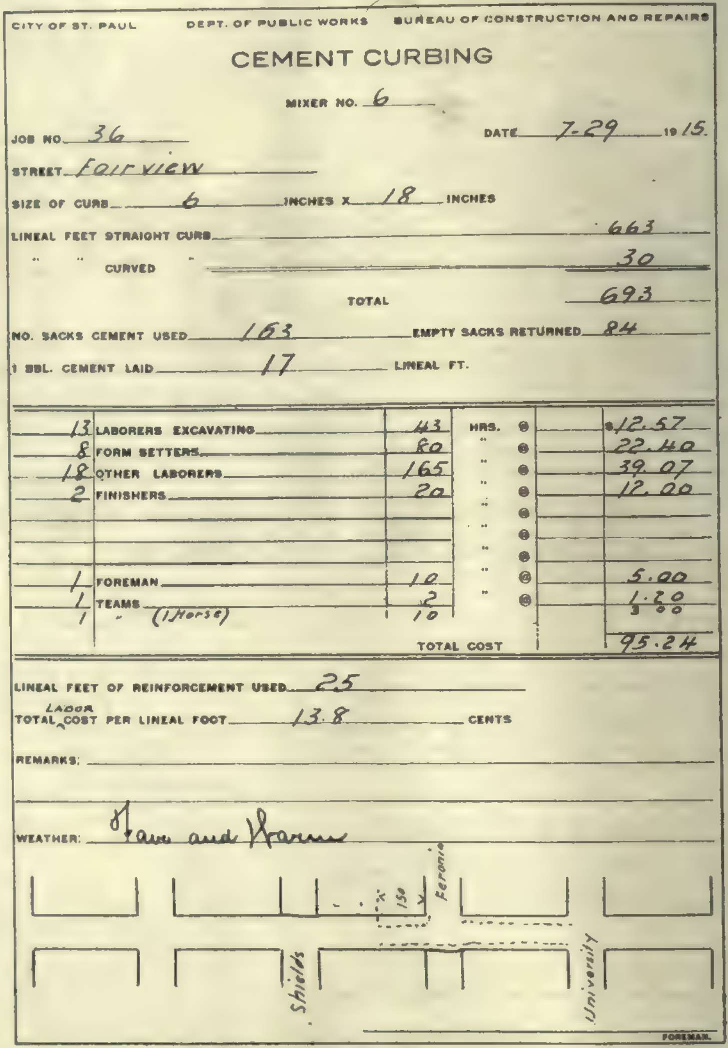
The first work started was rooter plow and then following it, the elevating grader which was operated by means of teams. We tried a traction engine for awhile but did not meet with much success, difficulty in getting teams up near engine, the cost of operating, and not satisfactory on streets with car tracks, also difficulty in making corners.

Practically all the rough grading was done by means of an elevating grader. This crew was made up as follows:

8 teams on grader	$ 48.00
12 teams hauling (variable)	60.00
5 laborers (some spreading)	11.25
2 machine men	7.00
1 checker	2.00
1 team boss	3.50
1 foreman	5.00
2 stakemen	5.25
Total	$142.00

Cost about 13 cts. per cubic yard, based on ⅜ mile haul.

Right here it might be mentioned that this cost does not signify very much unless you have the quantity of work done, the length of haul and distance machine was operated. For instance, a daily report showing that the cost of moving out the sub-grade was 15 cts. per cubic yard and further examination showed that 600 loads or 900 cu. yds. was moved on that day.



CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

CEMENT CURBING

MIXER NO. 6

JOB NO. 36 DATE 7-29 1915.

STREET Fairview

SIZE OF CURB 6 INCHES X 18 INCHES

LINEAL FEET STRAIGHT CURB 663

" " CURVED 30

TOTAL 693

NO. SACKS CEMENT USED 163 EMPTY SACKS RETURNED 84

1 BBL. CEMENT LAID 17 LINEAL FT.

13	LABORERS EXCAVATING	43	HRS.	@		$12.57
8	FORM SETTERS	80	"	@		22.40
18	OTHER LABORERS	165	"	@		39.07
2	FINISHERS	20	"	@		12.00
			"	@		
			"	@		
			"	@		
1	FOREMAN	10	"	@		5.00
1	TEAMS	2	"	@		1.20
1	" (1 Horse)	10				3.00
			TOTAL COST			95.24

LINEAL FEET OF REINFORCEMENT USED 25

TOTAL LABOR COST PER LINEAL FOOT 13.8 CENTS

REMARKS:

WEATHER: Fair and Warm

FOREMAN.

Fig. 5.

Next followed the sewer, water and gas connection crews. The trenches were accurately located and recorded primarily for the purpose of reinforcing them. Method of reinforcement as follows:

Two pieces of 2-in. by 6-in. pine plank strips with 1½ in. holes bored at proper intervals were anchored on each side of the trench to be reinforced. Usually the strips were lowered or filled with the reinforcing bars and carried to place as soon as the 1-in. mortar bed required was spread in place. This mortar bed spread to insure that reinforcing bars were not laying on the ground.

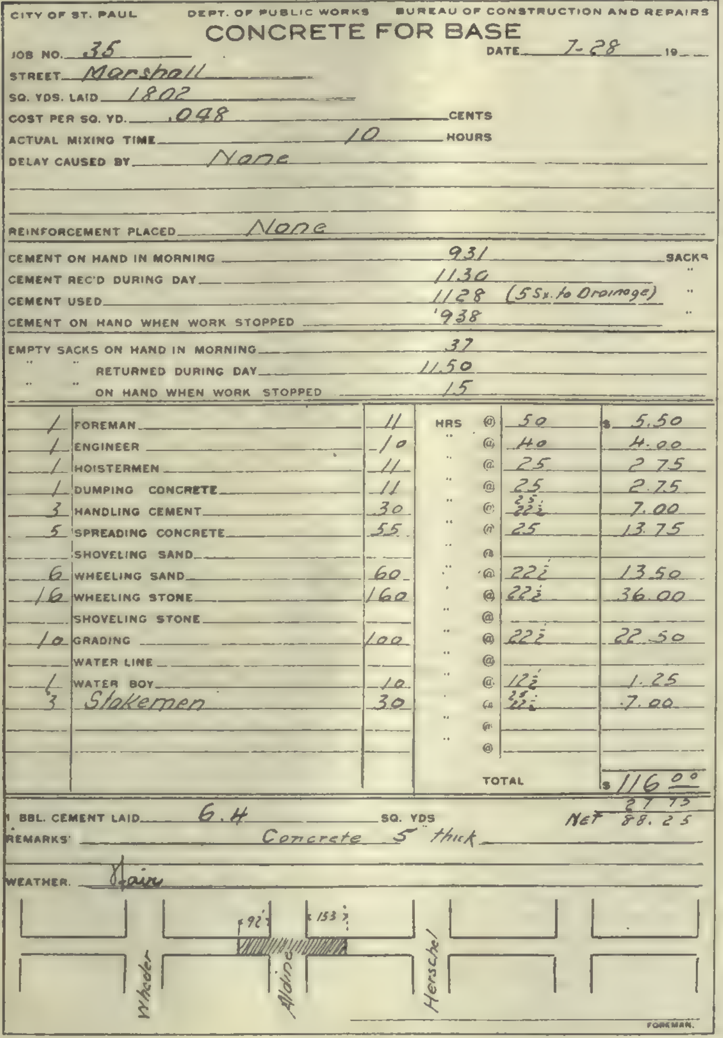
Next followed the curb crews, then the fine grading crew, which work of fine grading cost anywhere from 25 cts. to 60 cts. per cubic yard to remove.

Sandstone or granite curb cost us from 10 cts. to 12 cts. per lineal foot for setting in place and 6 cts. to 8 cts. for hauling, making a total for sandstone curb of approximately 77 cts. per lineal foot.

Concrete curb cost us from 30 to 35 cts.

In the matter of concrete curbing, we tried both the dry and wet mixes, so-called, the dry mix having a wearing surface of a richer mix than the body (near monolithic so-called), the wet mix made monolithic mixed 1:2:4 and well spaded in place.

We found that as a matter of first cost that there was not much difference between the two kinds, but we have found the wet mix is the most durable and in cases of changes in grades that it can be reset easily and without loss. For instance, in a number of cases, teams, in dumping crushed rock and gravel, have knocked out and down sections of curb that was not four days old. An examination of the curb disclosed only a slight blemish and it was reset as easily as a piece of natural stone. It needs no argument to prove that were the curb made of the dry mix, so-called, it would have been shattered beyond repair; in other words, a new section would have to be built in its place.


CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

CONCRETE FOR BASE

JOB NO. 35 DATE 7-28 19

STREET Marshall

SQ. YDS. LAID 1802

COST PER SQ. YD. .048 CENTS

ACTUAL MIXING TIME 10 HOURS

DELAY CAUSED BY None

REINFORCEMENT PLACED None

CEMENT ON HAND IN MORNING 931 SACKS

CEMENT REC'D DURING DAY 1130 "

CEMENT USED 1128 (5 Sx. to Drainage) "

CEMENT ON HAND WHEN WORK STOPPED '938 "

EMPTY SACKS ON HAND IN MORNING 37

" " RETURNED DURING DAY 1150

" " ON HAND WHEN WORK STOPPED 15

1	FOREMAN	11	HRS @	50	$ 5.50
1	ENGINEER	10	" @	40	4.00
1	HOISTERMEN	11	" @	25	2 75
1	DUMPING CONCRETE	11	" @	25	2.75
3	HANDLING CEMENT	30	" @	25 22½	7.00
5	SPREADING CONCRETE	55	" @	25	13.75
	SHOVELING SAND		" @		
6	WHEELING SAND	60	" @	22½	13.50
16	WHEELING STONE	160	" @	22½	36.00
	SHOVELING STONE		" @		
10	GRADING	100	" @	22½	22.50
	WATER LINE		" @		
1	WATER BOY	10	" @	12½	1.25
3	Slakemen	30	" @	25 22½	7.00
			" @		
			" @		
				TOTAL	$ 116 00 27 75 NET 88.25

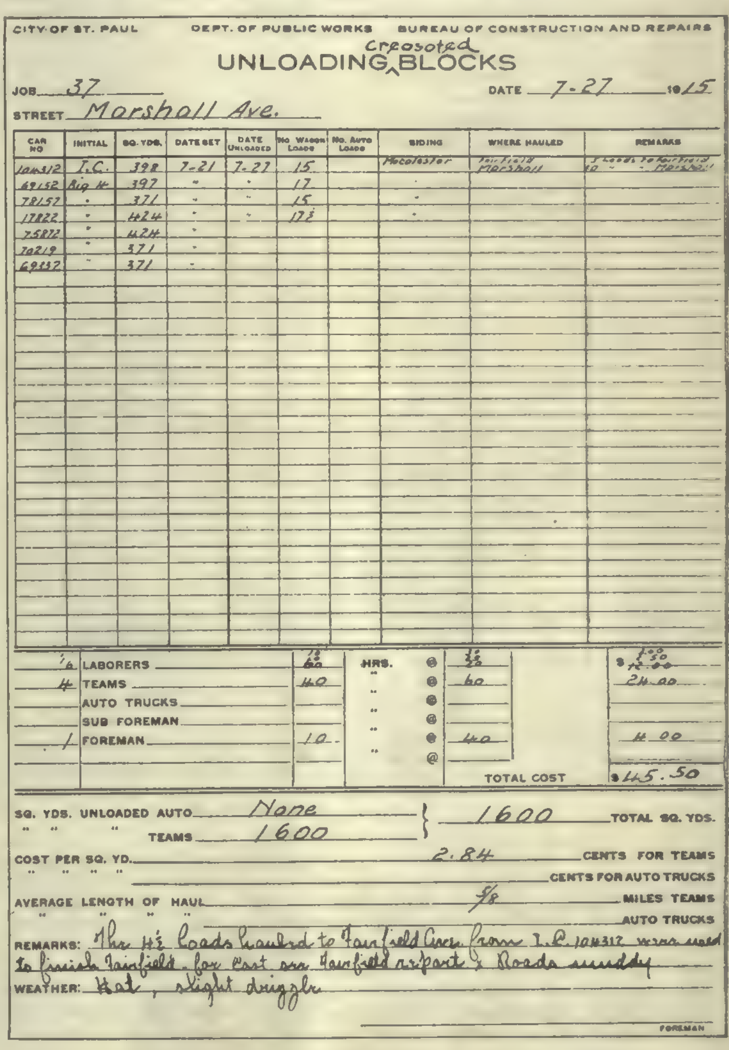
1 BBL. CEMENT LAID 6.4 SQ. YDS

REMARKS Concrete 5" thick

WEATHER Fair

FOREMAN.

Fig. 6.


CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

UNLOADING Creosoted BLOCKS

JOB 37 DATE 7-27 1915

STREET Marshall Ave.

CAR NO	INITIAL	SQ. YDS.	DATE SET	DATE UNLOADED	NO. WAGON LOADS	NO. AUTO LOADS	SIDING	WHERE HAULED	REMARKS
104312	I.C.	398	7-21	7-27	15		Macalester	Fairfield Marshall	5 Loads to Fairfield 10 " " Marshall
69152	Big 4	397	"	"	17		"		
78157	"	371	"	"	15		"		
17822	"	424	"	"	17½		"		
75872	"	424	"						
70219	"	371	"						
69137	"	371	"						

16	LABORERS	10 60	HRS. @	35 20	$ 1.00 1.50 12.00
4	TEAMS	40	" @	60	24.00
	AUTO TRUCKS		" @		
	SUB FOREMAN		" @		
1	FOREMAN	10	" @	40	4 00
			" @		
				TOTAL COST	$ 45.50

SQ. YDS. UNLOADED AUTO None
" " " TEAMS 1600
} 1600 TOTAL SQ. YDS.

COST PER SQ. YD. 2.84 CENTS FOR TEAMS

" " " " CENTS FOR AUTO TRUCKS

AVERAGE LENGTH OF HAUL 5/8 MILES TEAMS

" " " " AUTO TRUCKS

REMARKS: The 4½ loads hauled to Fairfield Ave. from I.C. 104312 was used to finish Fairfield. for cost see Fairfield report & Roads muddy

WEATHER: Hot, slight drizzle

FOREMAN

Fig. 7.

As soon as the curbing was set in place and the fine grading rolled and finished the material for the concrete was hauled and dumped on the street; only in few instances was this material dumped or piled at street intersections and the concrete hauled to place by means of carts. The sand and crushed rock were dumped load after load at proper intervals alongside of the curb, the sand on one side of the street and the crushed rock on the other, and the cement piled up at convenient places as near to the machine as possible.

Our experience has been that the use of carts to get concrete in place is the most expensive, even though suitable horses can be had to haul the carts.

The next method of getting concrete into place is using a self-propelling concrete mixer with boom and bucket of the Koehring type. This method costs less than by use of carts. On streets with 40 ft. or wider clear roadway this method is the most economical. On narrow roadways and on those with car tracks the cheapest and best way is to use a self-propelling machine having a chute or slide. Practically all makes of machines can be so equipped, and we are having chutes or slides made for all our boom and bucket machines.

Materials for Concrete.—We find that a well-graded gravel gives the best concrete. You can get a denser concrete and a smoother surface, which is of primary importance when the wearing surface is to be of brick, creosote block or sandstone blocks. Last, but not least, the gravel concrete costs less, not only for the material (even though the price per cubic yard is the same as for crushed rock) but also for the labor in spreading into place. It is safe to say a saving of at least 5 cts. per square yard can be effected by its use.

Labor of mixing and laying concrete varies from 4 to 9 cts. per square yard for concrete six inches thick.

After giving the concrete sufficient time to ripen, usually from 5 to 10 days, the wearing surface crews were put to work. If brick, sandstone or creosote blocks was to be the wearing surface, then the sand cushion was hauled on the concrete and blocks were hauled and dumped along the boulevard and wheeled to place.

Coarse or well-graded sand will give the best bed or cushion when properly laid. It will not be readily displaced should water find its way under the blocks. The use of fine sand is a dangerous experiment to try.

As the work progressed the blocks were hauled in patent dump wagons and dumped on the blocks already laid in place but not rolled or pitched. The dump wagons were provided with racks, so that approximately 25 sq. yds. of blocks were hauled each trip. During the summer we also used auto trucks carrying about 52 sq. yds.

The hauling of blocks was under a foreman whose duty it was to look after hauling for all streets, also to keep a detailed and accurate record.

The cost of hauling blocks varied from 1⅓ to 9½ cts. per square yard.

In general it was found that teams at $6 per day and auto trucks at $20 a day of ten hours, and using Lee Loaders, the cost of hauling blocks practically the same for both teams and autos for distances between ¾ mile and 2 miles—i. e., for a haul of ¾ mile out and ¾ mile back the team travels a distance of 1½ miles in all.

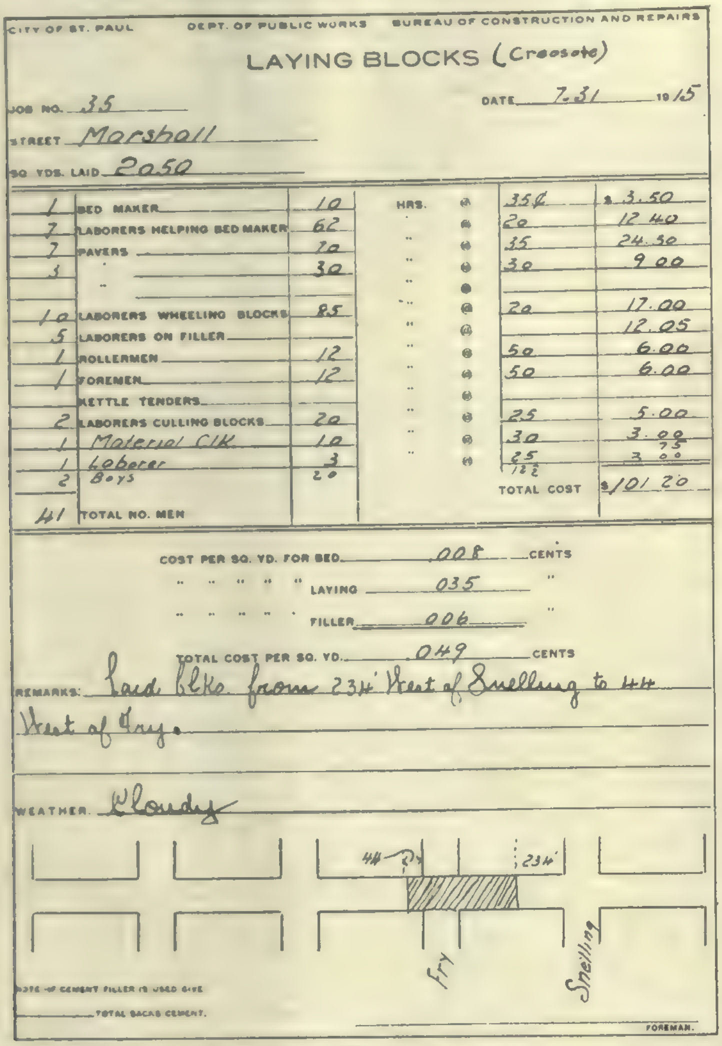
Team travels about 3 miles per hour.

Auto travels about 11 miles per hour.

Auto trucks were used of 5-ton capacity.

Block laying complete cost us from 4 to 10 cts. per square yard.

Cost of concrete and block laying on basis per square yard does not signify very much unless you are given the quantity laid on that basis. For instance, we had a case where concrete laying cost only 6 cts. per square yard. An analysis of the report showed that the crew laid on an average of only 700 sq. yds. each day. What was wrong was simply this, not enough men were at work on that particular activity and, further, the foreman was not getting results from the men he had. At the same time the concrete was being laid we were busily engaged in laying blocks on a nearby street. The foreman of the block-laying crew was doing his work somewhat like the concrete foreman, a small output at a cost per square yard that should be less. We moved the concrete foreman to the block-laying crew on account of his claiming to have had some experience and put another man in charge of the concrete crew. The result was the new man put in on an average 1,445 sq. yds. of 5-in. concrete each day at a labor cost of not over 5 8/10 cts. per square yard. Our former concrete foreman was placed in charge of a block-laying crew. He found his place, as is evidenced by the fact that he put in on an average each day of 1,700 sq. yds. of blocks at a cost per square yard that did not exceed six cents.


CITY OF ST. PAUL DEPT. OF PUBLIC WORKS BUREAU OF CONSTRUCTION AND REPAIRS

LAYING BLOCKS (Creosote)

JOB NO. 35

DATE 7-31 1915

STREET Marshall

SQ YDS. LAID 2050

1	BED MAKER	10	HRS. @	35¢	$ 3.50
7	LABORERS HELPING BED MAKER	62	" @	20	12 40
7	PAVERS	70	" @	35	24.50
3	"	30	" @	30	9 00
	"		" @		
10	LABORERS WHEELING BLOCKS	85	" @	20	17.00
5	LABORERS ON FILLER		" @		12.05
1	ROLLERMEN	12	" @	50	6.00
1	FOREMEN	12	" @	50	6.00
	KETTLE TENDERS		" @		
2	LABORERS CULLING BLOCKS	20	" @	25	5.00
1	Material Clk.	10	" @	30	3.00
1	Laborer	3	" @	25	75
2	Boys	20		12½	3 00
				TOTAL COST	$101 20
41	TOTAL NO. MEN				

COST PER SQ. YD. FOR BED .008 CENTS

" " " " " LAYING .035 "

" " " " " FILLER .006 "

TOTAL COST PER SQ. YD. .049 CENTS

REMARKS: Laid blks. from 234' West of Snelling to 44' West of Fry.

WEATHER. Cloudy

NOTE—IF CEMENT FILLER IS USED GIVE

TOTAL SACKS CEMENT.

FOREMAN.

Fig. 8.

The results of keeping the cost data answered for two purposes—it showed whether we were keeping within the limits of the estimated costs, and it also showed which of the foremen was doing the work most economically, also whether the proper amount of material was being used. As a result it was possible to place a fairly accurate estimate on the value of each foreman. It also enabled us to decide on changes in the methods as well as in the manner of doing the work, and right here it might be well to give a warning to those who are keeping such data not to get too technical; by that I mean you should not aim to get more divisions of the cost than what is absolutetly essential. It is not necessary to know that John Jones laid 250 sq. yds. and that Sam White laid 275 sq. yds.; there might be a good reason therefor, that reason rarely concerns us; what concerns us most is that the foreman should keep the shirkers speeded up or else get them out of the way of the men who are doing a fair day's work.

After the street was finished, in order to obtain the absolute cost of the various activities, the overhead cost, which consisted of the salaries of the paving superintendent, accountant, timekeeper, material clerks, was divided up proportionately. Our overhead cost was very nearly 9 per cent.

Now, I apprehend that I have spent very much more of your time than I should, but in closing I cannot refrain from saying that the good results, both in low cost of work, material saved and energy displayed all summer long, were due entirely to the loyalty of the men and to their superiors, and nothing would please me more than to have the same men to work with during the coming season. The loyalty displayed by them was such kind as this: it made no difference whose suggestion or idea was to prevail, each and every one tried hard to make it as much of a success as if it was his own, hence the reason why St. Paul was able to do the largest creosote paving in the world last year, as well as several other kinds of paving jobs, with a total of 317,000 sq. yds., or 25 miles (average roadway 27 ft.), of new paving.

For those who care for an itemized cost of paving I append here some unit prices from actual cost taken at the end of a day's work. Labor based on the following costs:

Foremen	.50 cents per hour
Laborers	.25 cents per hour
Block layers	.40 cents per hour
Teams	.60 cents per hour

	Creosote block cost.	Brick cost.	Sand-stone cost.
Subgrading	$0.30	$0.30	$0.35
Material for 5-in. concrete	.52	.52	.52
Labor laying concrete	.06	.06	.06
Sand for cushion	.04	.06	.08
Hauling blocks	.07	.12	.12
Laying blocks	.07	.10	.21
Pitch filler	.07	...	...
Cement filler	...	...	.15
Asphalt filler	...	.16	...
Laying filler	.01	.04	.05
Cleaning street	.01	.01	.01
Inspection	.01	.01	.01
Wearing surface	1.35	1.10	1.65
Total	$2.51	$2.48	$3.20

7 lbs. pitch per square yard of creosote blocks.

12 lbs. asphalt per square yard of brick blocks.

Cost of Removing:

Old asphalt, 10c to 12c per sq. yd.

Old natural cement concrete, 15c per sq. yd.

Old Portland cement concrete, 25c to 50c per sq. yd.

Note.—Above figures for itemized cost does not include anything for use of tools, machinery or overhead expense. As far as the above figures of cost are concerned it should be borne in mind that they are averages. Experience has proven that the cost of pavements of the same kind, even if all of the conditions entering into the cost of same, cost of material, equal haul, etc., are alike and identical, will vary considerable owing to the present equasion of the foreman, sub-foreman and laborers, also owing to conditions of the weather, prompt delivery of material, frequent or no breakdowns of machinery, traffic conditions and delays from public service corporations through their work on the street.

Extract from a discussion by J. E. Carroll before the Minnesota Surveyors and Engineers' Society.

WATER WORKS

Diplomacy in Collecting Water Bills at Terre Haute, Ind.

Contributed by Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., Terre Haute, Ind.

Where a water works company does not have rates which will permit of a liberal discount for prompt payment the matter of making collections is a very important one. It is necessary that the company should have its money promptly in order to meet its obligations. The matter of getting the money in is one of the most annoying features connected with the business. We have tried various ways and when our quarterly collections are due we make it a point to give every person who pays a bill before the 10th of the month one of our advertising pencils.

We have tried to do some educational work along this line and have worked up several letters and notices which we send to delinquent consumers. We have several varieties to meet the various cases. There are customers to whom we no longer send notices, as they do not pay any attention to them. The only thing which they seem to respect is the shut-off man with his key. Letter No. 1 was as follows:

EDUCATIONAL LETTER NO. 1.

To Our Valued Customers:

The public utility law, under which we are operating, contains a section prohibiting undue or unreasonable preference or advantage to any particular person. We are striving to conduct our business in conformity with the law and to treat our customers as we would like to be treated if we were buying water service from a public utility.

And, we are asking the co-operation of our valued customers in our efforts. Under the law we were required to file with the commission a schedule of rates and charges governing service; this schedule must contain the rules and regulations that in any manner affect the rates charged.

In our schedule, which we filed, as required, there is a rule, page 10, Section 5, which provides as follows:

> "Metered water service charges, including the minimum charges, are due and payable on the last day of the month during which the service was furnished for which the charges are made, and are in arrears from and after ten days from the said last day of such month during which the service was furnished as aforesaid."

Under the Delinquent Accounts, Section 3, is the following:

> "All delinquent metered service accounts not paid within ten (10) days after becoming due, the water supply service may be discontinued and the water shut off, without notice, and will not be resumed and the water turned on, until the gross amount of the account, and, in, the discretion of the company, the sum of one dollar ($1.00) for turning on the water supply has been paid."

> Just to remind you of the water bill and to ask that you kindly send us a check for $...... before the ...... of this month.
>
> Send cash if you prefer.
>
> Respectfully,
>
> THE TERRE HAUTE WATER WORKS CO., 634 Cherry St.
>
> M................................
>
> ....
>
> Please send or bring your bill with you and save time.

Fig. 1. Notice No. 1, Sent to Terre Haute Water Delinquents Who Have Not Paid Current Bill and Were Delinquent the Preceding Month.

> Office of
> THE TERRE HAUTE WATER WORKS CO.,
> 634 Cherry Street.
> Telephones No. 215.
> Terre Haute, Ind., ...
> ....
> ....
>
> We want to let you know that we appreciate your business; that we are glad to serve you and that we are on the job trying to furnish the best possible water and service; but we can't meet our own obligations when due unless we collect our bills promptly.
>
> Perhaps you forgot to send us a check before the tenth of the month, or you might have been out of town; anyway, this will remind you if you haven't already mailed us a check.
>
> How much is it, do you ask? Our book shows $......, and we will be pretty glad tomorrow if the postman brings in your check. Send the money, if you prefer, and we will pass it on to the other fellow and make him glad, too.
>
> Yours for good water service.
>
> THE TERRE HAUTE WATER WORKS CO.

Fig. 2. Notice No. 2, Sent to Terre Haute Water Delinquents Who Ordinarily Pay Their Water Bills Promptly.

We understand how easy it is to overlook a small matter unless one's attention is particularly called to it; hence we send out bills promptly and we print notices in all the daily papers each quarter for ten days as reminders.

This circular letter is sent with the hope that all who receive it will co-operate with us by paying bills before they are in arrears. We feel that we should obey the law and not give preference or advantage to any particular person.

We are planning, spending, and working to make the water service as near perfection as possible that our customers, neighbors and friends may enjoy safe, wholesome and satisfactory water.

Yours very truly,

THE TERRE HAUTE WATER WORKS CO.
"The Public Be Pleased."

The above letter was sent to customers who had been on any of the delinquent lists, at any time during the preceding six months. It was sent *after* the bills had been paid. Letter No. 2 was as follows:

EDUCATIONAL LETTER NO. 2.

To Our Valued Customers:

The object of state regulation of public utilities, as we understand it, is to insure good service at reasonable rates without unjust discrimination; to permit the utility to earn only a reasonable return on the value of its property after paying cost of operation, taxes and depreciation—the State Commission having full power to examine all books of the utility and to pass on its rules—the idea being that each consumer shall pay for his share of the cost of the service rendered.

Now, as the rules require payment within ten days from the due date, those who do not pay promptly should pay whatever additional cost there may be on account of such failure to pay. The cost of discontinuing the water and again connecting it should be met by those for whom such expense is made necessary. There is no such expense for those who pay within the ten days; hence those who are responsible for this extra work should pay for it. This is carrying out the idea that each should pay his share of the cost of providing the service. The usual charge where the water is discontinued and again turned on is $1, and it is doubtful if this covers the cost in all cases.

Someone must pay the cost of this extra work, and it is not fair for those who pay promptly to pay anything toward it. Therefore, as we see it, the cost should be met by those who occasion the work by not paying bills within the ten days.

As it is, a very large proportion of the money we collect is paid promptly, and we certainly appreciate the kindly co-operation of our customers. Please note that annual flat rate bills are due on the first days of January, April, July and October; metered water bills are due on the last day of the month and both are delinquent in ten days.

Occasionally we are requested to postpone time of payment; our reply is that the rules require bills to be paid by the tenth of the month and that we cannot guarantee a continuance of the water supply after that day—that the delinquent consumer takes his own chances after the tenth.

We dislike to inconvenience our customers, but with thousands of bills each month we are compelled to discontinue the supply when payment is not made promptly.

Many of our customers either pay or authorize their assistants to pay when the bills are delivered. Others send checks or come to the office within a day or two after the first of the month, thus making sure that the bills will not be forgotten.

This circular letter is sent with the hope that all who receive it will co-operate with us and avoid extra cost and inconvenience to themselves.

We look upon this business as a co-operative one—the law will not permit us to earn more than a reasonable return, and we are trying to spend the revenue so as to give the best possible service and to see that each pays only his share of the cost of the service. In this connection practically ten cents of every dollar we collect for water service is turned over to the civil authorities for taxes.

The management of the company is charged with a public duty, to furnish pure, safe water to its patrons and ample service for fires, and it is responsible to the public for its stewardship; it is striving conscientiously to perform its duty.

Respectfully submitted,

THE TERRE HAUTE WATER WORKS CO.
"The Public Be Pleased."

Letter No. 2 was sent under circumstances similar to Letter No. 1, some four or five months later.

On the first of the month our bills are delivered to the customer by messenger (a few being sent through the mail). On the 7th of the month we sent Notice No. 1 to customers who have not paid the current bill and who were delinquent the preceding month. We have two general notices, Nos. 2 and 3, which are here shown; these are sent to consumers who ordinarily pay their bills promptly. We have had complimentary references to these notices.

Notice No. 4 is sent where we want quick action and sometimes follows the preceding notices. In some cases we telephone the consumer, advising him that he has probably overlooked his water bill. And after all this is done there are still some on the delinquent list, these must be handled by the shut-off man. There are some people who dislike very much to separate themselves from their money and it takes a lot of persuasion to get them to either send a check or the cash.

Several other forms of notices used in connection with delinquent water consumers are here given. Our plan is to change these notices from time to time, as the hardened delinquent gets accustomed to a printed notice and does not pay much attention to it unless there is some change. We have a Schapirograph that we expect to use in this connection.

FOUR ADDITIONAL LETTERS TO DELINQUENT WATER CONSUMERS.

It is not easy to write a notice concerning a delinquent water bill which will be satisfactory to all people. To many it is sufficient to advise that the bill is past due—that's enough.

The months roll around pretty rapidly. We read the meters about the 25th; the bills are due on the last day of the month, and unless we get prompt payment we cannot get our work done before it is time to read meters again.

If it was only the current bill we could bring the matter to a settlement in short order, but what we have in mind is to impress our valued customers with the necessity of paying their bills promptly EACH MONTH; to have them get the habit of paying on the first of each month. By doing this they are pretty sure to have continuous service.

> Office of
> THE TERRE HAUTE WATER WORKS CO.,
> 634 Cherry Street,
> Telephones No. 215.
> Terre Haute, Ind., ...
> ....
> ....
>
> The check, or money, you intended to send us for the water bill, $......, has not yet arrived—no doubt forgotten.
>
> Not a serious oversight, of course, but for the sake of uniformity in our handling thousands of these small accounts PROMPT PAYMENT IS GREATLY APPRECIATED.
>
> The matter of making collections is quite a problem with us, and sometimes we find it necessary to withhold a further supply of water until the arrears are paid; you may be sure that we dislike very much to do this.
>
> Don't bother to write a letter, or even to make explanation—we understand perfectly how such oversights occur; just pin your check to the bill or to this letter and mail it back to us.
>
> In the words of the big life insurance company—"Do it today!"
>
> Thank you!
>
> Yours very truly,
>
> THE TERRE HAUTE WATER WORKS CO.

Fig. 3. Notice No. 3, Used Under Same Circumstances as No. 2.

> Not having heard from you in response to our notice, we are sending this one further notice to make certain that the water supply for your premises will not be discontinued without your knowledge, and in the hope that we may have your check before the discontinuance list leaves our office.
>
> THE TERRE HAUTE WATER WORKS CO., 634 Cherry St.
>
> M................................
>
> ....

Fig. 4. Notice No. 4, Sent to Terre Haute Water Delinquents When Quick Action Is Wanted.

The only personal part of this letter is the address and amount due.

The company believes in prompt service as well as prompt payments. When the company makes every effort to have the water ready for the customer the instant he wants to use it the customer should reciprocate by paying bills when due.

Let us state the case:

All contracts provide for payment of bills when due—with 10 days of grace. Meters are read about the 25th of each month, and bills are made for water and service used during the preceding thirty (30) days; these bills are due on the last day of the month. A large number of the bills are paid very promptly. Some customers wait until the 10th of the month, or about two weeks after the meter has been read. Others apparently forget all about their obligation.

The failure on the part of the customer to keep his part of the contract forces the company to use harsh measures—which it dislikes very much to do.

* * *

The man who throws a water bill or notice into the waste basket and pays no attention to it sometimes finds that the water does not run when the faucet is open.

And then he blames the company, when he himself is to blame.

Please don't force the company to use unpleasant measures; it much prefers to have the consumer observe the terms of his contract by paying bills when due.

HERE IT IS:

Tobasco or red pepper sauce is hot stuff, and we don't like to use it; but what kind of stuff can a man use to hurry up payments that are past due? We give it up. There are a lot of fellows that, somehow, or in some way, overlook their bills, or forget to pay. And when they are such nice fellows it is pretty hard to put them to any trouble or make trouble at home for them. Say, if they would just make out a check or send the cash as soon as a bill was received it would—well, it would make business matters so much more harmonious, don't you know.

Let it go at that.

FROM THE MAN WHO SELLS WATER
FOR HIS DAILY BREAD.

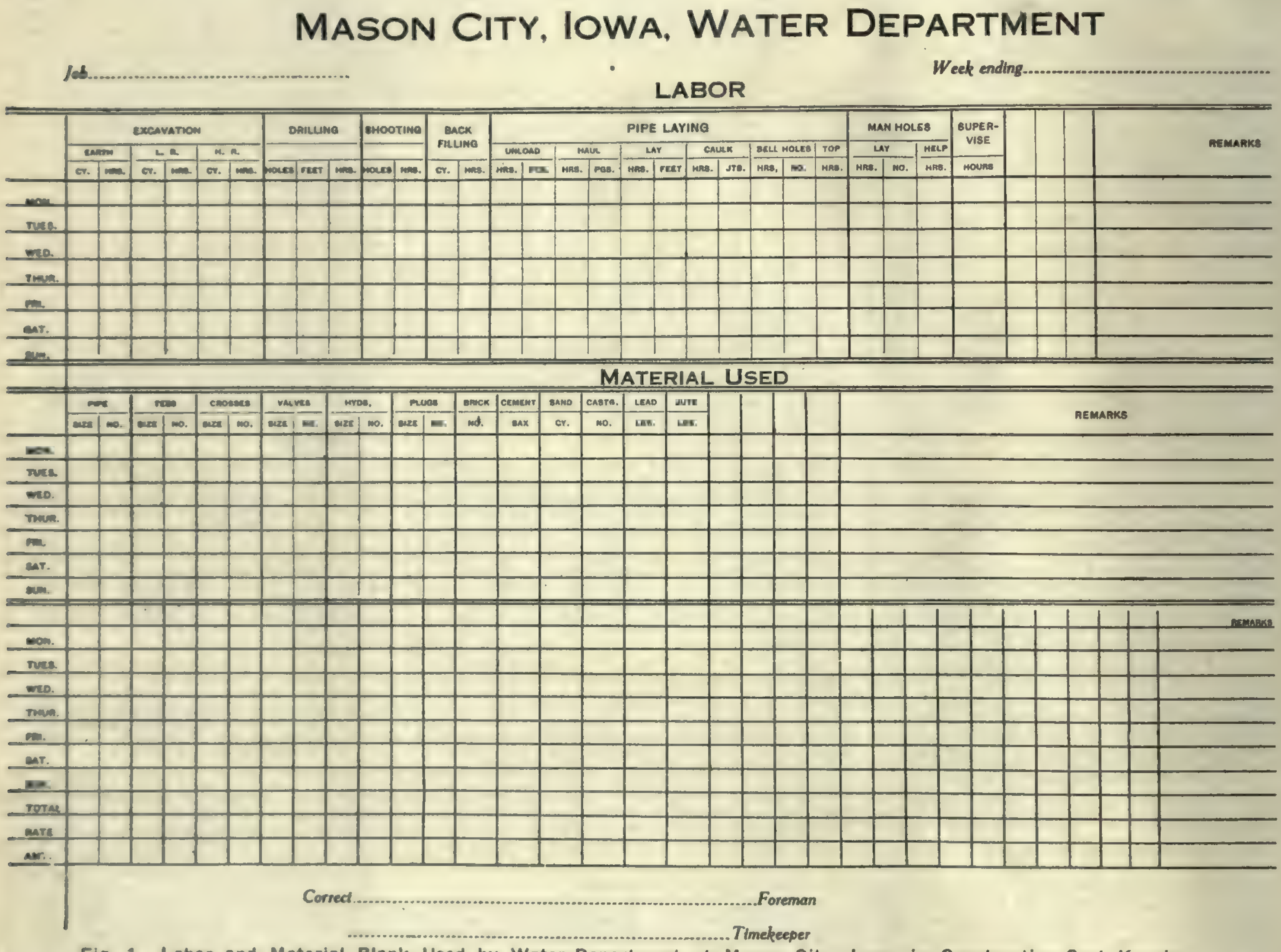
Construction Cost Keeping by the Mason City, Iowa, Water Department.

I found on taking charge of the Water Department of Mason City in 1913 that the construction records were not adequate; entirely too much reliance was placed on memory. In fact, the memory of our old construction foreman was the best record we had. The amount and kind of material, location of mains and specials were kept by him in an old note book, and if they could be deciphered were copied into a record book and placed on our maps once a year.

From the very first I inquired about such locations and other items and recorded them, checking his memory with our plats and finding a number of discrepancies. Generally where there was a discrepancy I found the foreman's memory to be correct. During the working season of 1913 I had him make a complete report on all material used as soon as a job was completed. Locations were then recorded and the information placed upon our plats at once. At the end of the season we had a fair record of all the material used, but it seemed to me that these items should be turned in daily with the time sheet, in order to do away with all reliance upon memory. I thought a time sheet could be devised which would be simple in form and an insistent reminder that nothing should be done without being recorded. It was partly to satisfy my own curiosity that I included on this time sheet a system for recording the unit labor costs. I have not regretted this move, and I believe it is one which can easily be applied to any water enterprise, private or municipal.

It sometimes happens on construction work that an estimate is made on a job and when the job is completed the final cost is above the estimate. The result is somewhat embarrassing to the one who made the estimate, especially when he cannot explain where and why the deficit appeared. With a unit system showing daily the cost of the various items of construction any tendency to overrun estimates is immediately visible, and the fault, if there is any, can be remedied. If unforeseen obstacles interfere, obstacles which cannot be removed, the record shows them, and the man in charge will at least have an alibi.

In our city all sewer excavation contracts are paid for by the cubic yard and the material is classified as earth, loose rock and hard rock. I adopted these same classifications and the same unit, as shown in Fig. 1, showing in one column the cubic yards of each classification excavated during the day and in another the hours spent. The drilling in hard rock is itemized by the number of holes drilled, feet of hole and hours spent. Shooting these holes is itemized simply by number of holes shot and hours spent. After all hard rock is excavated the cost of drilling and shooting may be spread over the cubic yards of hard rock, and the cost then becomes part of the cost of hard rock excavation. Back-



MASON CITY, IOWA, WATER DEPARTMENT

Job..

Week ending..

LABOR

	EXCAVATION						DRILLING			SHOOTING		BACK FILLING		PIPE LAYING											MAN HOLES			SUPER-VISE				REMARKS
	EARTH		L. R.		H. R.									UNLOAD		HAUL		LAY		CAULK		BELL HOLES		TOP	LAY		HELP					
	CY.	HRS.	CY.	HRS.	CY.	HRS.	HOLES	FEET	HRS.	HOLES	HRS.	CY.	HRS.	HRS.	[illegible]	HRS.	PCS.	HRS.	FEET	HRS.	JTS.	HRS.	[illegible]	HRS.	HRS.	NO.	HRS.	HOURS				
MON.																																
TUES.																																
WED.																																
THUR.																																
FRI.																																
SAT.																																
SUN.																																

MATERIAL USED

	PIPE		TEES		CROSSES		VALVES		HYDS.		PLUGS		BRICK	CEMENT	SAND	CASTG.	LEAD	JUTE					REMARKS
	SIZE	NO.	SIZE	NO.	SIZE	NO.	SIZE	[illegible]	SIZE	NO.	SIZE	[illegible]	NO.	SAX	CY.	NO.	LBS.	LBS.					
MON.																							
TUES.																							
WED.																							
THUR.																							
FRI.																							
SAT.																							
SUN.																							

																																	REMARKS
MON.																																	
TUES.																																	
WED.																																	
THUR.																																	
FRI.																																	
SAT.																																	
SUN.																																	
TOTAL																																	
RATE																																	
AMT.																																	

Correct..*Foreman*

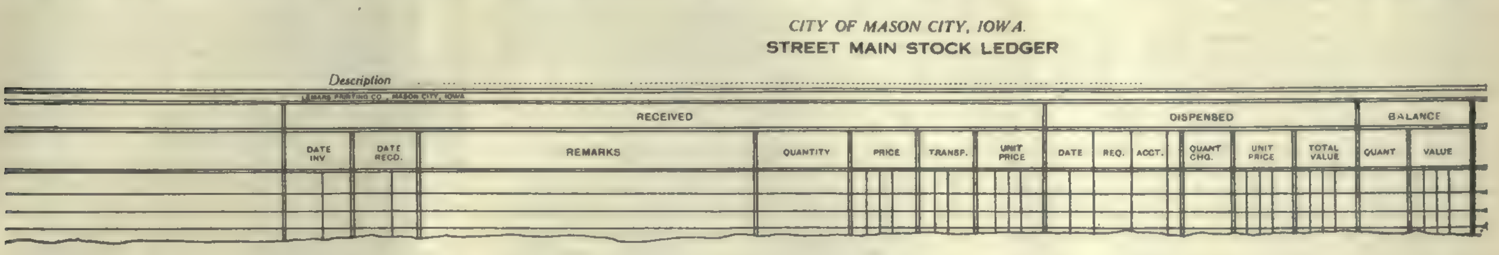
....*Timekeeper*

Fig. 1. Labor and Material Blank Used by Water Department at Mason City, Iowa, in Construction Cost Keeping.

filling is a simple proposition of yards of material moved and hours consumed.

In the unloading and hauling of material I have simply shown the hours spent and pieces handled. In the office, as will be explained later, the amount unloaded may be checked with the invoices and the cost of unloading spread over the pieces handled on a tonnage basis, if from a mixed car, or, if the material is of the same kind, simply prorated to get the unit cost of each piece. By a notation of the distance the material is hauled the cost per ton mile is easily ascertained. In recording the cost of pipe laying I have used one foot as a unit. This was mainly to have an accurate daily record of the number of feet laid, depending on the item "caulking" to get the number of joints. Bell hole digging is spread over the number dug and the pipe handlers and other top men are not itemized, just the number of hours being kept. The cost of laying, caulking, bell hole digging and handling can be later summarized as a total if desired under the general head of pipe laying, and the unit cost per foot can be readily determined. Our valves are housed in brick manholes, one man laying the brick and generally two attending him. The cost, of course, is kept per manhole. One column only is kept for the hours of supervision and the cost disposed of as a percentage of the other costs.

At the bottom of the time sheet is kept the total time of each man for the day, and from this the payroll is made. Incidentally, the total of hours worked should be in balance. Between the labor items and the time roll is a series of columns in which to show the amount of each kind of material used during the day. These are columns headed "Pipe, Tees. Crosses, Valves," and so forth, for the common items, and blank columns left for the incidental ones.



CITY OF MASON CITY, IOWA.
STREET MAIN STOCK LEDGER

Description ....

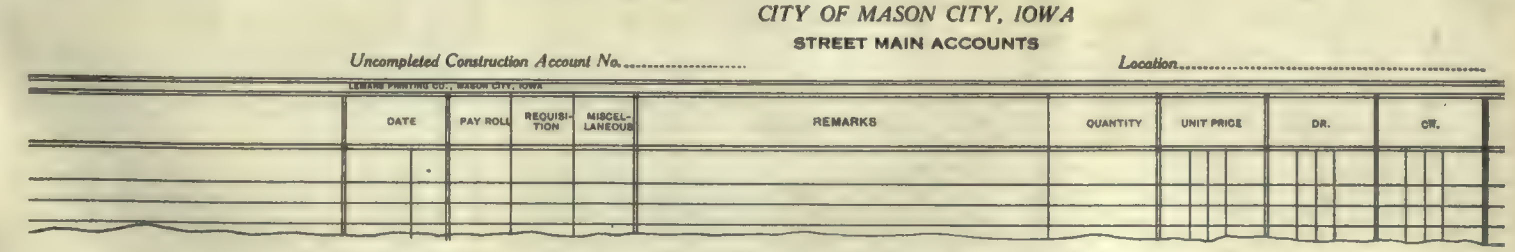
LEMARS PRINTING CO., MASON CITY, IOWA

	RECEIVED							DISPENSED						BALANCE	
	DATE INV	DATE RECD.	REMARKS	QUANTITY	PRICE	TRANSP.	UNIT PRICE	DATE	REQ.	ACCT.	QUANT CHG.	UNIT PRICE	TOTAL VALUE	QUANT	VALUE

Fig. 2. Sheet from Street Main Stock Ledger of Mason City Water Department.

We used this system last year and are continuing it now. However, with so complete a labor record, our system of buying material and charging it directly to our street main account seemed an antiquated one, offering no check on material on hand.

This year we made a complete inventory of all material on hand, estimated the cost of each piece, placed the total to the credit of our general street main account and opened a stock account and ledger. Our ledger is of the loose leaf type, having a separate sheet for each class and size of items and showing, see Fig. 2, the date of invoice, date received, from whom, quantity, price, transportation and unloading charges and the unit price. On the credit side is shown the date, requisition number, account, quantity, unit price and total value. A separate column shows the quantity balance and value. Requisitions are filled out by the man receiving the material and are handed in daily. See Fig. 3 for requisition blank. When material is hauled from one job to another a credit slip is turned in. If there is no corresponding requisition we know the material was taken back to the stock pile. Proper credits are made on the stock ledger and debits on the job ledger, which is an auxiliary book called the "Uncompleted Construction Account Book." A sheet from this book is shown in Fig. 4. Each job is given a number before it is started and a sheet in the book. On this sheet is entered all material and labor charged to the job. The total of material debits must balance with the credits in the stock ledger and the labor with the payrolls.



CITY OF MASON CITY, IOWA
STREET MAIN ACCOUNTS

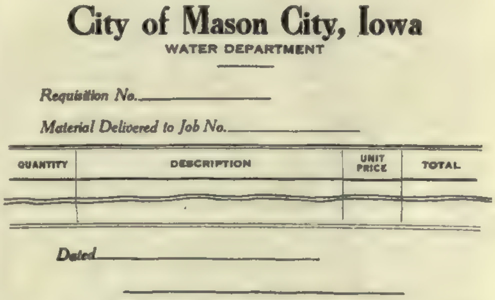
Uncompleted Construction Account No.......................   *Location*..

LEMARS PRINTING CO., MASON CITY, IOWA

	DATE	PAY ROLL	REQUISITION	MISCELLANEOUS	REMARKS	QUANTITY	UNIT PRICE	DR.	CR.

Fig. 4. Sheet from Street Main Job Ledger of Mason City Water Department.

We are using a continuous inventory system to keep our stock in check. An inventory of the classes of stock which have been most active is taken nearly every week, and if the amount actually on hand does not correspond with the balance shown on the stock ledger an effort is made to find where the material went to or came from. We have been very fortunate in having but few mistakes of this kind, and those few were readily corrected by these frequent invoices.



City of Mason City, Iowa
WATER DEPARTMENT

*Requisition No.*____________

*Material Delivered to Job No.*____________

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL

*Dated*____________

Fig. 3. Requisition Blank of Mason City Water Department, Used in Construction Cost Keeping.

In conclusion I want to say that while we have an itemized unit labor and material cost keeping system, one which shows the cost of every item and every job and the amount of material of every kind on hand and its value, it is not my claim that our system is the best one ever used on this class of work. I believe, however, that some such system can be worked out and applied to every water works.

ACKNOWLEDGMENT.

A paper before the first annual convention of the Iowa Section of the American Water Works Association by Mr. W. A. Judd, Superintendent, Water Department, Mason City, Iowa.

Written Examination in Selection of Water Works Superintendent at Niagara Falls, N. Y.

(Staff Article.)

The present superintendent of water works at Niagara Falls, N. Y., secured his position as the result of a written examination conducted by the Civil Service Commission of the state of New York. Some facts pertaining to the examination and the questions used are here given.

The questions were prepared at Albany by the State Civil Service Commissioners on request of the Municipal Civil Service Commission of Niagara Falls. The examination was held at Niagara Falls and the papers were sent to Albany to be marked.

We are advised by Mr. H. A. Keller, who received the appointment as a result of the examination, that he is the only man who ever took a written state civil service examination for the office of water superintendent in New York state. In the questions, which follow, it will be noted that the examination was divided into two parts: Knowledge of duties and experience. Equal weights were assigned to these two subdivisions of the examination. The questions follow:

KNOWLEDGE OF DUTIES.

No books or references of any kind were permitted in the applicant's hands during the examination. The time allowed for the entire examination was six hours.

1. By aid of a sketch, describe the general construction of a rapid sand filter having a mechanically driven sand agitator.

2. Describe the operation of the above filter and the usual preliminary treatment of water before filtering. What determines the quantity of coagulant needed, what substances are commonly used as coagulants, and what is the function of the coagulating chamber? Give approximately the length of time that this filter should be allowed to operate before cleaning.

3. What attention should be given to the location, placing and maintenance of fire hydrants? In case a hydrant becomes frozen, what suitable methods may be used to thaw it? How is the location of valves usually recorded?

4. By aid of sketches, describe the general construction and operation of the centrifugal pump and show how two, single-stage single-suction centrifugal pumps should be connected to operate as two-stage equipment. What principal advantage has the centrifugal pump constructed with a double suction? If a centrifugal pump is located at a higher elevation than the water to be pumped, what procedure is necessary to start a flow through the pump?

What devices are usually installed in the pump pipe line to aid in this operation?

5. Name five types of cast-iron pipe specials. Describe in detail how you would lay a cast-iron bell and spigot pipe line to form a long sweeping bend of large radius. In this problem give also the procedure to be followed in making joints, showing your practical knowledge of this work.

6. Where small gate valves are placed in a pipe line, by what means is a small clear opening maintained between street surface and top of valve stem so that a key may be inserted for operating valve? Make a sketch showing the construction of the "special" used for this purpose.

7. Describe in detail how you would connect a newly-laid cast iron branch pipe line to an existing cast iron water main composed of the usual straight lengths of pipe. Show your practical knowledge of this work and include in description any castings or special tools necessary. (Assume the service to be temporarily shut off.)

8. Suppose that a small crack, say 1 ft. long, occured in a cast iron water main. Assuming that the desired equipment, castings, etc., were available, state how this cracked section may be repaired without removing the pipe length or shutting down the service.

9. By sketch and description show one form of service tapping machine. Give the operation of making a connection by means of this machine.

10. Describe the general construction of the alternating current induction motor. Give the usual methods of controlling the speed of this motor. What is the function of the alternating current transformer?

EXPERIENCE.

1. (a) Give place, month, day and year of your birth. (b) How long have you resided in the City of Niagara Falls?

2. State in detail—(a) What has been the nature and extent of your school education? Give particulars as to schools attended, length of time and dates, course pursued, and date of graduation and degree (if any) obtained.

3. Give a complete record from time of leaving school to present time of your residence, occupations and salaries or estimated annual earnings. Your statements should give names and addresses of your former employers, the business in which they were engaged, the approximate dates and length of your employment in each position, your title and general duties.

4. Important: Describe in detail any experience you have had that, in your opinion, would tend to qualify and fit you to perform the duties of superintendent of water works. Give the exact nature of work done, the exact part of such work done personally by you, the approximate dates and the length of time so employed in each instance, also extent of supervision of others. Where work was in "pumping" or filtration plants, give a brief description of location, size and kind of plant; if laying of water mains, etc., give extent of work.

ACKNOWLEDGMENT.

For a copy of the foregoing questions we are indebted to Mr. H. N. Saxton, Chief Examiner, Civil Service Commission of the State of New York, Albany, N. Y.

GENERAL

Grouting to Solidify Fissured and Broken Rock for Astoria Tunnel Excavation, New York City.

(Staff Abstract.)

Grouting to close leaks in or to solidify shattered and fissured rock in tunnel excavation has been practiced for many years but in a somewhat haphazard fashion. In recent years it has been employed systematically in the Buffalo, N. Y., under-lake water supply tunnels and more notably in several tunnels of the Catskill Aqueduct. All previous uses of grouting in tunnel excavation have been subordinated by its use in the Astoria Tunnel for gas mains constructed under the East River at New York city. This tunnel is 4,662 ft. long between two vertical shafts and its penetrates a stretch of medium hard gneiss at each end separated by a dolomite limestone. At the junction of the limestone and the gneiss at the Bronx or west end the rock for a distance of some 350 ft. was broken and fissured and gave large volumes of water. This was the zone in which grouting was successfully employed as described in the following extracts from a very useful paper by J. Vipond Davies in Proceedings, American Society of Civil Engineers, Vol. XLI, p. 1,405.

Water Flows.—The water-bearing fissures in the 354 ft. of decomposed dolomite were quite numerous, sixteen appreciable streams, each averaging from 300 to 10,000 gals. per min., under a full pressure head of 95 lbs., having been encountered. These flows were usually quite sudden, and were accompanied by an inrush of greensand, the miximum flow of 10,000 gals. alone washing in 400 cu. yds. of sand, coal, etc., and, during a period of 6 weeks, some 1,700 cu. yd. of sand were washed into the Astoria heading. The establishment of a direct connection to the river bed was proved by the appearance of air bubbles on the river surface during grouting operations in the headings, as well as by the quantities of coal, wood, shells, bricks, etc., washed in at various times.

Theory of Procedure.—The theory on which tunneling operations were executed through the decomposed rock formation was the thorough exploration of the formations ahead by test holes and the consolidation of the rock by grouting. It was very obvious, in working in a narrow top heading, even by drilling numerous holes in the form of a fan, that a very limited area could be reached for consolidation, and as the percussion drill, working on more or less horizontal or dry holes, is only capable of extending to a depth of about 20 ft., the tunnel section which it is possible to consolidate is very short, particularly in view of the fact that there is a definite limit to the number of grout holes which can be drilled into the face of such a small heading, and that considerable time must be allowed for cement grout to attain strength to permit of blasting safely. It was obvious, therefore, that a greater area of attack must be provided, and this was done on the theory of diverting the heading from the straight line to lines external to the final side lines of the tunnel, following the line of the strike of the sound rock as far as possible to permit of cross access to the decomposed strata. By doing this a long face could be exposed from which the drilling could proceed. Further, whenever the rock was sound and reasonably hard, a full and adequate anchorage for the grout pipes was naturally provided, but, if the rock was decomposed, seamy, and water-bearing, it was usually found to be so soft that proper anchorage could not be obtained for the grout pipes. In such cases it became necessary to construct buttress faces to the soft rock after exposure, before grout pipe holes could be drilled and pipes inserted. The work was carried out on the further theory that grouting above the extrados of the arch and outside the side-walls, within the limit of the top heading, would in all reasonable probability cut off the direct access of heavy water flow and consequent danger of breaks occurring in the bottom. This was carried out to the end of the work and proved successful, as was illustrated by the fact that it was found unnecessary to do any grouting of considerable extent in order to take out the later bench excavation, the water-bearing seams having evidently been plugged at the higher level and the resistance of the decomposed material in the seams being adequate to resist any indirect access or flow.

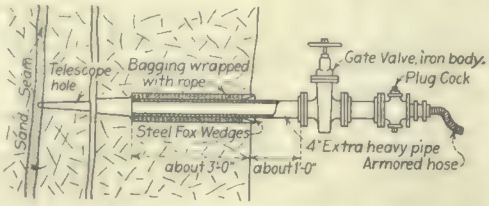


Fig. 1. Nipple and Attachments Used in Grouting Astoria Tunnel.

Buttresses.—Reference is made to the necessity for buttressing the face of soft rock to provide anchorage for grout pipes, in the event of the rock being unsound and not giving adequate security for the insertion of such pipes. In such cases, owing to the high pressures involved, these concrete buttresses were allowed to set for practically two weeks on each occasion before they could be utilized. When such buttresses were set and thoroughly hard, or when sound rock existed, the process of preparing the grout pipes for use, as indicated by Fig. 1, was generally as follows:

Nipples.—The drilling was commenced with 6-in. percussion drills, and entered from 3 to 4 ft. deep into the concrete buttress or hard rock. A piece of 4-in. pipe, about 1 ft. longer than the depth of the hole, was then wrapped tightly with bagging and wound around with marline to secure it tightly to the pipe, the quantity of bagging being put on up to practically the dimensions of the 6-in. hole. The wrapped pipe was then inserted in the hole, and driven to its extreme end, no thread, flange, or other protector being put on the inner end of this first length of pipe. When thus inserted the wrapping was caulked back into the hole, and steel wedges were inserted and driven tightly between the 6-in. hole in the rock and the body of the 4-in. pipe. These wedges were driven so hard as to indent the 4-in. pipe and secure it rigidly. A screwed flange was then put on the outer end of this 4-in. nipple and an open gate valve was attached to the flange, in order to provide a clear opening equal to the diameter of the pipe. Drilling then proceeded through the gate valve, commencing with 3-in. percussion drills and telescoping if necessary, as the drilling advanced. The length of the test holes rarely exceeded 20 ft. Of course, it will be understood that where the drilling was carried out from narrow cross-headings, and the holes were drilled at an angle with the strike, the effective length was reduced on account of the lack of clearance to insert long drills.

Diamond Drills.—Reference is made in the following pages to the use of the diamond drill. On first meeting the decomposed rock at the Bronx end, a 1⅞-in. diamond drill was set up in the heading and holes were driven, one at the elevation of the heading, horizontally at righ angles to the strike of the rock, in order to intercept the seams at right angles to the general strike; and two holes straight ahead on the axis of the tunnel, one horizontally and one pointing downward. The hole at right angles to the strike of the rock was extended in only some 50 ft., but the long holes ahead were extended for about 200 ft., and these drill holes gave an excellent idea regarding the conditions to be met, as far as drilling could be accomplished with the small machine used. At a later date, a heavier diamond drill, capable of drilling 3-in. holes, was used, and gave much more satisfactory results. The use of the diamond drill for long holes was extended considerably, previous to and after the flooding of the tunnel, giving long penetration and providing a means for grouting at considerable distances. The later diamond drill outfit was of the Sullivan type, of heavy construction, and proved to be admirably adapted to work of this character. In the entire construction through this decomposed rock section, some 3,300 test holes were drilled, aggregating a length of about 43,300 ft. by percussion drills, in addition to seventeen diamond drill borings aggregating a length of 1,500 ft.

Characteristics.—Grouting in the Astoria Tunnel has probably exceeded very greatly that in any other work executed, in consolidating soft fissured rock, and in stopping extensive and large leaks at high pressure. Grouting at a higher pressure was done on the Catskill Aqueduct, though the volume of inflow was probably very much less. In the case of the Astoria Tunnel, the grouting was a continuous operation for consolidating and cementing decomposed rock throughout the entire length of the sheared contact between the gneiss and dolomite, and as such served the purpose, a result which has not, it is thought, been approached or attempted in other work. The work involved was the conversion of a rotted and decomposed rock filled with fissures into a solid and substantial substance through which the tunnel could be driven and, incidentally, at the same time, stop the influx of water. In the grouting operations it was found to be almost impossible to grout into a seam of decomposed dolomite sand. This would apply equally to any other sand or material filling seams, which is likely to be scoured out by a flow of water. On meeting a seam filled with decomposed rock sand, the indications on this work were, that the sand was practically impervious, but, after a short exposure to water flow, the soft rock abutting on the seam became water-loaded and softened; then the passage of small quantities of water loosened and demoralized the sand filling the seams, following which the sand was scoured out, thus forming an open water channel. Therefore, it was found particularly desirable, after drilling grout holes into a seam filled with sand, to rake the sand out with rods, as far as was feasible, and then to allow these test holes to flow freely, by blowing with high-pressure air or in any other way, the idea being to get the sand to flow with the water and thus empty the seam, after which the grouting operation was much more thorough, successful, and permanent. When these seams were emptied of the sand and grouted at high pressure the result was practically a solid rock formation, and the tunnel could be built by blasting operations with security; whereas a seam not so clear of sand would resist the flow of grout and be a menace to the future advance of the tunneling operations.

Grouting.—During the early stages of adverse tunneling, the grouting of the water-bearing fissures was performed with ordinary grout machines, using a neat Portland cement mortar at a pressure varying from 100 to 200 lbs. per sq. in. This made it necessary, in September, 1911, to put in a steam-driven, straight-line booster at each plant. Grouting continued with this pressure for some months, but it became apparent as the work proceeded that an air pressure of even 200 lbs. was insufficient to insure success.

For successful grouting into narrow seams it is essential to obtain a high initial velocity of grout flow, in order to overcome the frictional resistance; consequently, to grout against a water head of approximately 100 lbs. per sq. in., more than 100 lbs. additional pressure was found to be necessary. The increase of the starting pressure insured the initial flow, and the expansion of the air, even down to 200 lbs. or less, was adequate to maintain the continuity of the flow. The use of the high pressure also insured that the seam would be packed more tightly and that the grout would be more dense when it had taken its ultimate set and attained strength.

Consequently, an additional steam-driven straight-line booster was erected at the Astoria end in November, 1912, this machine being capable of developing an air pressure of 500 lbs. per square inch, for which special grout machines were constructed. The injection of cement into the water-bearing fissures at this pressure (500 lbs.) was exceptionally effective, and was undoubtedly a valuable factor in the ultimate success in driving through the unsound water-bearing rock.

The disintegrated rock structure frequently necessitated the construction of concrete wall buttresses, in order to withstand the high grouting pressures used, and considerable difficulty was experienced during the early stages of the work in preventing the injected cement from washing out of the water-bearing crevices. Unsuccessful efforts were made to prevent this by mixing oats and bran with the cement mortar, as used in other subaqueous tunnels.

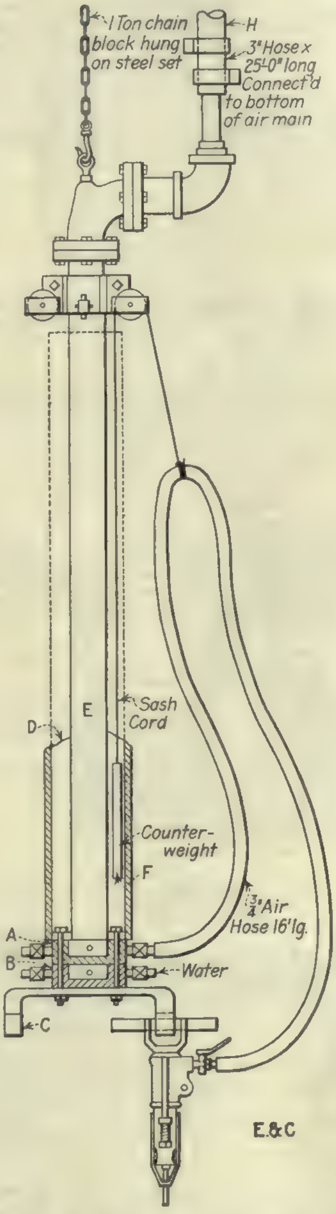

1 Ton chain block hung on steel set
H
3" Hose x 25'-0" long Connect'd to bottom of air main
E
Sash Cord
D
Counter-weight
F
¾" Air Hose 16' lg.
A
B
Water
C
E.&C

Fig. 1. Drill Connection Used in Sinking a Mine Shaft at Ironwood, Mich.

Another method introduced, which proved of great benefit and aided in securing the injected cement, consisted of the addition of a handful of fine-cut cotton waste to each batch of grout, which by fibrous reinforcement of the cement held it in place while it was setting. During lengthy grouting periods, two machines were used alternately in series, thereby maintaining a continuous injected flow.

The special machines for grouting with 500-lb. air pressure were designed and assembled at the tunnel works. The general arrangement and capacity were identical with the riveted pans for 200 lbs. pressure, with the exception of some details designed to resist the higher pressure. The entire pan and the cover were made of cast steel, carefully annealed and tested, and having no joints other than that of the cover. The heads were made in convex form; one end was cast in one piece with the body, and the other was a cast-steel removable cover with male and female bolted flanged joints. In operation these pans were very reliable, and, when required, one pan was operated 25 hours without a stop, and discharged 4,500 bags of cement at pressures varying from 350 to 500 lbs. Extra heavy 2-in. screwed pipe was used for the transmission of the high-pressure air from the engine-room to the heading, with the exception of the first 600 ft., where extra heavy 4-in. pipe was used to give greater storage capacity. Special 1-in. hose was used to make the connection between the air line and the grout pan. This was a 6-ply rubber and canvas hose, with a marline woven cover, wound with 3/16-in., half-round, steel wire, 4/10-in. pitch. Knox standard couplings were fitted to each end. A special 2-in. grout hose was used, this also being of 6-ply rubber and canvas, wound with 3/16-in., half-round wire, ½-in. pitch.

A Novel Method of Handling Drills in Shaft Sinking.

(Staff Abstract.)

The shaft is vertical and its overall dimensions are 13 ft. 1 in. by 21 ft. 1 in. It is being sunk by the Newport Mining Co., at Fernwood, Mich. The novel feature of its excavation is the use of so-called "headers" to support and supply a number of drills each. The sketch, Fig. 1, shows a "header" with a single drill attached. When ready to drill, all that is necessary is to remove the jackhammer from the hook and pull downward, the counter weight *F* keeping the slack hose out of the way while drilling.

A is a casting 9 ins. in diameter, bored out in the center, and having a bolt circle of a standard 4-in. flange. Eight holes evenly spaced are drilled in the sides and tapped for ¾-in. nipples, to which the machine hose connections are made. *B* is a duplicate of *A* with the exception that the holes for the nipples are of different size. There are seven ½-in. connections and one 1-in., the latter being an inlet for the water and the others for water discharges to the drills. The hooks or hangers marked *C*, are made of ⅜-in. x 2-in. strap iron. There are four straps with a hook on each end. *A*, *B*, and *C* are all held together by four ¾-in. bolts passing through the 4 in. flange at the bottom of the 4-in. air pipe *E*. The ell at the top is made special, with a lug cast on it to accommodate the 1-in. eye bolt by means of which the "header" is suspended. *D* is a 9-in. pipe which serves as a casing to enclose the counter-weights, *E*.

Two of these headers are used. Each will accommodate seven jackhammers and one blowpipe, but only six machines are used on each at present. When not in use the "headers" are hung off to one side in the headframe and can be easily lowered by means of a sling beneath the bucket. While in use they hang on a small chain-block fastened to the bottom shaft set. By means of this chain-block the apparatus can be brought to any desired height, the adjustment being allowed by the use of a 3-in. air hose *H* which connects to the air main, the bottom of which is always far enough up the shaft to avoid any severe blows during blasting. One of these outfits can be taken from its position on surface and placed on the chain-block below ready for drilling in less than five minutes, only one connection being necessary to make.

The preceding description is taken from a paper by J. M. Brown, Mining Engineer, Newport Mining Co., read before the Lake Superior Mining Institute.

Method of Recovering a Caved in Shaft in South Africa.

(Staff Abstract.)

An ingenious method of excavating through caved material filling an inclined shaft is illustrated by the accompanying drawings. The work was done in South Africa at the Bantjes Consolidated mines and is described in the September Journal of the South African Institution of Engineers by Percy Cazalet and W. W. Lawrie, engineers. The abstract which follows is much condensed and the illustrations have been redrawn.

The shaft is a five-compartment one, with four skipways and a ladderway, the outside dimensions being 33 ft. by 7 ft. 6 ins., and the grade 34½°. Figure 1 gives details of the shaft and equipment, and also shows the steel setts with which the shaft was framed. The method by which the tracks are laid on continuous concrete stringers, instead of on timber sills, is also shown.

Figure 2 shows two cross-sections through the shaft, and conveys a good idea of the geological features. The large dyke overlies the shaft at a distance varying from 8 ft. on the east side to 38 ft. on the west. The subsidence was due to the decomposed dyke becoming saturated with water from heavy rains and being converted into a plastic mud with little or no "internal friction." The whole weight of this saturated mass was thus applied to the capping of sandstone, which forms the immediate roof of the shaft, which latter fractured under the stress, throwing the weight onto the steel shaft framing, which collapsed with practically no warning. The sides of the shaft remained intact and solid, and showed no signs of pressure.

The steel setts totally collapsed for a distance of 95 ft. (from 125 ft. to 220 ft. from the collar of the shaft), while a further 35 ft. partially collapsed. The vertical distance from the surface was 65 ft. at the top end and 115 ft. at the bottom, or, say, 90 ft. at the center of the fall. All the power cables were fractured, as well as the air and water mains. A winze 85 ft. in depth was started from the west side of the shaft, above the fall, to the first level, and a second winze of about 20 ft. from the first level into the incline below the fall. Cables and rising mains were then connected through, and the pumps restarted ten days after the accident.

It was decided to first recover and timber the two eastern compartments and to equip the winze which had been sunk to the first level as a ladder way, leaving the recovery of the remaining three compartments until the ground had settled and drained. In reopening caved areas the removal of the broken rock is the principal factor in the speed of advance. The initial stages of work were much delayed by this difficulty, which was overcome by opening up a rise in the channel between the concrete stringers in the east compartment (the steel girders and lagging of the setts, which were resting on the rails, forming a natural cover). Small curved plates were laid down on the bottom of this rise to form a chute. In order to control the size and amount of rock passed down this chute and thus prevent it from becoming choked, an 8-in. pipe, 9 ft. in length, was laid in the chute at the face of the fall, and moved forward as the face advanced, the broken rock being hand fed through this pipe into the chute and carried down with a stream of water.

A temporary 3 ft. track was laid between the rails of the main track, on which ran an ordinary drill trolley, 7 ft. 6 ins. in length and 12 ins. in depth and 2 ft. 9 ins. wide. To facilitate discharging, the lower end was hinged and fastened by means of a hook and catch pin.

For cutting through the bent and twisted steel "setts" the oxygen-acetylene flame was used. The plant was a size 2 Sirius plant. The cutting was done by an apprentice fitter, the time taken to cut through a 9 ins. by 4 ins. girder varying between seven and fourteen minutes.

From the experience gained in the preliminary work, it was evident that one had to deal with running ground consisting of badly crushed, rotten sandstone with water-logged decomposed dyke above, and it was recognized that "spiling" in some form or other was necessary in advancing through the fall. It was decided to depart from the methods which have usually been employed in work of this kind, and to adopt the method developed while working in the ladder way. This method is a modification of that employed in tunneling through loose ground by means of advanced casing pushed forward by hydraulic plant, followed by permanent brick or other casing built up in sections as the work advances. In this example the advanced casing was represented by four to five traveling setts of timber supporting 15 ft. lengths of 45 lb. rails. These rails were driven forward with 14 lb. hammers. As they advanced the broken ground was cleared from under them at the face and a sett of timber erected, the rear sett being taken down.

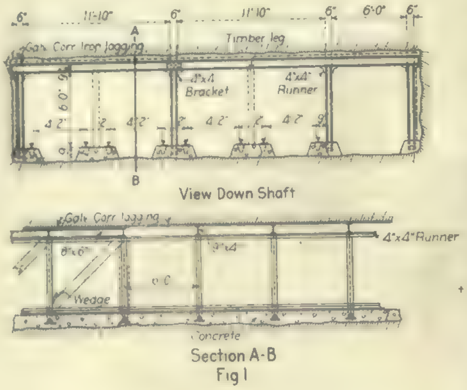


Fig 1

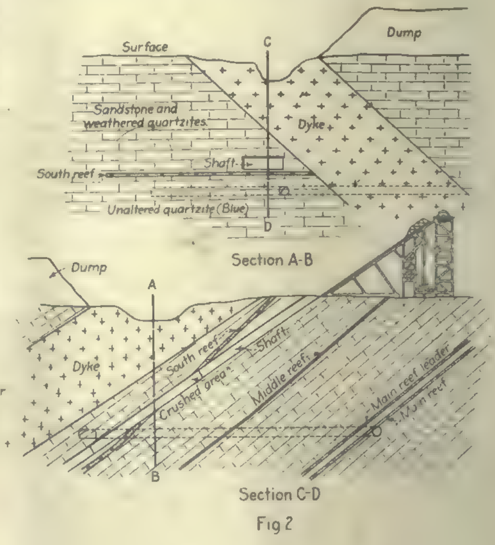


Fig 2

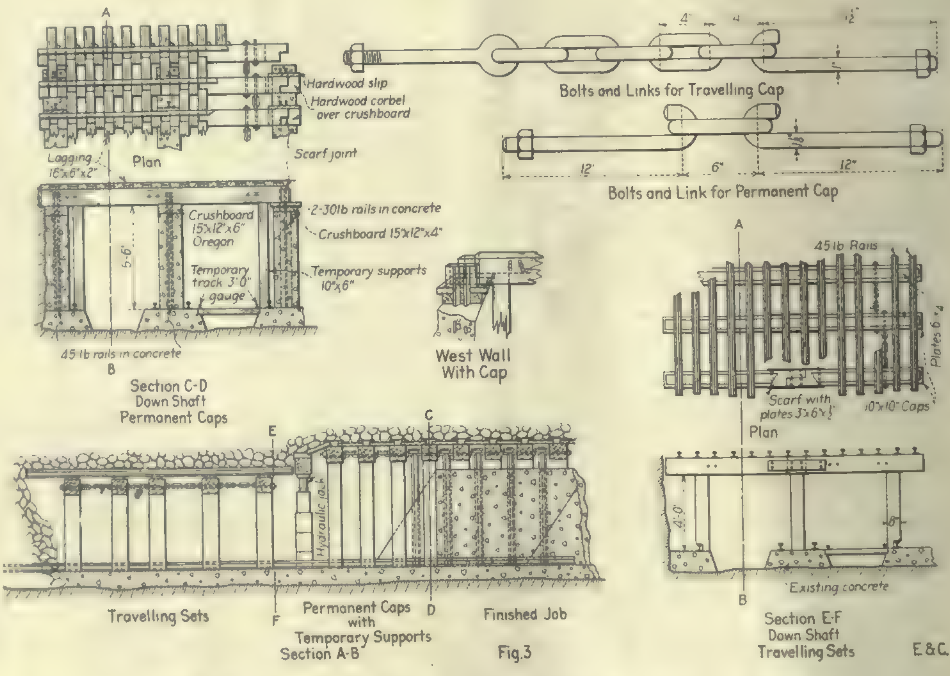

A
Hardwood slip
Hardwood corbel over crushboard
Lagging 16"x6"x2"
Plan
Scarf joint
Crushboard 15"x12"x6" Oregon
Temporary track 3'0" gauge
2-30 lb rails in concrete
Crushboard 15"x12"x4"
Temporary supports 10"x6"
45 lb rails in concrete
B
Section C-D Down Shaft Permanent Caps
West Wall With Cap
4"
Bolts and Links for Travelling Cap
12"
6"
12"
Bolts and Link for Permanent Cap
A
45 lb Rails
Plates 6"
Scarf with plates 5"x6"
10"x10" Caps
Plan
4'0"
Existing concrete
B
Section E-F Down Shaft Travelling Sets
E
C
Hydraulic jack
Travelling Sets
F
Permanent Caps with Temporary Supports
D
Finished Job
Section A-B
E&C.

Fig.3

Sketches Showing Method of Recovering a Caved-in Shaft.

Fig. 1. Sections of original shaft showing timbering. Fig. 2. Geological sections showing cause of collapse of shaft. Fig. 3. Sketches showing details of new shaft construction.

Five complete setts of timber were used, consisting of 10-in. square caps 14 ft. long, made in two halves for convenience in handling, with a scarf joint in the center. The legs or dividers were of 10x8-in. timbers, 3 ft. 6 ins. long. The setts were tied together with studdles and chains with short hook bolts, instead of the usual hanging bolts. The chains and hook bolts allowed of a great variation of centers, and enabled the setts to be easily taken adrift.

The height of the traveling setts depends on the height of the permanent work to be put in. They should be of such a height that the permanent caps do not interfere with the free use of the hammer when driving the rails, while at the same time giving the maximum height possible for convenience in working. Six-in. by ½-in. steel plates (to reduce friction) were bolted on the caps, and to ensure that the rails travel parallel to the shaft the caps should be pegged, the distance between the rails being 6 ins. If this is not done it is found that the rails tend to collect towards one end of the cap.

To prevent the setts from traveling down hill as the fallen ground was drawn off in advance, every second sett was anchored back by two long 1¼-in. steel hoisting ropes provided with large turn-buckles at their upper ends for making them taut.

The driving of the rails presented no difficulties, traveling right through the full 95 ft. of fall with very few renewals and with but little exertion on the part of the native strikers.

The permanent caps were of 10x10 ins. pitchpine, fitted on the top with boxing (see Fig. 3), which makes it possible to place short lagging on the caps and to renew this lagging easily. The caps were put in at 20 in. centers, and were hung from one another by 1-in. bolts and links. The safe distance which the traveling setts could be advanced ahead of the permanent work was not more than 22 ins., and that distance was only obtained by putting the short lagging into the boxes on top of the last permanent cap, and keeping them in place by spikes through temporary blocks nailed at the side of each box.

The permanent caps, after being placed in position under, and as close as possible to, the lagging, and after the links and bolts had been fastened up, were jacked into position by two 50-ton hydraulic jacks.

Attempts were first made to support the caps on 10x10-in. dividers; resting on 6-in. softwood footboards, with a 5-in. hardwood corble against the caps. These dividers stood the pressure, but it was found impossible to prevent the caps from being forced down the shaft, and thus taking the dividers out of the square, even when these were set as much as their own width out of the normal.

It was, of course, impossible to put in bearers on account of the running nature of the ground, and the only other alternative was to anchor the setts with wire ropes. These ropes (1¼-in. steel hoisting ropes) were anchored to the concrete stringers higher up in the shaft and fastened to the caps by means of 1⅛-in. eyebolts. They were from 60 to 100 ft. long, and were made taut by large turn-buckles. The creep of the caps continually stretched the ropes to near breaking, but in all cases it was the eyebolts which fractured and not the rope.

After all attempts had been made to overcome the downward creep of the setts it was decided to try whether concrete walls, built up on the existing concrete stringers to such a height as to form both a support and anchorage for the caps, would solve the difficulty. The unusually large clearance of 24 ins. between the tracks made it possible to put in fairly thick walls, and thus made for the success of the idea. By planing down the wide tread rear skip wheels of 5-in. to 3-in. tread and altering the headgear tip it was possible to make these walls 15 ins. in width.

In the meanwhile the first caps put in hand had been subjected to pressure and movement, and were pushed out of alignment. These, for the sake of speed, were left as they were, and concrete piers were built up under them. When the concrete was set, and advance was again possible, the new caps were fasteend to these caps by hanging bolts, and also anchored back by wire ropes fastened to every sixth cap. Where possible the caps were further supported by means of 10x8-in. diagonal struts off the footwall of the shaft pending the setting of the concrete.

These first concrete piers or walls fractured somewhat under the strain, but as they were extended down the shaft they soon became strong enough to catch up and hold the strain, and have held up since then most satisfactorily.

The caps, after being jacked into position, were supported by temporary 10x6-in. legs. Two legs only were necessary, one at each end. A center leg would have added to the difficulty of swinging the caps into position. It is, however, an easy matter to put in a center leg and move it to a fresh position when necessary should the pressure on the cap make an additional leg advisable.

Figure 3 shows the position of these temporary legs and the 3-ft. track laid down. The legs rested on the edge of the concrete stringers and the permanent rails, the foot being cut so that the pressure was taken up by the rail as well as the concrete. When in this position the legs formed the uprights for the housing of the concrete boxes.

The end walls vary in width according to irregularities of the side of the shaft, but all others are 15 ins. wide. The walls are 5 ft. in height, surmounted by a 15x12x6-in. crush-board, on which the caps rest. Forty-five-pound rails, 5 ft. to 6 ft. long, are set in the concrete 1 in. below where the caps are to lie. These rails project 12 ins. above the wall and take the sliding thrust of the caps, and act (through being embedded in the concrete) as bearers supported off the footwall alone. To prevent the rail from crushing into the caps hardwood filling pieces were inserted between the rail and caps.

The west end of the caps was cut so as to form a scarf joint with the east end of the caps to be put into the western portion of the shaft. To increase the bearings portion of the caps at this end they rested on hardwood corbles set out 2 ins. from the wall, while these crush-boards were reduced to 4 ins. in thickness.

It is, of course, necessary when using such an unyielding substance as concrete as the legs on which the caps are carried to supply some form of cushion to take up the crush, as otherwise the caps would themselves be damaged, and, thereafter, when the limit of their compressibility was reached, the concrete might tend to split and slab off the edges. To prevent this and the needless replacement of the caps themselves, which would be expensive, 6-in. Oregon pine crush-boards were laid on the top of the concrete under the permanent caps, and these, as they crush and before their spring is gone, will be renewed by jacking up the cap and substituting a new crush-board. The hardwood filling between the back of the cap and the 45-lb. rail bearer tends to spread the crushing action of the creep down the shaft over a larger area than if the cap pressed directly against the rail, and so also prevents damage to the cap.

Methods and Costs of Driving a 9x10-ft. Drift.

(Staff abstract.)

The work described is interesting because of the speed of driving and the successful employment of mechanical muck loading.

Progress.—The drift was started on September 1, 1914, and was completed June 17, 1915, a distance of 2,960 ft. having been driven, in 240 working days. The record month was May, 1915, when 406 ft. of drift was driven in 26 working days. During this month the best day's progress was 19 ft. 9 in. (due to a partly missed cut on the previous shift); the poorest day's was 12 ft. 9 in., the average daily progress being 15 ft. 8 inches. The average monthly progress throughout the 9½ months was 311 ft. 6 in., the average daily progress being 12 ft. 4 in.

General Methods.—The materials encountered were slate, greywacke and quartzite. The work was done on 2 8-hour shifts, 4 miners, and, for the greater part of the time, 6 muckers constituted the crew. The muckers alternated, one gang of 3 filled a car, while 3 rested. Two No. 18 Ingersoll-Leyner drill machines were used through the work, except for the first 100 ft., when two 3¼-in. piston machines were used. Electric motor haulage was used in 2,300 ft. of the drift, and hand tramming in the first 600 ft. Permanent track on a ¾ per cent grade was laid and kept up to the face of the muck-pile. The trolley wire was kept up within 150 ft. of the breast, the muckers tramming the car this distance to the motor. At intervals of 300 ft. along the drift, sidings were cut to hold these motor cars. Throughout the work 80 per cent dynamite was used.

Cuts Employed.—Figures 1 and 2 represent the two cuts used. Figure 1 was the cut commonly employed for the slate drifting, and Fig. 2 for the quartzite and greywacke. This latter cut was varied as the ground required.

In Fig. 1, holes 1 to 11 were drilled from the bar in one position, and fired in one blast. To complete the square, all 14 holes were fired on the second blast. It was found that only when holes 5-6 and 9-10 intersected at their respective ends, that good results were obtained. This point was carefully watched, the shift boss always testing these holes before each blast. For the extremely hard ground, such as the quartzite encountered, the cut was made as in Fig. 2, the top 15 holes being fired in the first blast, and all 19 holes to complete the second cut and square. The two relief cut holes (see Fig. 2), were drilled to meet at a depth of 3 feet. For the moderately hard ground, such as the greywacke, two easing holes were drilled as in Fig. 2, instead of the 3-ft. relief cut.

Fig. 3 shows the cycle of operation to complete the square, "A" representing the portion removed in the first blast, "B" that portion removed in the second blast. Each shift blasted twice, completing the cut, leaving the drift squared at the end of the shift. During the entire progress of the drift, there was but one slight injury, that being caused by a piece of rock hitting a miner's hand while barring down loose ground from the back.

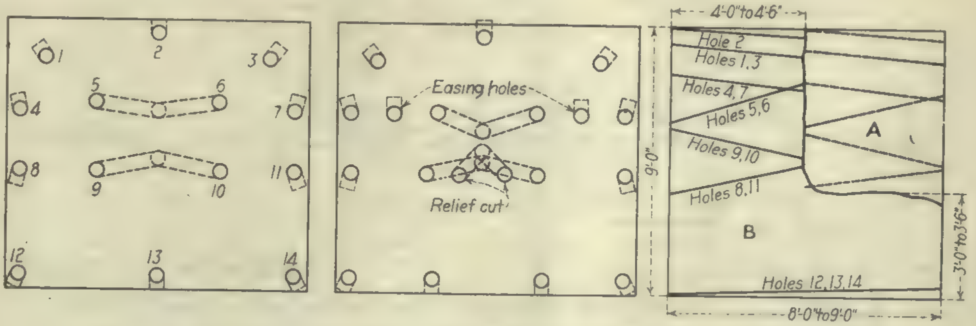


Fig. 1-3. Sketches Showing Cuts Employed in Driving a 9x10-ft. Drift.

Disposal of Rock.—Three-ton saddle back motor cars were used in the work, having a height of 5 ft. 6 ins. above the rail in the clear, which necessitated considerable lifting by the muckers. This difficulty was greatly overcome by the installation of a portable loader. This loader consisted of an inclined steel-apron conveyor belt with 2¼-in. angle irons placed 15 ins. center to center, mounted on a roller bearing truck, operated by a 5-h.p. series motor taking current from the underground haulage wire. The loader was arranged so that the angle of the incline could be reduced, allowing it to pass under the trolley wire. The muckers shoveled into a hopper at the lower end of the belt, the rock being conveyed up the incline and dumped into the motor car, which was run under the top end. A small part of the rock could be picked down from the pile into the hopper. Three muckers shoveled, while one trimmed the car. The work was speeded up after the loader went into commission, as it became possible to handle more rock. Within a week the output was increased 25 per cent, and later on it often reached 30 per cent. The whole cycle of operation was completed earlier on the 8-hour shift, giving more time for drilling, consequently deeper cuts were tried, with extra holes, to incure breaking.

Costs.—Table I gives the cost of the 2,960 ft. of drift.

TABLE I.

	Labor.	Supplied.	Total.	Cost per ft.
Miners	$ 8,430.27	$ 1,587,73	$10,018.00	$ 3.384
Mucking	8,169.03	......	8,169.03	2.760
Tramming	1,117,92	498.39	1,616.31	0.546
Explosives	......	6,889.86	6,889.86	2.325
Air	......	720.00	720.00	0.244
Shop expense	460.00	230.00	690.00	0.233
Machine repairs	135.50	1,196.27	1,331.77	0.451
Air & water hose	......	75.00	75.00	0.025
Carbide	......	95.00	95.00	0.032
Total cost	$18,312.72	$11,292.25	$29,604.97	$10.000
Per foot	6.18	3.82	......	......

These data are abstracted from a paper by J. E. Hayden, Mining Engineer, Cleveland Cliffs Iron Co., read before the Lake Superior Mining Institute.

Underground Magazines for the City Tunnel Catskill Aqueduct.

(Staff Abstract.)

One of the rare instances in American tunneling in which use has been made of underground magazines for storing explosives was the tunnel work in New York city for the Catskill Aqueduct. Figure 1 shows a 1,000-lb. magazine in plan; all magazines were located adjacent to shafts. Referring to Fig. 1 the chamber is 20x32 ft. in plan, 7 ft. high, and is connected with the main tunnel by an accession drift 6 ft. wide by 7 ft. high. This drift is provided with two right angle turns and dead ends to retard the explosion wave. The shortest distance to the tunnel is 55 ft.

A heavy door built to withstand a pressure of 150 lbs. per square inch with a factor of safety of 6 and designed to confine within the chamber the noxious gases and full force of the explosion is located at the entrance of the accession drift. This door is arranged to stand at an angle less than 45 degrees to the line of drift, when opened. The force of the explosion will close it instantly; in fact, an experimental explosion of half a dozen sticks of dynamite closed the door.

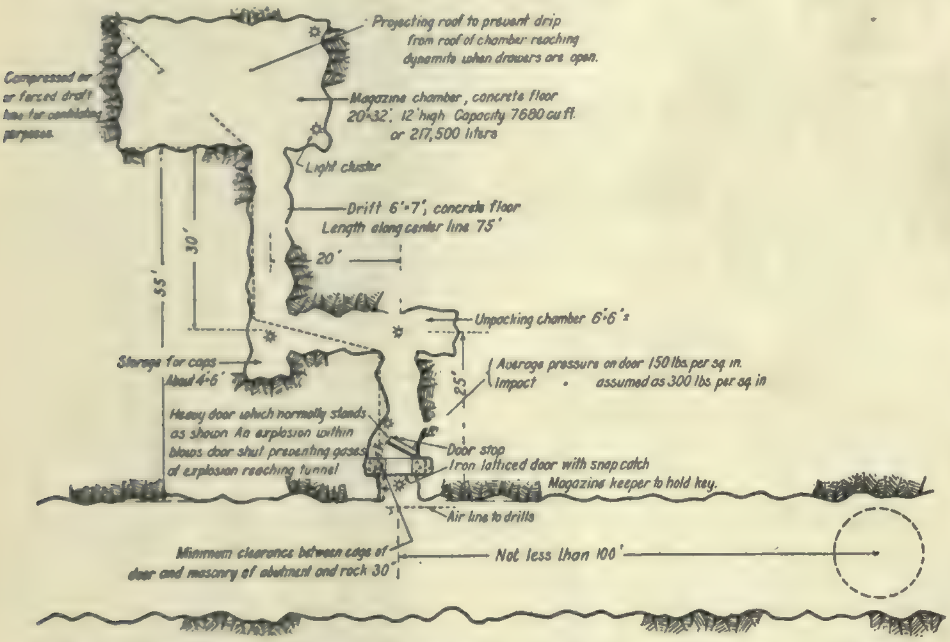

Projecting roof to prevent drip from roof of chamber reaching dynamite when drawers are open.
Compressed air or forced draft line for ventilating purposes.
Magazine chamber, concrete floor 20'×32'. 12' high Capacity 7680 cu ft. or 217,500 liters
Light cluster
Drift 6'×7'; concrete floor Length along center line 75'
30'
55'
20'
Unpacking chamber 6'×6'
Storage for caps About 4'×6'
25'
Average pressure on door 150 lbs per sq in. Impact " assumed as 300 lbs per sq in
Heavy door which normally stands as shown An explosion within blows door shut preventing gases of explosion reaching tunnel
Door stop
Iron latticed door with snap catch Magazine keeper to hold key.
Air line to drills
Minimum clearance between edge of door and masonry of abutment and rock 30"
Not less than 100'

Fig. 1. Underground Explosives Magazine Used on the City Tunnel, Catskill Aqueduct, New York City.

Ventilation is provided by a connection with the compressed air line to the furthest corner of the chamber and illumination is furnished by electric lights as indicated. A latticed door with snap latch at the drift entrance excludes unauthorized persons.

The chamber has the dimensions shown, in order to keep the average pressure down to 150 lbs. per square inch. With a charge of 1,000 lbs. (455 kilograms) and a chamber volume of 217,500 liters the relation is 1 to 455. If we include the volume of the accession drift, this relation is reduced to 1 to 674. As determined by French experiments, the relation between the charge in kilograms and the capacity of the chamber in liters should not be less than 1 to 100.

The resulting pressure on the door figured from Heise's formula is 150 lbs. per square inch. To prevent deformation due to impact, the design of the door is based on 300 lbs. per square inch. The door to withstand this pressure on the span over an opening 4 ft. wide and 6 ft. high was made up of 15-in. I-beams spaced about 12 ins., filled in with 12x12-in. timbers. Mr. M. J. Ungrich, Section Engineer in the City Aqueduct Department, designed the door.

All underground magazines for the City Aqueduct tunnel were located at safe depths below the street level; the shallowest being at Shaft 18, where the depth was 195 ft.

Minimum Slopes for Concrete Chutes.

To The Editors: In your issue of Nov. 17 I notice correspondence with reference to the minimum slope for concrete chutes. The importance of selecting a proper mimimum is evidenced by the large number of structures in which the concrete is defective, either in actual strength or in separation of layers by laitance, because of the use of a too wet consistency. When wet concrete first supplanted dry concrete mixtures an extremely wet mixture was adopted, sometimes as flat a slope being used as one foot vertical to 8 feet horizontal. Tests* and experiences have shown the poor quality of concrete that is obtained with a mixture wet enough to flow on flat slopes. After much experimenting the minimum slope adopted by the Superintendent, Mr. Carr, in the construction of the new buildings of the Massachusetts Institute of Technology was 30 degrees with the horizontal. This slope will permit a concrete of first-class consistency for reinforced concrete work which will just flow in the chute and will find its place around the reinforcement and in the corners of the forms. A flatter slope than this, such as is indicated by your correspondent in the letter referred to, results in a concrete which is weaker than is required for normal stresses adopted in building construction and tends to produce separation of the materials. As a consequence, thick layers of scum or laitance are formed on the surface of the layer of concrete or on the tops of columns, which endanger either the strength, or, in other cases, the water-tightness of the structure.

So many cases have come to the attention of the writer during the past few years of poor concrete produced by a wet mixture such as must be used in a chute of flat slope that he desires to emphasize the absolute necessity in first-class construction of limiting the slope to a pitch which will eliminate soupy concrete mixtures.

Yours very truly,

Sanford E. Thompson.

Boston, Mass., Nov. 19, 1915.

The government of Greece has under consideration plans for the construction of 603 miles of main and branch line railroads. The present mileage is 1,367.

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Excavation Progress in the Culebra Slides.—Excavation from the bases of the Culebra slide on the Panama Canal during the week ending at 6 a. m., Nov. 23, amounted to 246,340 cu. yds. Other excavation from the cut during the same period amounted to 57,510 cu. yds., making a total for the week of 303,850 cu. yds. Excavation on Nov. 22 amounted to 48,622 cu. yds. for the 24-hour day. This sets a new high record for a day's excavation in the Cut. The excavations by the several dredges on the record day and during the week ending at 6 a. m., Nov. 23, were as follows:

	Yardage.	
Dredge and type.	Day.	Week.
Cascadas, 15-yd. dipper	12,445	83.205
Gamboa, 15-yd. dipper	11,175	73,040
Paraiso, 15-yd. dipper	10,660	50,675
Corozal, ladder	6,005	33,430
No. 86, pipeline suction	5,100	34,120
Culebra, seagoing suction	3,237	23,390
Marmot, Belgian ladder	......	5,990

The total excavations for the preceding four weeks were 239,885; 254,286; 256,262; and 294,698 cu. yds., respectively.

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*See paper on "Consistency of Concrete," by Sanford E. Thompson, American Society for Testing Materials, Vol. VI, 1906, p. 358.

4-19-23

The Lighter Side of Engineering and Contracting

The Hairs on His Head Are Numbered 1, 2 and 3.

THE St. Louis Globe-Democrat tells this one:

Andrew Koenig, president of the Koenig Labor Agency, shook from head to foot with laughter when he hurriedly stepped into a barber shop the other day. Incidentally, it was some shake, for Koenig weighs about 325 pounds. "I want to be shaved real quick," Koenig told the barber. Then, as he took a seat in the chair, he exclaimed: "Oh, I forgot to take off my collar, but I guess you can shave me without me taking it off?" "Sure," replied the barber, "I could cut your hair without taking your hat off."

Lest the point of the joke on Andy be lost we quote the following dimensions from a letter of B. A. D., to whom we are indebted for the above anecdote: "To be exact, eliminating the mustache, his face covers 296 sq. ins., and the hair on his head ends 2⅜ ins., due north of the back collar button on his shirt."

"The Quality of Mercy."

IN a town in northern Canada, where considerable railway construction was in progress and where liquor was contraband, the police magistrate was something of a character. Usually his duties consisted in trying offenders against the liquor laws, and his knowledge of the statutes covering such cases was sound and complete. On the present occasion, however, the prisoner's offense, in addition to being drunk, was vomiting on the bedding supplied by the local hotelkeeper, and the court was distinctly puzzled. He fingered the pages of the heavy book in front of him while the prosecution thundered denunciation of the offender's misconduct. He was still fingering the pages when the impassioned eloquence of the defense exhausted itself. Turning the last page he closed the book emphatically and glared down on the prisoner. "Vomited in the bed, did you?" he inquired. "Well, vomitin' aint in this book." Then, to the constable in attendance, "Take the disgustin' brute away an' hang him!"—C. T. L., Capitola, Cal.

Why He Didn't Grease the Axles.

ON a certain reservoir job the contractor was short of laborers, so when a hobo came along and applied for work he received the glad hand. The foreman started the new man at greasing the axles of some wagons. In a remarkably short time he came back for a new task. "What," said the boss, "do you mean to say you've got all those wheels greased?" "Well," said the 'bo, "I greased the two front ones." "And why didn't you fix up the two hind ones?" "Well," explained the man calmly, "so long as the two front wheels go all right, the two hind ones have to follow, don't they?"

You Can't Tell Me Nuthin'.

BERTON BRALEY IN THE COAL AGE.

"You can't tell me nuthin'," the pitboss, he says;
"You can't tell me nuthin' a-tall,
I don't need advice from no hunkies like you—
An' if I do need it, I'll call;
I guess I kin tend to my business o. k.
Without no attention to nuthin' you say.

"You can't tell me nuthin'," the pitboss, he says;
"I reckon I'm on to my job,
An' I'll thank you to keep your suggestions to home,
You miser'ble ignorant slob;
I haven't no time fer to hear your idees;
I guess I'm the boss an' I'll do what I please."

Yes, that was the way that the pitboss come back
When I made a suggestion, polite,
But the Super he heard what the pitboss had said
An' he wasn't contented—not quite.
"Hold on there," he says, when the pitboss got through,
"I guess I'll horn in with a brief word or two."

"They can't tell you nuthin'," the Super repeats,
"Then Lord help you, brother," says he,
"For the guy who imagines he's knowin' it all
Ain't quite the right pitboss fer me.
If YOU can't learn nuthin' from no other man,
I'll go get a feller for pitboss who can.

"We haven't no use fer the feller," he says,
"That thinks he has knowledge to burn,
Who scorns all suggestions that comes from his men
An' won't never listen an' learn.
They can't tell *you* nuthin'—them words makes me tired,
An' I'll tell you something right now—you are fired!"

Apples in Liquid Form.

ONE time when we were on a survey we stopped at a farm house. The owner very kindly brought out some cider. The farmer after drinking a glass of the cider turned to me and remarked: "By gum! there goes about eight apples, and it certainly beats chawin'."—A. P. G., St. Louis.

"Off Again—On Again—Gone Again—Flinnigan."

WHILE the present revolution in Old Mexico was at its greatest height the Southern Pacific Co. of Mexico endeavored to maintain a weekly train service between Nogales and Guyamas, Sonora, Mexico. The distance between the two points is 267 miles, and the rebels have destroyed in the neighborhood of 83 bridges, requiring the construction of numerous shoo-fly tracks to maintain through operation of the line. The company during this period engaged the services of a new section boss, by name of Pat Flinnigan, who was brave enough to take the care of a section in the turbulent country. Pat happened to be a passenger on one of the weekly trips, instead of proceeding over the line via hand car. While the train was traveling along at a lively clip Pat suddenly observed a sudden jolting of the car. Being particularly nervous from the disturbances prevalent in "The Land of Mañana," Flinnigan excitedly ran to the conductor, inquiring the trouble. The latter replied in a nonchalant manner. "Oh, there's nothing the matter, Pat—we're just back on the main line again—that's all."—C. A. E., Los Angeles, Cal."

Unclassified Material.

ON a certain railway construction job the engineers were instructed to report all accidents at once to the chief engineer's office. Some Russians were blasting stumps over a borrow pit and one of them was killed by a premature explosion. The resident engineer ran to the telephone and called up his superior, whose abruptness of speech was his most outstanding characteristic: "A Russian has just been killed by dynamite," he reported. "What shall I do?" "Don't put him in the fill," came the reply. "Those foreigners make damned poor roadbed."—C. T. L., Capitola, Cal.

MURRAY C. STREET, Deputy Commissioner of Public Works of Syracuse, N. Y., recently received a letter from a man who wanted a job. The superscription on the envelope read: "Mr. May Streetsd City Hall Asinte Comnissin Syracuss, N. Y."

Skinner Mulvey says: "Bill Carey writes from Shanghai that a revolution is about to revolute in China and that there's likely to be an Irish president in that country before they get through.

CURRENT NEWS

The Doings of the Week.

Business activities during the past week established a new high record. Bank clearings for the six days were the greatest for any similar period in the history of the country. Exports for October amounted to $334,638,758, a new high level, and indicate an excess of exports over imports for the ten months of $1,626,886,623. Congestion of freight on the eastern railways is now worse than it has been at any time since 1907. Plans are understood to be under way to have a general embargo declared on export freight for a period of 30 to 60 days. One feature of the week was the success of underwritings and security offerings. The $60,000,000 bond issue of the Baltimore & Ohio R. R. found a ready market, being covered three to four times over both in the underwriting and in the public subscriptions. The issue was underwritten at 98, offered for subscription at par and sold in the open market well above 101. In the construction field activities, as indicated by new work advertised for bids, are not on an imposing scale. Building operations are better than normal for this time of year. But other lines are lagging behind. Some construction concerns, realizing the futility of delaying orders for structural material, came into the market last week with specifications and inquiries. Several American contractors are now in foreign countries with a view to sizing up construction prospects. One concern already has been formally awarded a contract by a South American government for sewerage work calling for an expenditure of over $5,000,000. In the iron and steel trade there has been no slowing up of activities. Producers have even booked contracts for a considerable amount of finished material for the third and fourth quarters of 1916. The prices for plates and shapes for cars were said to be 1.85 cts., Pittsburgh. Rail orders include 20,000 tons for the Southern Pacific, 10,000 tons for the Chicago & Eastern Illinois, 15,000 tons for the Missouri, Kansas & Texas, and 25,000 tons for the Missouri Pacific. The Chicago & Northwestern Ry. placed orders for 10,000 tons of structural steel, of which 5,000 tons are for bridges and the remainder for a grain elevator. A Chicago company also placed two orders for reinforcing bars amounting to 4,600 tons. *The Iron Age* prices for finished iron and steel are for sheets, nail and wire for the week ending Dec. 1 were as follows:

Finished Iron and Steel.	Dec. 1.	Nov. 24.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.859	1.859
Iron bars, Pittsburgh........	1.65	1.65
Iron bars, Chicago...........	1.60	1.60
Steel bars, Pittsburgh.......	1.70	1.70
Steel bars, New York.......	1.869	1.869
Tank plates, Pittsburgh.....	1.90	1.90
Tank plates, New York......	2.169	2.169
Beams, etc., Pittsburgh......	1.70	1.70
Beams, etc., New York......	1.869	1.869
Skelp, grooved steel, P'gh...	1.70	1.70
Skelp, sheared steel, P'gh...	1.80	1.80
Steel hoops, Pittsburgh......	1.90	1.75
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.50	2.40
Galv. sheets, No. 28, P'gh....	4.75	4.25
Wire nails, Pittsburgh.......	2.00	1.90
Cut nails, Pittsburgh........	1.85	1.85
Fence wire, base, P'gh......	1.85	1.75
Barb wire, galv., P'gh........	2.85	2.75

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.70 cts. to 1.90 cts.

Railways.—The present freight congestion on eastern railways brings out clearly the need for more adequate facilities for the carriers. As a result it is likely that the eastern lines will soon take steps for carrying out many betterments. One eastern railroad president states that he believes the existing activities will continue for five years anyway. "For that length of time, at least," he states, "there will be an abnormal demand from England, France, Germany, Belgium, Russia and other European countries for food and iron, and steel, and cement, lumber and machinery." In the grain growing districts of the west a number of new railroad projects have made their appearance recently. Most of these presumably are backed by trunk lines, and prospects are good that active construction may be started shortly on some of them. The new management of the Denver & Rio Grande R. R. has announced that a considerable amount of narrow gage line will be standardized and that a new 72-mile extension will be constructed. It is possible, however, that this latter work will not be ready for letting this year. F. Rolandi, San Francisco, Cal., was low bidder for the construction of the 67-mile Hetch Hetchy Valley R. R., for the city of San Francisco. The Central Construction Co., Harrisburg, Pa., is reported to have been awarded contract for the 17-mile line of Richmond, Rappahannock & Northern R. R. in Virginia.

Roads and Streets.—Very little work in the state highway field is being advertised at present. Most of the commissioners are now busy preparing their construction programs for the coming year. Massachusetts is calling for bids on two sections of road. Several small road jobs in Alabama also are ready for bids. A considerable amount of street paving is slated to come up for bids early in January. Ohio opened bids last week on twelve contracts. Oakland County, Michigan, awarded a $62,000 concrete road contract; Austin, Tex., let a 43,000 sq. yd. paving job; Ida Grove, Ia., awarded sheet asphalt contracts amounting to $97,000.

Bridges.—No especially large bridge undertakings reached the call for bids stage during the past week. Philadelphia, Pa., is asking proposals for two fair-sized bridges and the Philadelphia & Reading Ry. also is advertising two jobs. Bids are being asked for construction of 180-ft. steel bridge at Camptown, Pa. Plans are under way for several bridges in western cities, which will cost from $150,000 to $200,000 each. The State Highway Department of California awarded a contract, at $24,671, for a plate girder bascule bridge in Yolo County; E. W. Foley Contracting Co., New York City, secured the contract for the Hamlet Ave. bridge for the city of Woonsocket, R. I., and R. E. & E. N. Spaulding, Suffield, Conn., was awarded the Fairmont St. bridge.

Drainage and Irrigation.—The Secretary of the Interior has approved the budget asking for a congressional appropriation of $9,200,000 for finishing 28 western irrigation projects now under construction. The Drainage Commissioners of Union County, Kentucky, are asking bids on 18 miles of open ditch requiring about 670,000 cu. yds. earth excavation; Cameron County Irrigation District No. 1, of Harlingen, Tex., opens bids Dec. 30 on canal extensions involving 411,900 cu. yds. of excavation. P. Seastrand, Cambridge, Minn., was awarded a contract, at $104,000, for Judicial Ditch No. 3 of Itasca County, Minnesota.

Waterworks.—Hamilton, O., is asking bids for driving three 10-in. wells; South Charleston, O., has readvertised the work of constructing water works; Lees Summit. Mo., opens proposals Dec. 15 for labor and material for water works; Elmhurst, Ill., is taking bids on construction of reinforced concrete reservoir, tower and tank, etc., and for furnishing pumps. Plans have been prepared for a $250,000 water works installation for Tyler, Tex.; plans for new water supply for Oklahoma City, Okla., will be ready in January and bond election will be held in March; Batavia, N. Y., voted $175,000 for water works improvements.

Sewerage.—Cincinnati, O., is calling for bids on the Duck Creek interceptor and Boston, Mass., opens bids Dec. 15 on the Davenport Brook conduit; Edgewater, Colo., let contract for sewerage to cost $29,597; Charleston, S. C., awarded a $16,780 job, and Cleveland, Tenn., let contract for sewerage amounting to about $64,000.

Rivers and Harbors.—The U. S. Engineer at Washington, D. C., is asking proposals for dredging in Anacostia River, D. C. Miami, Fla., is about to begin work on an extensive harbor development and has asked bids for excavating a slip, turning basin and channel, and for constructing a concrete dock. The excavation calls for moving of 1,194,000 cu. yds. of earth and sand and 497,000 cu. yds. of rock. The Port Commissioners of New Orleans, La., are advertising for bids on several large contracts. One of these calls for the erection of a reinforced concrete grain elevator of 1,000,000 bus. capacity.

Work for Irrigation Districts.

A tremendous amount of construction is proposed by irrigation districts in the far west. If all this work was placed under contract at one time there probably wouldn't be an idle outfit west of Salt Lake. This plan of reclamation has made decided gains in favor in the past three or four years. Many districts have been organized, have completed their engineering details and have authorized bond issues for installing the systems. Unfortunately these securities, under the present financial conditions, are not as popular as they might be with the investing public. As a consequence work that would keep many contractors busy is being held in abeyance. Some districts recently entered into negotiations with contractors to construct their projects and take bonds in payment. Under certain conditions this plan would seem to be attractive for large contractors in a position to finance such an undertaking. It seems likely that there will be a better market soon for the bonds of irrigation districts. If this should be the case there will be plenty of earth moving jobs in Oregon and Washington ready for contractors to move onto.

$90,000,000 for Construction.

There is nothing slow about Philadelphia, Pa. It probably has more construction under way at present than any other eastern city, with the exception of New York. And it now proposes a $90,000,000 loan for municipal development. At lease one-half of this total is to be applied to the building of subways and elevated railroads, while $8,000,000 is to go for piers and other waterfront improvements. Practically every kind of city construction is provided for in the loan. Main and branch sewers and the new sewage disposal system are provided for; provision also is made for street improvements, for grade crossing elimination, for parks, for water works improvements and for erection of buildings. All classes of contractors will find construction opportunities if the loan is authorized at the special election on Feb. 8. A $90,000,000 city expansion plan is worthy of note.

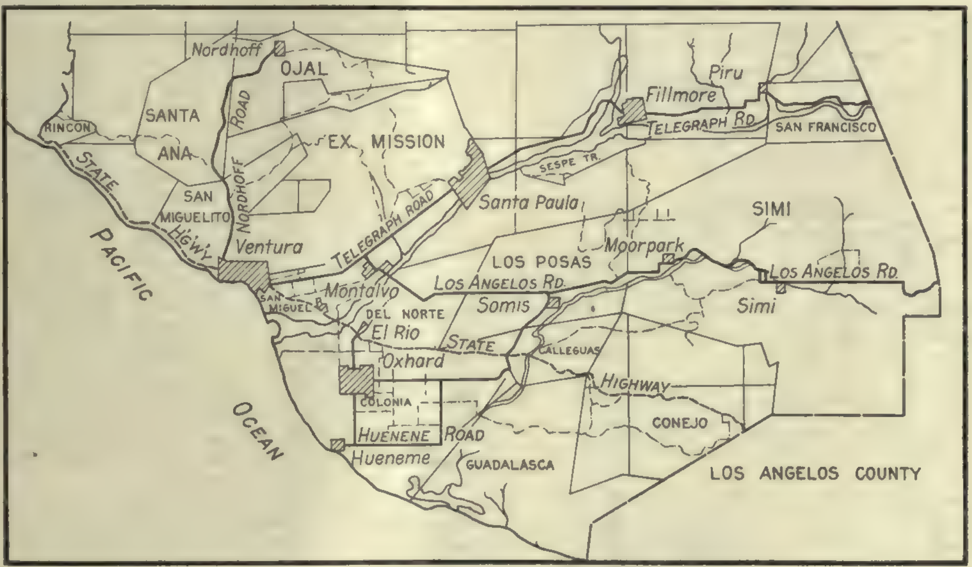
A $1,000,000 COUNTY HIGHWAY SYSTEM.

Improvements for 104 Miles of Roads in Ventura County, California.

Bituminous Surfaced Concrete and Bituminous Macadam.

Ventura County, California, proposes the expenditure of $1,000,000 during the next two years for the improvement of its main trunk highways. Engineering work is now underway and it is expected that the first construction letting will be held sometime next month. The system will be constructed under a $1,000,000 bond issue authorized at an election last August.

The plan of development in general provides for the improvement of two main roads (Telegraph Road and Los Angeles Road) extending across the county from the west to the east; a main road (Nordorff Road) extending north from Ventura, and several roads radiating from Oxnard. The Nordorff Road follows the Ventura River for the greater portion of its route and has its terminus at Nordorff in the northern part of the county. The Telegraph Road starts at Ventura and follows roughly the Santa Clara River. It passes through Santa Paula, Fillmore and Piru. The location of the roads is shown in the accompanying map. About 104 miles of main trunk roads are to be improved under the bond issue. In addition connecting links through the incorporated towns will be constructed from general county funds.



Location of Main Trunk Highway System of Ventura County, Cal.

A considerable amount of bridge and culvert construction is included in the program and it is expected that part of this work will be started at once. The total expenditure for bridges and culverts is estimated at $170,000. The other estimates include the following items:

Grading and shaping roadbed	$204,000
Pavement	563,000
Guard fences	9,000
Protection jetties	5,000
Engineering and inspection	49,000

Two types of surfacing will be used in the improvement. One of these will consist of a concrete base with a bituminous wearing surface, this construction being similar to that employed on the State Highway System. The other type will be a bituminous macadam similar to that of the Los Angeles County Highway system. A rock crushing and gravel screening plant will be installed by the county for furnishing materials for the work. The construction will be carried out by contract.

The system will be installed under the supervision of a County Highway Commission with headquarters at Ventura, Cal. A. G. Hardison is Chairman of the Commission and Charles W. Petit is Chief Engineer

Railway Contracts Let Recently.

An encouraging development in the railway construction field is the number of small lines placed under contract recently. In a number of cases these developments probably are to be carried out by subsidiary companies of the larger railways. Some of the projects, however, are to be undertaken by independent concerns. This in itself is important, for it indicates that the smaller undertakings are beginning to interest investment capital.

In Texas the Midland Northwestern Ry., a new company, has started grading for a line from Midland through Andrews and Gaines County. The Texas & Pacific Ry. will furnish the steel and equipment for this line, and the promoters will carry out the construction. The work involves 350,000 cu. yds. of earth excavation and embankment and one 400 trestle. J. A. Hunter, Strawn, Tex., is the grading contractor; G. W. Thaxter, Midland, Tex., the engineer, and T. J. O'Donnell, Midland, the president.

In Kentucky a number of short spur lines are projected, most of them being backed by large railroads. These new lines are planned for the most part for reaching new coal fields. Construction was started a few days ago on one of these lines. This is the Cumberland & Manchester R. R., which proposes a 24-mile road. The route leaves the Louisville and Nashville R. R. at Barbourville, Ky., and extends up Little Richland Creek, through Jones Gap and down Collins Fork of Goose Creek to Manchester, Ky., passing Cannon, Girdler, Hopper and Woodlawn, Ky.

The construction of the Cumberland & Manchester R. R. will require 150,000 cu. yds. of earth excavation, 243,000 cu. yds. of embankment, 30,000 cu. yds. of rock excavation, 3,400 lin. ft. of trestle, 7,000 cu. yds. of masonry and five bridges, 20, 30, 40, 30 and 50 ft. spans, respectively. The contract was let on Oct. 31 to the Reid Construction Co., Pittsburgh, Pa. Mr. E. S. Posey, Barbourville, Ky., is Chief Engineer of the railroad.

Railway Construction in Mexico.

A great amount of railroad construction probably will be undertaken in Mexico when peace is permanently restored. Already the Carranza government has taken under consideration plans for the building of several thousand miles of new line. In addition a great deal of work will be required for the restoration of the present lines to their former condition. New bridges will have to be built and many miles of roadbed reconstructed.

Several of the new lines projected by the de facto government will serve the northern portion of the Republic. One of the most important of these projects will parallel the Rio Grande River and will furnish transportation facilities to the border territory between Nuevo Laredo and Piedras Negras. Later it is proposed to extend the line from Nuevo Laredo to a connection with the Matamoras-Monterey division of the National Rys. This would form an all rail route between Matamoras and Piedras Negras, a distance of about 500 miles.

Another of the proposed lines extends from Monclova, State of Coahuila, to the city of Chihuahua, a distance of about 450 miles. This line would traverse a region containing many coal deposits. American capitalists were granted a franchise by the Diaz administration for this line and had their preliminary details well advanced at the time of the Madero revolution.

One of the most important of the railway enterprises now under consideration is the line from Tampico to Matamoras, 315 miles. This line will connect with the Tampico-City-Mexico cut-off, work on which is to be resumed soon and will give a new rail route between the Mexican capital and the United States, which would reduce the distance about 200 miles as compared with the shortest of existing lines. It is proposed to extend the Monclova branch of the National Rys. to the mining town and district of Sierra Mojada, a distance of 70 miles. At the latter place a connection will be made with the Mexican Northern R. R.

Railway conditions in Mexico have undergone a great improvement in the last few weeks. This is indicated by the visit last week of Mexican officials to New York City to arrange for the resumption of sleeping car service between American cities and the city of Mexico.

Alberto Peni, Mexico, D. F., is Director General of Railways for the Republic of Mexico, Arturo Peni, Mexico, D. F., is in charge of construction for the National Rys.

A $90,000,000 Construction Program.

The citizens of Philadelphia, Pa., according to present plans, will vote Feb. 8 on a $90,000,000 loan for municipal improvements. A bill of this amount was introduced in the lower branch by the Council's Finance Committee. The principal items in the proposed expenditure are $45,000,000 for the construction of subways and elevated railways and $8,000,000 for port developments. It is planned to take care of these items under the provisions of the authorized amendment to the constitution, giving the city by an increase of 7 to 10 per cent on the realty and personal property assessment an additional borrowing capacity for these special purposes of $68,700,000.

A summary of the various projects to which the loan is to be applied is as follows:

Port	$ 8,000,000
Subway and elevated railways	45,000,000
Mandamuses	2,000,000
Parkway	2,000,000
Main sewers	2,000,000
Branch sewers	1,000,000
Bridges	1,000,000
Sewage disposal system	2,000,000
Repaving	1,250,000
Grading	1,000,000
Country roads	750,000
Street intersections	500,000
Water improvements	2,500,000
South Philadelphia grade crossings, etc.	5,000,000
Grade crossings	1,000,000
Philadelphia Hospital	2,000,000
Fire and police houses	1,000,000
Art museum	3,000,000
Free library	1,000,000
Small parks	750,000
Fairmount Park	1,000,000
Recreation centers	750,000
Convention hall	1,000,000
Municipal Court building	1,000,000
Byberry Hospital for Insane	2,000,000
League Island Park	500,000
Northeast boulevard	1,000,000
Total	$90,000,000

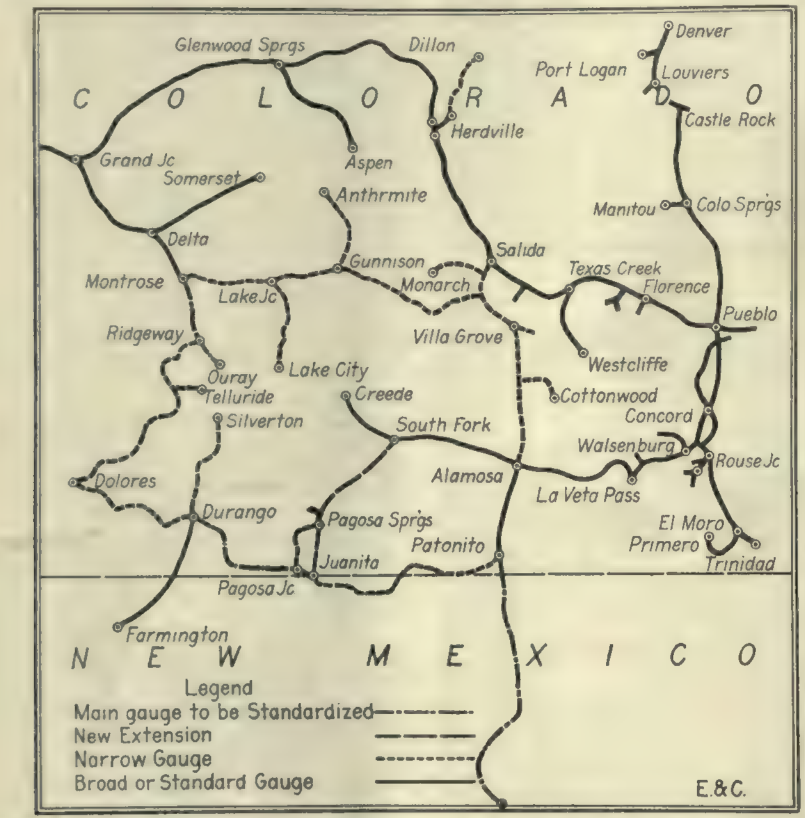
The $5,000,000 item for South Philadelphia will be used for the completion of the improvement scheme for that seltion of the city. It will include the elimination of grade crossings, the reclamation of land south of Oregon Ave. and the building of great diagonal boulevards and new connecting streets.

RAILROAD WORK IN COLORADO.

Construction Proposed by Denver & Rio Grande R. R.

255 Mile of Line to Be Standard Gaged—72 Miles of New Work.

An extensive construction program was announced last week by President H. U. Mudge of the Denver & Rio Grande R. R. The work, in general, calls for the standard gaging of 255 miles of narrow gage lines in Colorado and New Mexico and the building of 72 miles of new line. The accompanying map shows the lines to be broad gaged and the new branch.



Narrow Gage Lines of Denver & Rio Grande R. R. to Be Standardized and New Branch.

The new construction will extend from South Fork to Juanita, where a connection will be made with the present 3-ft. gage line to Durango. From this point a standard gage line extends to Farmington, N. Mex. The section from Juanita to Durango, 65 miles in length, will be widened to 4 ft. 8½-in. gage. The new line will follow up the south fork of the Rio Grande del Norte, crossing the Continental Divide at an altitude of 10,000 ft. The present narrow gage line from South Fork to Pagosa Springs will not be used for the new line because of the steep grades. From Pargosa Springs the new route swings east and extends through the valley.

It is proposed to standard gage the line from Antonito to Santa Fe, N. Mex., a distance of 125 miles, and the line from Monyrose to Ouray, 36 miles. Other narrow gage sections linking with through lines also eventually will be widened.

New Track Records.

Railway construction, as indicated by mileage of new line completed, was at its lowest ebb this year. The Baltimore & Ohio R. R. reports that it added but 55.04 mile of first track during 1915. Of this amount 13.04 miles were embraced in the Magnolia cut-off between Okono and Orleans Road, W. Va., which has been under construction for some time, and 36.61 miles resulted from the acquisition of the Hampshire Southern R. R. between Ronney Junction and Petersburg. The remainder of the new first track includes 2.18 mile between North Fork and Busercher, Pa., and 3.16 miles between Strum and Bowood Mine, Pa. In addition the Baltimore & Ohio added 5.49 miles of second track and relocated 3.34 miles of line. Of the relocated line 2.74 miles were changed between Murray Cut and Orleans Road, W. Va., and 0.6 mile between 74th St. and 79th St., Chicago. Of the second track 2.81 miles were built at Piedmont, O., and 2.68 miles of side tracks in Ohio and Pennsylvania were connected.

The Seaboard Air Line reports that 25½ miles of new line were added to the system during the year ended June 30, 1915. Of this the principal item was the Lake Wailes extension from Bertow to Bagnard, Fla., 22.04 miles in length. Track also was laid from Pembroke, Fla., to the Juneau phosphate plant, 3.59 miles. In addition 13 miles of new sidings or extensions of existing ones were built.

A $1,500,000 Coal Pier.

A very large coal pier was placed under contract recently by the Baltimore & Ohio R. R. The structure will be constructed at Curtis Bay, Baltimore, Md., and will cost approximately $1,500,000. It will have a capacity of 10,000,000 tons per year and a maximum hourly capacity of 6,000 tons. It will be 700 ft. long by 115 ft. wide and will be of fireproof construction throughout. The car dumpers will be capable of handling cars 53 ft. long and will have a capacity of 40 100-ton cars per hour. It will be possible to load vessels from either side of the pier or to concentrate the total capacity to the loading of one vessel.

The contract for the superstructure and bulkhead was awarded to H. S. Kerbaugh, Inc., Munsey Bldg., New York; this company also will do the dredging. The Robbins Belt Co., New York City, will furnish the conveying machinery, while the car dumpers will be installed by the McMyler Interstate Co., Cleveland, O. The grading will be done by Smith-McCormick Co., Easton, Pa. The thawing shed, in which the coal in carloads will be placed in cold weather prior to being dumped over the pier, will be built by the Suertz Engineering Co., of New York.

A $212,000 DITCH JOB.

Judicial Ditch No. 26 in Beltrami and Koochiching Counties, Minnesota.

Excavation—Road Leveling—Road Dragging—Culverts—Bridges.

Bids are now being asked on a drainage ditch job in Minnesota that calls for an estimated expenditure of over $212,000. The work is located in Beltrami and Koochiching Counties, one end being 16 miles south of Baudette, Minn., and one end 35 miles north of Kelliher, Minn. The development will be known as Judicial Ditch No. 36. It will be 127 miles in length and its construction will require about 1,162,601 cu. yds. of excavation

The main features of the work include the following:

	Amount.	Total est cost.
Clearing, acres	945	$ 13,930
Grubbing, acres	307	10,778
Machine excavation, cu. yds.	1,162,601	151,138
Redigging creeks, cu. yds.	62,000	4,169
Road leveling	....	10,498
Road dragging	....	2,360
*Culverts	30	2,292
*Pile and timber bridges	40	12,476

*Contracts will not be let at this time.

The maximum cut for the ditch is 15.9 ft. and this is on a section containing only 16,398 cu. yds. The minimum cut is 1 ft. and the average cut 5 ft. Of the 127 miles of ditch 105.91 miles will have a 30-ft. base, 3.01 miles a 4-ft. base, 6.61 miles a 5-ft. base, 2.46 miles an 8-ft. base and 9 miles will consist of re-digging creeks. The side slopes will be 1 ft. horizontal to 1 ft. vertical. All excavated material will be placed on one side of the ditch, leaving at least a 6-ft. berm, and so deposited as to form a foundation for a road bed. This roadway will be built alongside the ditch, will be 117.99 miles in length and is estimated to cost $460.98 per mile.

The clearing will cover a strip 66 ft. in width. All logs, timber, brush, stone and rubbish will be removed. The grubbing covers a 40-ft. strip along the course of the entire ditch. All material excavated from the ditch, except stone, stumps, roots and rubbish will be spread along this grubbed strip in a uniform and compact manner. The top earth will be deposited so as to form a foundation and the bottom material will be used as a surface for the roadway.

The leveling of the road material will be kept within a reasonable distance of the excavation. The first part of the leveling may be done by hand, tooth dragging or grader. Final leveling may be done with a grader or road drag. Bids will be considered for one or more sections or laterals or for the work as a whole. Bids also will be considered for the road construction as a separate contract. Certified check for 10 per cent of amount of bid is required with proposal, and bond for the amount of the contract is required of the successful bidder. Work must be started as soon as weather will permit or at least 60 days after the time the contract is signed, and must be completed by Dec. 31, 1917.

Bids for the construction of Judicial Ditch No. 36 will be received at the office of the County Auditor at Bemidji, Minn., until 10 a. m., Dec. 15. W. M. Everts is the engineer.

Harbor Development at Miami, Fla.

A considerable number of harbor developments are now under consideration or construction by cities on the South Atlantic and Gulf Coasts. Miami, Fla., is one of the latest of these municipalities to take definite steps toward securing improved water terminal facilities. The plan of improvement for this city includes the excavation of a channel across Biscayne Bay, the excavation of a slip and a turning basin and the building of a dock. This latter will be of concrete construction and will require 460 reinforced concrete piles of an average length of 25 ft., 92 reinforced concrete caps, each containing 8.6 cu. yds.; 168 reinforced concrete stringers of 1.53 cu. yds. each, 17,584 sq. ft. of 10-in. reinforced concrete floor slabs, 84 column guides each containing 2.3 cu. yds., and 16,380 sq. ft. of reinforced concrete sheet piling. The dock will have 23 cast iron snubbing posts. It also will require 92 anchor piles 20 ft. long and 92 anchor logs 10 ft. long.

The dredging for the channel and other parts of the development will require 1,194,000 cu. yds. of earth excavation and 467,000 cu. yds. of rock excavation. Plans for the work were prepared by Isham, Randolph & Co., Miami, Fla., Jacksonville, Fla., and Chicago, Ill. Bids for the work will be received by the City Clerk of Miami, Fla., until noon, Dec. 22.

NEWS LETTERS

St. Louis Items.

The Kinser Construction Co. has started ed work on its big government levee job on the other side of the river. The East Side Levee and Sanitary Board succeeded in inducing the government to appropriate $60,000 on this work. The government part of the work will be of sand construction with a facing of stone or concrete.

Notification that the East St. Louis Interurban Electric Railway will seek to operate a line across the free bridge was received by the Board of Public Service. In a letter addressed to President Kinsey of the board, W. H. Hauss of the railway also suggests a plan for an interurban loop at the St. Louis end of the bridge. He would build the loop north over 7th St. to Lucas Ave., west to 8th St., south to Walnut St., east to 7th St., and thence south to the bridge. He also suggests a cut-off at Pine St. for night service

We are in receipt of an invitation from T. J. Dolan, the wideawake and hustling secretary of the International Brotherhood of Steam Shovel & Dredgemen, to come out to San Francisco and take a swim. Dolan states the water is fine. Sorry we cannot accept your invitation, Tom, but hope you will find time to stop off a day in St. Louis on your way back to Chicago. We have a swimming place of our own in the back of the office. You may want to get rid of some of the western dust and dirt before putting in an appearance at home. Consider this a standing invitation, and we hope you will make use of it often.

A petition for injunction will be heard by Judge Gillham in the Madison County Circuit Court in Edwardsville, Ill., in which farmers along Cahokia Creek ask that the Illinois Terminal be required to make a larger span in its bridge over the creek. The petition was filed several weeks ago, when the railroad began the erection of a new bridge to replace one washed out during August.

N. Clifford Ricker, dean of architecture at the University of Illinois, and consulting architect during the construction of the new $250,000 Madison County Court House in Edwardsville, made his final inspection of the building Nov. 26 in conjunction with Supervisors Henke and Leef, members of a special committee. The final payment of about $30,000 will be made in a few days.

PERSONALS

The Aberthaw Construction Company, specialists in concrete, announces the removal of its offices to more commodious quarters in the newly erected Niles Building, 27 School Street, Boston. Here this company will be still better equipped for handling the construction of industrial plants, dams and similar structures.

Mr. Edward N. Lake, formerly in charge of the Chicago office of the Stone & Webster Engineering Corporation, has become a partner in the Krehbiel Company, engineers and constructors, with offices in the Marquette Building, Chicago. The business will be continued under the present firm name. Mr. Lake will be treasurer and manager and Mr. Krehbiel will continue as president. Mr. Krehbiel has specialized in fuel, steam and mechanical engineering and construction. Mr. Lake has made electricity and its commercial applications his specialty. Both have been active in their respective lines for fifteen or twenty years. Both were connected with the Arnold Company and Bion J. Arnold for a number of years and are personal friends of long standing. Mr. Lake has also been connected in turn with the Western Electric Company, Chicago Edison Company and Board of Supervising Engineers.

OBITUARIES

John S. Wattles, a civil engineer of Sioux City, died in that place Nov. 23, aged 85. He was for 23 years in practice in the Missouri Valley, and was the first general manager of the Sioux City Elevated Railway Co. He was one of the locating engineers on the old Sioux City & Pacific Railway and also on the Dakota Southern, now part of the C., M. & St. P.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces examinations for positions as follows:

Laboratory Aid and Engineer; $900 per annum; Jan. 19.

Junior Engineer, Water Resources, Branch Geological Survey; $1,080 to $1,200 per annum; Jan. 19-20.

Marine Engine and Boiler Draftsman; $3.52 per diem; Jan. 5-6.

Aid Coast and Geodetic Survey; $900 per annum; Jan. 12-13.

NEW CATALOGUES

TRANSITS AND LEVELS.—Paper, 4¼x6¾ ins., 24 pp.; Warren-Knight Company, 136 N. Twelfth St., Philadelphia, Pa.

"Facts," a booklet containing photo-reproductions and brief descriptions of "Sterling" transits and levels. Lists attachments and extras and other engineering field equipment. Copy will be sent by the company on request.

ASPHALT PAVEMENT.—Paper, 6x9 ins., 16 pp.; The Barber Asphalt Paving Co., Philadelphia, Pa.

"Good Pavements and How to Get Them." Describes and shows some good views of various city pavements in Michigan, constructed of Bermudez or Trinidad sheet asphalt and asphaltic concrete; gives data as to date laid, amount, type and service of the pavement.

WATERPROOFED WHITE PORTLAND CEMENT.—Paper, 6x9 ins., 32 pp.; Sandusky Portland Cement Co., Cleveland, Ohio.

Describes various applications and special advantages of Medusa Water-proofed White Portland Cement, with specifications for stucco, floors, building blocks, colored concrete, etc. Shows numerous residences and other structures of this material. Copy sent on request.

CHICAGO TUNNELS.—Paper, 8¼x9 ins., 32 pp.; Chicago Warehouse & Terminal Co., 754 W. Jackson Blvd., Chicago.

An interesting description of the system of freight tunnels and its transportation facilities and methods of operation under the streets of Chicago. Tells the history of the enterprise and is well illustrated with views of actual operations. Data as to traffic handled, size, capacity, etc., are given.

MEXPET RECORD.—Paper, 7x10 ins.; 18 pp. Mexican Petroleum Co., Ltd., of Delaware, 52 Broadway, New York City.

The first issue of the Mexpet Record, a publication whose purpose as stated in the preface is to give a comprehensive idea of the nature and extent of the Mexican Petroleum Co.'s properties and to furnish information which it is hoped will make clear to the power users of the world the advantages of oil as fuel. This number describes a fuel-oil burning tug, a new oil discovery in California, auto trucks using fuel oil, and gives some useful quantitative data. Illustrated.

CULVERTS.—Paper, circular. Canton Culvert & Silo Co., Canton, Ohio.

Canton Culvert Company's standard specifications for corrugated metal culverts, prepared with a view to co-operating with railway and highway engineers, and not limited to any arbitrary style of culvert. Copy may be had on application to the company.

WATER WHEELS.—Paper, 7¾x10¾ ins.; 4 pp. The Pelton Water Wheel Co., San Francisco.

Circular issued in Spanish, Portuguese and English for the purpose of directing the attention of machinery users to the advantages of the Pelton drive for various purposes, and especially in the development of small stream power systems. Illustrated.

WAUGH GLAZING CONSTRUCTION.—Paper, 8x10½ ins.; 20 pp. Asbestos Protected Metal Co., Pittsburgh, Pa.

Bulletin No. 56, describing a new form of glazing construction known as the "Waugh" system. Views of typical installations of skylights, monitors, sawtooth fronts, or plain windows are shown and diagrams showing the essential features of the system, with specifications and summary of its advantages are given.

WATER LIFTED BY COMPRESSED AIR.—Paper, 6x9 ins.; 80 pp. Ingersoll-Rand Co., 11 Broadway, New York City.

Form 76, a booklet with the above title is a very complete treatise on the air lift, and explains in thorough detail the air lift system of pumping. Those interested in adequate water supply will find this book useful, as it presents in intelligible form the facts essential in analyzing a proposition involving the use of clean water in quantity.

CATALOGUE REVIEWS

TESTS.—Paper, 8½x11 ins.; 30 pp. The Berger Manufacturing Co., Canton, Ohio.

"The Tests" is the title of an interesting bulletin which illustrates and describes in a technical way the unofficial and official tests made on Berger's Metal Lumber and Pressed Steel Fireproof Construction. These tests were designed to produce as nearly as possible the maximum conditions which prevail in large conflagrations and at the same time provide means of accurately recording the action of the material at all times. Views of fire, load and water tests are shown and diagrams of the construction tested and the testing furnace; also gives temperature and deflection curves and detailed results of the tests. There is no advertising comment in the book, which confines itself wholly to the tests and their results, and is prepared in a way to interest the architect, engineer and contractor. A copy of the bulletin will be sent by the Berger Manufacturing Company to anyone interested.

PREVENTION OF CORROSION.—Paper, 8x10 ins.; 48 pp. American Bitumastic Enamels Co., 17 Battery Place, New York City.

Booklet No. 10, sent out by the above company, bears the title "Recent Achievements in the Prevention of Corrosion." It consists of a summary of the corrosion problem, a brief history of the development and applications of bitumastic compositions as corrosion preventives. The principal bitumastic products for this use are the Bitumastic Solution and the Bitumastic Enamel, Bitumastic Cement and Bituros Enamel. The various fields in which these products are especially valuable are taken up separately and illustrated with views of structures on which they have been used. The subjects discussed are Marine Work, including vessels, dry docks and pontoons; Water Works, including aqueducts, standpipes, tanks, etc.; Sewage Plants; General Engineering, including structural steel, steel piling, sheet iron buildings; Industrial Plants; Acids and Alkalis; Scientific Tests and Determination; Application; Specifications for Steamers.

RAILWAYS

PROSPECTIVE WORK.

Arizona:

Phoenix, Ariz.—Phoenix State Ry Co. will double track its line on W. Washington St. to the Capitol.

California:

San Francisco, Cal.—It is reported here that when the Western Pacific R. R. Co. is taken from the hands of the receiver it will have means provided for the construction of branch line to cost nearly $20,000,000.

Colorado:

Denver, Colo.—Denver & Rio Grande Ry. will broad gage 255 miles of line in Colorado and New Mexico, and also will construct a 72 mile extension. This latter will connect South Fork with Juanita. The present narrow gage line from the latter place to Durango, 65 miles, will be standard gaged; also it is proposed to standard gage 125 miles of line between Antonito and Santa Fe, N. Mex., and the 36 miles of line from Monyrose to Ouray.

Georgia:

Ocilla, Ga.—Ocilla Southern R. R. is making surveys for extension from Perry to Macon. It is reported that construction will be started in the near future.

Idaho:

Pocatello, Ida.—Pocatello Transportation & Interurban Co. will be incorporated shortly by business men of this city. Company has offices in Kane Bldg., and proposes construction of 7 miles of line.

Lewiston, Ida.—City has granted lease for terminal grounds to Nez Perce & Eastern Ry. Co., and it is reported railway will now float bonds sufficient to construct its line to Waha.

Indiana:

Decatur, Ind.—Fort Wayne & Springfield Ry. a 21 mile interurban line is reported to have been sold to interests represented by Chas. H. Worden, Ft. Wayne, Ind., for $75,000.

Iowa:

Des Moines, Ia.—Citizens at election Nov. 30 voted to grant 25-year franchise to Des Moines City Ry. Co. Company under this franchise must spend $1,500,000 within 3 years for improvements to include building 8 miles of extension.

Maryland:

Hagerstown, Md.—The Baltimore & Ohio R. R. will start construction in the near future on 3½-mile line from Hagerstown to Security. The line will be built under the name of the Washington County R. R. and will cost about $110,000.

Minnesota:

Duluth, Minn.—It is reported here that a new company to be known as the Great Northern, Minnesota & Duluth R. R. is to be organized for the purpose of building a railroad to connect Port Arthur direct with Duluth. Surveys for the project are understood to be now under way.

Missouri:

St. Louis, Mo.—Federal Court has authorized expenditure of $648,000, by Missouri Pacific for improvements and equipment.

New York:

Batavia, N. Y.—Delaware, Lackawanna & Western R. R. will abolish 2 grade crossings in town of Alexander.

New York, N. Y.—The Public Service Commission for the First District has disapproved the bids submitted by the Interborough Rapid Transit Co. for construction of the West Farms subway connection, the Webster Ave. extension of the Third Ave. elevated railroad, and the Eighth Ave. and 172nd St. connection between the existing elevated lines and the Jerome Ave. branch of the Lexington Ave. subway. These three contracts are upon company-owned lines and will be paid for by the company itself. Pursuant to permission from the Commission, the company obtained bids from different contractors. The company was notified to advertise these contracts for public bidding.

North Carolina:

Sanford, N. C.—Seaboard Air Line Ry. is reported to be planning to start construction shortly on grade improvement for final double tracking, between this place and Hamlet.

Ohio:

Cincinnati, O.—Improvements contemplated by the Baltimore & Ohio R. R. include the following: $305,000 on the Ohio Division at Cincinnati of which $100,000 is for stockyards; $300,000 for double-tracking on the Indiana Division; $250,000 on the Clark Ave. Freight Yards in Cleveland, and $135,000 on the West St. Freight House in Cleveland; $250,000 on the East Shore Line running through Cleveland, and $300,000 for additional freight facilities at Akron.

Cincinnati, O.—Citizens probably will vote in April on $6,000,000 bond issue for rapid transit developments.

Oklahoma:

Tulsa, Okla.—Santa Fe System is reported considering constructing spur from Sumpter to oil field, northeast of Blackwell in Kay County.

Oklahoma City, Okla.—Clinton, Oklahoma & Western Ry. is reported to have completed plans for an extension into this city. Surveys have been made for a route from Clinton to Tuttle, via Union City, and also from Clinton to Chickasha.

Pennsylvania:

Philadelphia, Pa.—Special election may be held Feb. 8 to vote on a loan of $90,000,000 for municipal and harbor improvement. Of this amount $45,000,000 is for subways and elevated railway.

South Dakota:

Mitchell, S. D.—South Dakota & Western R. R. has secured right-of-way and has applied for permission to build a line, Mitchell to Platte and northwest into Brule County.

Texas:

Jefferson, Tex.—Charter of Jefferson & Northwestern Ry. has been amended so as to provide for a 9 mile extension to a connection with Texas & Pacific Ry. at Kildare. H. B. Montgomery, Jefferson, is Chief Engineer.

Orange, Tex.—Lutcher & Moore Lumber Co. has surveys under way for extension of its Gulf, Sabine & Red River R. R., for 35 miles.

Marlin, Tex.—Marlin & Temple Interurban Promotion Co. has completed its organization and will apply for a charter. S. D. Hanna, Temple, is Chief Engineer.

Washington:

Tacoma, Wash.—It is reported here that the Oregon-Washington R. R. & Navigation Co. is considering early construction of its extension from North Yakima to Tacoma, a distance of 150 miles. This extension will require heavy construction and would involve the building of a long tunnel. The survey follows the Naches River, northwestward, from North Yakima and cross the mountain at Naches Pass.

West Virginia:

Wellsburg, W. Va.—Wabash R. R. will construct 3-mile spur into Follansbee. Work will involve large bridge and considerable amount of trestle.

BIDS OPENED; CONTRACTS LET

California:

San Francisco, Cal.—F. Rolandi, San Francisco, was low bidder for construction of the 67 miles Hetch-Hetchy Valley R. R., for the City of San Francisco.

Turlock, Cal.—Grading has been started for extension of Tidewater Southern Electric Ry. from Modesto to Turlock. A. G. Chatam has the contract.

Blythe, Cal.—Grading is under way for completion of California Southern Ry. to its terminal in Blythe. Geo. W. Grayson has the contract.

Kentucky:

Barbourville, Ky.—Reid Construction Co., Pittsburgh, Pa., has contract for construction of Cumberland & Manchester R. R., a new line 24 miles long, to extend from Barbourville to Manchester. Work involves 150,000 cu yds. of earth excavation, 243,000 cu. yds. embankment, 30,000 cu. yds. rock excavation and 5 bridges, 20, 30, 40, 30 and 50 ft. spans respectively. There also will be 3,400 lin. ft. of trestles, and 7,000 cu. yds. of masonry. M. E S. Posey, Barbourville, is Chief Engineer of Railway.

Texas:

Midland, Tex.—J. V. Hunter, Strawn, Tex., has grading contract for Midland Northwestern Ry., proposing line from Midland through Andrews and Gaines Counties. Work involves about 350,000 cu. yds. earth excavation and embankment and one 400 ft. pile trestle.

Virginia:

West Point, Va.—Central Construction Co., Harrisburg, Pa., is reported to have been awarded contract for constructing Richmond, Rappahannock & Northern R. R., from West Point to Urbana, 17 miles. C. L. Ruffin, 514 American National Bank Bldg., Richmond, Va., Chief Engineer.

ROADS STREETS

BIDS ASKED.

Alabama:

Opelika, Ala.—Until Dec. 27, by County Commissioners, for sand clay road, to cost about $11,000. W. S. Keller, State Highway Engineer, Montgomery.

Monroeville, Ala.—Until Dec. 27, by County Board of Revenue, for grading, draining and surfacing with gravel section of old Federal Road. P. W. Turner, County Engineer.

Bay Minette, Ala.—Until Dec. 14, by County Commissioners, for sandy clay road, about 10 miles in length, to cost about $11,000. J. F Garrett, Engineer, Montgomery, Ala.

California:

Pasadena, Cal.—Until Dec. 13, by City Clerk for paving Hillside Terrace.

Illinois:

Des Plaines, Ill.—Until 7:30 p. m., Dec. 13, by Board Local Improvements, H. H. Talcott, Secretary, for improvement of Lee St., with 2 in. of asphaltic concrete upon present macadam base. W. H. Allen, Engineer, 1403 Harris Trust Bldg., Chicago, Ill.

Evanston, Ill.—Until 8 p. m., Jan. 17, by H P. Pearsons, President Board of Local Improvements, for 71,300 sq. yds. of brick pavement.

Des Plaines, Ill.—Until 7:30 p. m., Dec. 13, by Board of Local Improvements, H. H. Talcott, Secretary, for paving on Ashland Ave., with reinforced concrete. W. H. Allen, Engineer, 1403 Harris Trust Bldg., Chicago, Ill.

Indiana:

Michigan City, Ind.—Until Dec. 14, according to report, by Board of Public Works, for paving with brick on Center St. and Lake Ave.

Angola, Ind.—Until 1:30 p. m., Dec. 15, by Roy Hirst, City Clerk, for 18,000 sq. yds. of pavement. C. S. Powers, City Engineer.

Indianapolis, Ind.—Until Dec. 28, by County Auditor, for motor truck for road construction, to cost about $5,500.

Massachusetts:

New Braintree, Mass.—Until noon, Dec. 14, by State Highway Commission, 15 Ashburton Place, Boston, for 5,100 ft. of state highway.

Gloucester, Mass.—Until noon Dec. 14 by State Highway Commission, 15 Ashburton

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
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Smoke Abatement and Electrification of Railways in Chicago.

About four years ago the Chicago Association of Commerce appointed a committee to investigate the problems connected with smoke abatement and electrification of Chicago railway terminals, this action being brought about by a rather insistent demand for legislation to require that railways electrify their terminals. This committee, which consisted of four members appointed by the mayor, four appointed by the railroads and nine appointed by the Association of Commerce, employed an efficient staff of experts and made the most comprehensive study of smoke prevention and electrification which has ever been conducted. The results of the committee's labors have recently been made public, and we are presenting, elsewhere in this issue, a summary of its report.

Briefly summarized, some of the important conclusions of this investigation, as regards smoke abatement and air pollution are: The committee finds that the pollution of the air from smoke, from a standpoint of health, is not nearly so serious a matter as has generally been supposed. It also finds that only two-thirds of the atmospheric pollution emanates from fuel sources, the other third being due to bad municipal housekeeping and to the waste products of industrial activity. The committee recommends the creation, by the city, of a permanent "Pure Air Commission," its membership to be made up of persons possessing high technical qualifications; this commission to have authority to investigate all sources of air pollution, to determine the most effective means of mitigating or eliminating such pollution, and, so far as is practicable, to be invested with power to force obedience to its decisions. The committee emphasizes the fact that the solid and visible portions of smoke are not a fair criterion of its harmful effects to plant and human life, as the gaseous and invisible products are of greater importance. An elaborate investigation was made to determine to what degree each of the contributors to Chicago smoke was responsible, considering both visible smoke and its solid and gaseous constituents. The results of this investigation are herewith summarized:

	Visible smoke, per cent of total.	Solid constituents.	Gaseous constituents.
High-pressure plants	44.49	19.34	44.96
Metallurgical plants	28.63	64.26	21.13
Steam locomotives	22.06	7.47	10.31
Low-pressure plants	3.93	8.60	23.00
Steam vessels	0.74	0.33	0.60
Coke and gas plants	0.15	*	*

*No test.

It will be noted that the steam locomotive produces only about one-fifth of the visible smoke, about one-thirteenth of the solid constituents of smoke and about one-tenth of its gaseous constituents.

The committee reaches some interesting and important conclusions as regards the advisability of electrifying the Chicago railway terminals. Its general conclusion is that electrification is "technically practicable but financially impracticable." The committee finds that the electrification of all the terminals in Chicago would involve 3,476 miles of track, which exceeds the total mileage of steam railway thus far electrified in the world. It concludes that the best system of electrification is uncertain to such an extent that legislation, to compel electrification at present, is not justifiable. The cost of the electrification of lines within the city is estimated by the committees, at $178,127,230; while the total cost, based on estimates made by railroads, including changes beyond the zone covered by the committee, is estimated at $274,440,630. Although electrification would make it possible to effect certain economies in operation it would increase the fixed charges to such an extent that there would result an annual loss of $14,600,000 by its adoption.

In considering the committee's report it should be borne in mind that the committee did not consider the problem of electrification except as it involved all terminals within the limits of Chicago—the practicability of electrification as applied to a single railroad was not considered. The data presented which attempt to fix the responsibility of the various smoke-producing agencies are comprehensive and pertinent, as there has been a popular misconception of the percentage of the total Chicago smoke contributed by the railroads. Another important finding is that at least one-third of the atmosphere pollution is due to causes other than fuel consumption; this emphasizes the fact that much can be accomplished by the municipality itself in purifying the air. The report presents data to show that electrification would only result in a reduction of 5 per cent in the present amount of Chicago smoke, when all other factors are considered; it therefore can hardly be justified on the grounds of smoke abatement. Although the committee will undoubtedly be criticised for not attempting to solve the problems of electrification as applied to one or more specific railroads the data collected will prove of great value in any future investigation of this subject. The committee's comprehensive treatment of the subject of atmospheric pollution is especially commendable.

Shaping Water Tanks to Symbolize the Industry They Protect.

A water tank shaped like the conventional quart milk bottle, and holding 25,000 gals., was recently erected on a 70 ft. 4 post tower for the City Dairy Co. in the city of Toronto. The tank is of steel plate construction and differs only in shape from the ordinary steel water tank. The tower and balcony are of regulation design. The "bottle" is 13 ft. in diameter at the bottom and 35 ft. 9 ins. high. The proportions of the tank are exactly those of the company's standard quart milk bottle. The odd shape was adopted, of course, to give the owners "a striking and permanent advertisement of their business." The idea is said to have originated with the owners. According to our contemporary, *The Canadian Engineer*, which reports the building of this novel structure, the owners are very much pleased with the completed job in every way—it has entirely reached the purchaser's expectations. Nothing is said about what the people of that section of Toronto think of the tank's appearance.

Our contemporary concludes its description of the tank by saying:

> As steel plate construction lends itself readily to unusual shapes, in many cases, we may come to see the customary water tower lose its long-established and well-known form, to adopt various new ones, each an indicator of the industry which it protects.

The possibility suggested is worthy of brief consideration. From the standpoint of the structural engineer the shaping of a water tank to symbolize an industry presents no insurmountable difficulty. The drawbacks of this unique advertising expedient arise from aesthethic consideration. We do not believe that the public would approve of the general extension of this idea. People, generally, believe in advertising, but do not like to have it flaunted needlessly. The billboard with its flaming lithographs is unpopular and has, of late years, been fighting a losing fight for its existence. Lithographs are changed frequently but are nevertheless considered undesirable embellishments of the landscape. What, then, is likely to be the popular attitude towards a riveted steel advertisement which will not change its appearance in less than 20 years? This form of advertising is not unlikely to be prejudicial. It is not to be encouraged. Perhaps it will not be. The Toronto tank may simply be another evidence of the constancy of those historic affinities, milk and water.

Activated Sludge Is Capturing the Popular Fancy.

Our advice to engineers to stick to the old processes of sewage treatment until the activated sludge process has definitely made good at Milwaukee, Urbana and elsewhere, may be recalled. We stated that "we do not believe that engineers in general practice can again afford to take the public in on their enthusiasm over partially developed processes of sewage treatment." There are indications that our advice, while sound, was in part transposed. The boot seems to be on the other leg. Evidences continue to appear that in this case engineers will have to hold the public back instead of leading it forward.

Practically all the Chicago daily papers, certainly all the more influential ones, have already published enthusiastic articles about the merits of the activated sludge process. Similar articles clipped from the newspapers of the secondary cities have been brought to our attention. The world's champion column conductor, Mr. B. L. Taylor of the Chicago Tribune, has written some verse about "The Activated Sludge" which we publish in "The Lighter Side of Engineering and Contracting" this week. It will be noted that he refers to an article on this subject by Dr. W. A. Evans. Dr. Evans is a former Health Commissioner of Chicago. His "How to Keep Well" department is published in various papers throughout the country. It was in that department that his activated sludge article appeared.

Activated sludge will need to be active indeed if it accomplishes all that the public expects it to do.

Specification Writing as a Means of Self-Examination and Instruction.

Some years ago, while in the first flush of a new discovery of an old truth, the editor put the following question to Professor Wiel of the Engineering Department of the Michigan Agricultural College: "Professor, do you know any better way for a young engineer to get a knowledge of the details of engineering procedure than by reading specifications?" "Yes," was the reply, "by writing specifications." Many times since have we reflected on his reply and the various shades of its meaning. The writing of specifications is an exceedingly searching form of self-examination. It is amazing the way knowledge shrinks when one starts to set it down precisely on paper.

A mature engineer of our acquaintance was once asked to write off-hand, a set of specifications to govern the design and construction of an ordinary steel standpipe. He consented readily enough for he was, even then, an experienced water works engineer and was experienced in the writing, or more accurately compilation, of specifications. Being separated from his notes and reference books, in this instance, he experienced the greatest difficulty in writing out a satisfactory set of specifications for this simple structure. Before his task was finished he found it necessary to mobilize nearly all his engineering knowledge of regular application and he also had to call upon his reserve knowledge. While he never forgot the travail entailed by this piece of specification writing he later came to regard the specifications so produced as the best he had ever seen on the subject. When thrown on the resources of his own knowledge and memory of fundamental principles and facts he was, in large measure, independent of precedent. The result was a forward step in this particular field.

This experience indicates the desirability of more original work in the production of specifications. There has been too much blind copying in this line of engineering endeavor. With all due respect to engineering precedents we believe that engineering will be gradually improved by more originality in specification writing. While the present general tendency is reactionary the engineer can well afford to modify his standpattism in this important particular. We do not refer to the legal persiflage which ornaments the present day specifications, but to matters of purely engineering nature.

To the young engineer on construction, particularly, do we commend the writing of specifications as a means of self-examination. If he is willing to undertake self-improvement he can readily ascertain, by the means suggested, just where he is strong and where he is weak. He can then intelligently direct his study and observation with a view to strengthening himself at the points where he has found himself weak in knowledge.

GENERAL

Report of Chicago Association of Commerce Committee on Smoke Abatement and Electrification of Railway Terminals in Chicago.

The committee appointed by the Chicago Association of Commerce, in 1911, to study the problem of smoke abatement and electrification of railway terminals in Chicago has recently made its report in the form of a 1,177-page book. After an exhaustive investigation the committee finds that "the complete electrification of the Chicago railroad terminals as a means of abating smoke is technically practicable but financially impracticable." Moreover, the committee holds that the elimination alone of the steam locomotive would produce a hardly perceptible betterment of the Chicago atmosphere. It urges the appointment of a permanent Municipal Pure Air Commission, which, both through instruction and coercion, shall reduce all sources of air pollution to a minimum. The importance and thoroughness of the investigation are so great that we give the following abstract of a summary, prepared by W. F. M. Goss, chief engineer, of the findings and recommendations of the committee:

GENERAL CONCLUSIONS OF COMMITTEE.

The association committee, as a result of its painstaking investigations, reaches the following conclusions:

That the minimum cost of electrification as a means in smoke abatement would be...........	$178,127,230
That the more probable cost, due to the necessity for improvements and re-arrangements, which would be precipitated by electrification, would be	274,440,630
That the least net annual operating deficit produced by electrification would be...............	14,609,743

That Chicago, under the state constitution, cannot aid in meeting this expense.

That an arbitrary or tax on terminal traffic to support the capital for electrification would constitute a burden upon the business interests of Chicago.

That the cost would be so heavy that no court would uphold an electrification ordinance.

That the Chicago electrification would equal the combined electrifications of the whole world, would involve problems never heretofore met, and would be the first ever undertaken for air betterment where terminals were adequate from an operating viewpoint.

That before the steam locomotive is eliminated pollution must first be reduced to a minimum from the three more damaging services, high pressure steam plants, metallurgical and other manufacturing furnaces, and domestic fires.

That the steam locomotive stands third among smoke producing services, using but 12 per cent of the fuel consumed, and that its elimination would reduce the gaseous pollution of the air only 5 per cent and the solid pollution less than 4 per cent.

That electrification, hydroelectric and other long distance transmission being inapplicable, would add powerhouse smoke in quantities sufficient to offset much of the gain through elimination of locomotive smoke.

That suburban passenger services, such as those of the Illinois Central and other roads, produce but 1.54 per cent of the total visible smoke, and 1.97 per cent of all the dust and cinders.

That electrification will involve at least 3,476.4 miles of track.

That electrification would subtract only 1,291,282 tons of coal from the total of 21,208,886 tons now consumed annually.

That all smoke regulation in Chicago and elsewhere has erred in confining itself to the visible aspects of smoke, whereas the really

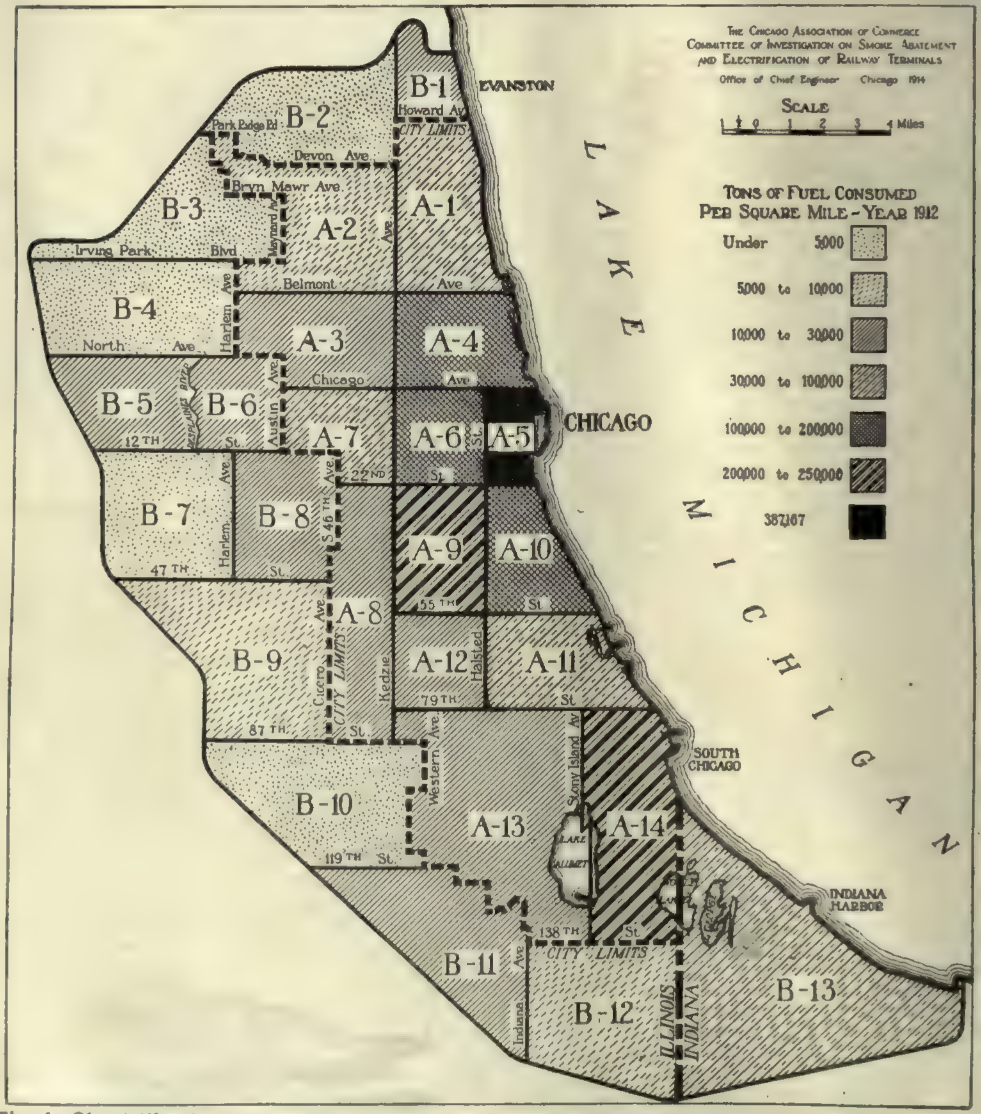

Fig. 1. Chart Illustrating Coal Consumption in Area Considered in Smoke Abatement and Electrification Investigation by Chicago Association of Commerce—Zone B Districts are Outside of Chicago—Also see Table I.

harmful factors are the invisible gases and the solids of combustion, sulphurous gas and mineral dust in particular.

That Chicago air is polluted annually by the introduction of 304,391 tons of soot, dust and cinders and of 5,008,111,106,758 cu. ft. of sulphurous and other gases.

That, despite the fact that Chicago burns more coal annually than any other large city —eight tons per capita as against four for Manchester and one and one-half for Berlin —its air is better than that of most large cities.

That Chicago air has the benefit of better sun, wind and rain conditions than that of most other cities.

That the loop is the smokiest district, with the stock yards and South Chicago a close second and third.

That, in Chicago air, the products of combustion constitute only two-thirds the total pollution, the other third being due to avoidable and unavoidable dirt from the general activities of the city and from poor municipal housekeeping.

MEANS OF REDUCING AIR POLLUTION TO MINIMUM.

In the report of its world-wide investigation, which is now submitted in a volume of 1,200,000 words, the Committee suggests the following as the only program by which air pollution in Chicago may be reduced to the minimum:

These recommendations are based upon the conviction that pure air is essential to the health and comfort of an urban population, and that it is the imperative duty of the authorities of the city of Chicago to secure, through persistent and intelligent action, a clean atmosphere. The committee's recommendations are as follows:

(1) That there be created by the city, a permanent Pure Air Commission, the membership of which shall be made up of persons possessing high technical qualifications.

(2) That financial support be placed at the command of the Commission, which shall be sufficient adequately to provide for the organization and development of investigations of a highly scientific character.

(3) That the Commission be empowered to investigate all sources of air pollution, to determine, by experiment or otherwise, the most effective means for mitigating or eliminating such pollution, and that so far as practicable, it be invested with power to enforce obedience to its decisions.

(4) That no materials shall be employed in paving, without the consent of the Commission, to the end that dust-creating pavements may be abolished.

(5) That the paving and cleaning of alleys and other highways shall be subject to the supervision of the Commission.

(6) That the Commission shall have power to require that the wrecking and erection of buildings shall proceed by methods which will protect the air from all unnecessary pollution.

(7) That the Commission shall have power to require roofs to be cleaned and other minor sources of air pollution to be abated.

(8) That new installations of boiler and other furnaces be permitted only as licensed by the Commission, which shall have power, under reasonable rules, to determine the character of the installations.

(9) That the Commission be charged with the duty of investigating present practice in the construction and operation of domestic furnaces, with a view to so perfecting such practice that fuels now used may be burned without objectionable air pollution, or to so changing the character of present fuels as to accomplish the same result.

(10) That the Commission be charged with the duty of investigating the construction and operation of metallurgical and high pressure steam boiler furnaces, with a view to eliminating, so far as practicable, the air pollution for which such furnaces are responsible, and that it formulate and enforce regulations under which such furnaces shall hereafter be constructed and operated.

(11) That the Commission be charged with the duty of investigating the pollution of the air by railroad locomotives, by steamboats and by other transportation agencies making use of movable engines, of devising methods of abating air pollution from these sources, and of enforcing such provisions for the suppression of air pollution as may be found necessary.

It is not the opinion of this committee that radical action should be expected of the Pure Air Commission, or that action involving abandonment of the use of Illinois and Indiana coal is either advisable or practicable, or that action involving the general abandonment or rebuilding of existing boiler or heating plants, either stationary or portable, is advisable or practicable, or that the immediate or general electrification of railroads for the purpose of eliminating their part in air pollution is under present conditions advisable or practicable, but that all efforts to improve existing conditions shall be carried on with due regard to the responsibility of each of the fuel consuming services for their contribution to the pollution of the atmosphere, and that such changes as may be determined upon may be gradually made. with due regard to financial and mechanical difficulties.

CONCERNING FINANCIAL PRACTICABILITY OF ELECTRIFICATION.

As regards the financial practicability of electrification the Committee submits these findings:

(1) The complete electrification of the railroad terminals of Chicago as a betterment to be brought about by the railroads through the investment of free capital is, under present-day conditions, financially impracticable.

(2) Any procedure designed to bring about the complete electrification of Chicago's railroad terminals which is based upon a financial program involving municipal co-operation is, under present-day conditions, impracticable.

(3) Any procedure designed to bring about the complete electrification of Chicago's railroad terminals, which is based upon the application of an arbitrary to traffic of Chicago, will constitute a tax which must be borne by the business interests of the city. The practicability of such a tax is a matter which has not been studied by the Committee.

(4) The preceding conclusions apply to the complete electrification of Chicago's railroad terminals. The financial practicability, under present-day conditions, of electrification as it might be applied to individual roads or to a single service of individual roads, is a matter which has not been investigated by the Committee and concerning which no opinion is expressed.

(5) The credit of the individual railroads, the properties of which make up the Chicago railroad terminals, differs greatly. Some have high credit and could secure funds for almost any project which their managements might care to propose; others must prove the profitable character of a particular project before underwriters would consider the placement of their securities; others would find it difficult to borrow on reasonable terms even if the particular project for which the funds are sought promises some return; and still others are in the hands of receivers, their administrative function being performed by the courts. These facts cannot be overlooked in estimating what portion of the potential credit of the railroads is available for the purpose of electrification.

(6) Certain railroads making up the Chicago terminals operate entirely within the prescribed zone, while for others the great predominance of traffic lies outside the terminal limits. There is more to this contrast than is implied by the fact that some of the roads involved are switching roads while others are long-haul freight and passenger roads. Complete electrification, from a financial point of view, would affect but a relatively small part of the fixed investments of some roads, while for others it would require practically the rebuilding of the property.

(7) Electrification is a matter which may present greater advantages in connection with certain classes of service than with other classes of service; for example, the electrification of a railroad having a large suburban business would be more effective in developing opinion favorable to the railroad concerned than the electrification of a road the activities of which are wholly those of freight switching yards. A few only depend upon passenger traffic within the city limits for any considerable amount of their revenue. A larger number derive passenger revenue within the terminals from the movement of through passengers only; while other roads perform little passenger service or no passenger service at all.

(8) The extent to which individual railroads have recently made large capital expenditures for terminal improvements, track elevation and enlargement of facilities in Chicago, and the extent to which they are committed to further expenditure for these purposes, must have a material bearing on their ability to make expenditures for new projects.

The committee holds that the city might well be expected to share in the burden of electrification, seeing that it would be undertaken for the public benefit, but a perusal of court decisions shows that this is impossible. A separate section of the constitution of 1870 has the following article:

"No county, city, town, township, or other municipality shall ever become subscriber to the capital stock of any railroad or private corporation, or make donation to or loan its credit in aid of such corporation, provided, however, that the adoption of this article shall not be construed as affecting the right of any such municipality to make such subscription where the same have been authorized under existing law by a vote of the people of such municipalities prior to such adoption."

Moreover, the report points out that it would be impossible for the city, under present constitutional and statutory limitations, at least for some years to come, to raise the necessary funds without the issuance of bonds beyond the authorized limit.

PROBLEMS PECULIAR TO CHICAGO.

The committee, realizing that many public-spirited citizens will not understand its decision, in the light of reports of electrifications in New York and elsewhere, points out the essential difference between electrification here and those installations that have so far taken place. Nowhere in the world, it finds as a result of its investigations, has a steam railroad been electrified to avoid the pollution of a city's atmosphere. Nowhere has a terminal been electrified when that terminal from an operating standpoint has been satisfactory. No electrification in existence, either in America or abroad, is comparable, in scope and diversity of service, with that involved in the electrification of the Chicago terminals. A wide gap exists, the committee reports, between that which has been accomplished and that which would have to be done before local electrification would become a success.

Some of the electrifications that have been most widely heralded as such, says the committee, were in fact only a subordinate, though necessary, part of a greater scheme for terminal enlargement. The New York Central, the New York, New Haven & Hartford, and the Pennsylvania electrifications are not alone projects of electrification; primarily they are an essential detail of a new tunnel entry into the heart of New York City. These projects must necessarily stand upon a different basis than the Chicago proposal, where physical conditions absolutely requiring electrification are lacking and where physical conditions and the nature of the traffic would make electrification extremely difficult.

REASONS FOR ELECTRIFICATION ELSEWHERE.

The committee finds that elsewhere steam roads have been electrified for these reasons:

(1) Electrification has most frequently

been employed in operating suburban passenger service.

(2) It has been used for all passenger service in connection with the intensive development of great passenger terminals where underground operation has been involved.

(3) It has been used for both freight and passenger operation in tunnels.

(4) It has been applied to sections of through lines of route to improve operation of both freight and passenger service on difficult grades.

(5) It has been applied to sections of through route lines in anticipation of operating economies through the utilization of water or other relatively inexpensive centralized power.

(6) It has been employed by a single railroad in this country in the operation of three switching yards, the work of which must still be regarded as being in an experimental stage.

ELECTRIFICATION TECHNICALLY PRACTICABLE.

Notwithstanding the engineering difficulties that would have to be overcome in electrifying the terminals, the committee believes that these difficulties can be surmounted. Its work leads it to be the conclusion that the only feasible means of electrification will be by the overhead contact system or trolley. Great obstacles exist to the installation of any system, but it is believed the trolley wire more nearly meets all demands than the third rail. The committee states its conclusions as follows:

(1) A limited mileage of track in Chicago (approximately 1 per cent of the total) cannot be equipped with any system of contact. The electrification of this is not technically feasible.

(2) While the third rail system of contact might be extensively used in Chicago, there are, at intervals throughout a considerable percentage of the total trackage, conditions which would make difficult the use of this form of contact. The third rail is applied with difficulty wherever special track work abounds, where street and railroad crossings occur at frequent intervals, and in switching yards. In locations where employes must be between or must cross tracks, as in freight yards, it constitutes a physical obstruction which is highly objectionable. For these reasons the third rail is not considered feasible for general use in the Chicago terminals.

(3) The facts developed show that any form of overhead contact which can be placed high enough above the rail to give the clearance necessary to permit men to ride and perform necessary duties on the tops of freight cars, is not objectionable from a technical point of view. The application of an overhead contact system to the terminals of Chicago will, however, require the contact wire to be lowered in many places in order that it may pass under structures presenting minimum clearance. The great number of points at which the contact wire must be lowered will require the installation of many warning devices, or the enforcement of rigid rules governing the presence of trainmen on tops of cars.

STUDY OF ATMOSPHERIC POLLUTION.

The study of atmospheric pollution carried on by the committee is said to be by far the most extensive and scientific ever attempted. One of the most interesting exhibits produced is a smoke map of the area under investigation, see Fig. 1. This covers Zone A, which includes all the territory within the city limits, and Zone B, which includes adjoining territory from Gary on the south, through Hammond, Whiting, and East Chigo, on around through the large railroad yards at Godfrey, Proviso, Clearing and Dolton, to the lake north of Evanston. This map divides Zones A and B into 27 districts and shows just what part each district plays in smoke production. All the committee's figures, both on smoke and on electrification, are for the year 1912.

The total consumption of coal for Zones A and B was 21,208,886 tons. To this should be added 514,613 barrels of gasoline and naphtha, 231,579 barrels of kerosene and 3,510,840 barrels of crude or low distillate oils. Three barrels of crude oil in industrial furnaces are assumed to be equal to one ton of Illinois coal, so that the crude oil used adds the equivalent of 1,170,000 tons of coal, or approximately 5½ per cent of the total annual consumption.

The total annual per capita consumption of coal in 1912 in the city limits was 7.7 tons. In Zone B, outside the limits, it was 13.7 tons. The average for the two zones was 8.3 tons. The average square mile consumption of coal within the city limits was 10,797 tons for steam locomotives as against 79,436 tons for all other services combined.

TABLE I. — CONSUMPTION OF COAL IN VARIOUS ZONE DISTRICTS IN CHICAGO.
—Also see Fig. 1.

Zone district.	Area, sq. miles.	Tons consumed.	Tons per sq. mile per annum.	Per cent of total consumed by locomotives	All other services.
A-1	16.08	615,404	38,271	2.42	97.58
A-2	18.26	120,464	6,597	33.67	66.33
A-3	13.50	299,268	22,168	30.75	69.25
A-4	12.16	2,141,965	176,148	2.91	97.09
A-5	4.52	1,749,995	387,167	14.78	85.22
A-6	9.00	1,387,024	154,114	18.92	81.08
A-7	8.75	562,651	64,303	24.70	75.30
A-8	15.50	172,678	11,141	49.39	50.61
A-9	12.00	2,951,027	245,919	7.58	92.42
A-10	9.58	1,413,813	147,580	16.90	83.10
A-11	12.36	778,071	62,951	16.64	83.36
A-12	9.00	137,132	15,237	56.95	43.05
A-13	33.55	717,217	21,378	36.38	63.62
A-14	20.16	4,535,814	224,991	4.69	95.31
Total Zone A.	194.42	17,582,523	90,436	.....	.....
B-1	5.28	138,368	26,206	8.30	91.70
B-2	15.93	60,263	3,783	19.55	80.45
B-3	14.59	43,458	2,979	26.46	73.54
B-4	19.25	44,502	2,312	68.65	31.35
B-5	11.84	151,854	12,826	30.71	69.29
B-6	8.16	198,857	24,370	9.48	90.52
B-7	16.48	62,292	3,780	32.99	67.01
B-8	12.75	234,003	18,353	26.49	73.51
B-9	24.00	200,122	8,338	16.07	83.93
B-10	21.57	19,879	922	93.85	6.15
B-11	20.32	313,680	15,437	31.82	68.18
B-12	21.28	110,530	5,194	79.09	20.91
B-13	42.35	2,048,555	48,372	12.94	87.06
Total Zone B.	233.80	3,626,363	15,511	.....	.....
Totals Zones A and B	428.22	21,208,886	49,528	.....	.....

In only four out of the 27 districts into which Zones A and B are divided do steam locomotives use more than half the total fuel consumed, and these districts are sparsely populated and have very limited smoke producing services other than smoke from residence chimneys.

For the purpose of its investigation the committee considered smoke in the following aspects:

Visible smoke.
Solids in smoke.
Gases in smoke.

Smoke, in each of its phases was found to have undesirable features. Smoke from each service was found to have a definite relation to the total volume of smoke pollution, both as to quantity and as to particular features of pollution. In order to ascertain which services produced the visible smoke, the solids of smoke and the gases of smoke, and in what proportion, 11,976 observations were made of locomotive smoke, 1,241 high pressure smoke stacks were put under observation, 2,801 low pressure stacks and 280 stacks of metallurgical and other furnaces. As a result it was found that, in the Chicago smoke district, high-pressure steam power and heating plants are the principal smoke producers, metallurgical furnaces and other similar manufacturing fires come second, steam locomatives third, and low pressure steam and other heating plants (domestic fires) fourth. (See Table II).

TABLE II. — PERCENTAGE OF CHICAGO SMOKE CONTRIBUTED BY VARIOUS AGENCIES.*

	Visible smoke, per cent.	Solids of smoke, per cent.	Total of smoke, per cent.	Gaseous carbon, per cent.	Gaseous sulphur, per cent.
Steam locomotives	22.06	7.47	10.31	10.11	18.22
Steam vessels	0.74	0.33	0.60	0.55	0.45
High pressure steam stationary power and heating plants	44.49	19.34	44.96	40.68	53.70
Low pressure steam and other stationary heating plants	3.93	8.60	23.00	23.06	19.73
Gas and coke plants	0.15	.....	.....	.....	.....
Furnaces for metallurgical, manufacturing and other processes	28.63	64.26	21.13	25.60	7.90

*One-third of all air pollution is due to dirt other than that of combustion. These percentages refer to the remaining two-thirds.

SOLID CONSTITUENTS OF SMOKE.

A significant fact disclosed by the researches of the committee is that which emphasizes the relatively great importance of the solid constituents of smoke. Hitherto most discussions concerning smoke, and practically all measures designed to show the extent of atmospheric pollution resulting from it, have dealt only with its cloud effects. It now appears that the cloud effects are of secondary importance, as compared with effects produced by the soot and dust of smoke. The problem of smoke abatement, therefore, as viewed in the light of the committee's disclosure, is not entirely or largely a problem of suppressing visible smoke, but is one of suppressing the shower of soot, dust and cinders constantly falling from a smoke polluted atmosphere.

Smoke arising from solid fuels was found to be never free from such solids. The amount of solids discharged has no direct relation to visibility. A stack may appear smokeless to the eye, it is said, and yet be the source of a heavy discharge of dust. The adoption of anthracite coal or of coke as a fuel, the committee asserts, will serve to make stack discharges invisible, but will not eliminate the dust discharge.

The following table (1912) shows the tremendous solid pollution of Chicago air and the part played by metallic and other mineral dust, not originating in the fuel:

	Tons per annum.
Total solid constituents of smoke from all fuel consuming services	304,391
Non-fuel solid constituents of smoke from steel plants, foundries, forges, and allied processes	123,955
Non-fuel solid constituents of smoke from brick and pottery plants and allied processes	923
Total solid constituents of smoke of non-fuel origin	124,878
Total solid constituents of smoke of fuel origin	179,513

Of the total solid materials in the smoke of all services in the city of Chicago, metallurgical and manufacturing plants are responsible for 33 per cent of the coarse cinders (those remaining on a 20-mesh sieve), 47 per cent of the fine cinders (those remaining on a 200-mesh sieve), and 70 per cent of the fuel dust (those cinders passing through a 200-mesh sieve). They are responsible also for 21 per cent of the hydrocarbons (tar), 35 per cent of the combustible solids (carbon), 76 per cent of the mineral matter and 30 per cent of the sulphur.

High-pressure steam stationary power and heating plants rank first among the smoke-producing services in Chicago. They consume 41.7 per cent of the total fuel used in the city. They are responsible for 44.5 per cent of the visible smoke, for 19.34 per cent of the total solids, ranking second in this particular. They are responsible for 45 per cent of the total polluting gases of combustion and rank first in this division.

It has been estimated by the committee that within the city of Chicago there are approximately 17,000 high pressure (10 lbs. or more) steam boilers, served by not less than 11,000 smokestacks.

Low pressure steam and other heating plants (domestic fires) consume 23.63 per cent of the city's coal. They are responsible for 3.93 per cent of the visible smoke, for 8.60 per cent of the solids in smoke and for 0.23 per cent of the total gases of combustion. In connection with their solid constituents these fires are responsible for 57 per cent of the total hydrocarbons or sooty materials, which makes their smoke the most damaging of any to clothing and similar articles.

There are within the city of Chicago, the committee finds, more than 11,000 low-pressure steam boilers in which a steam pressure of less than 10 lbs. per square inch is maintained. There are also several hundred thousands domestic heating furnaces and stoves in houses and stores. In point of number of establishments, therefore, the service included by the classification "low-pressure steam and other stationary heating plants" is many times larger than any other service considered in the committee's investigation.

While this class of service consumes more than 23.5 per cent of the total amount of fuel consumed by all services combined, it contributes less than 4 per cent of the total visible smoke produced by all services within the city of Chicago. This low percentage of visible smoke is largely due to the character of fuel used, to the dilution of the smoke through the intermingling of large percentages of excess air, and to the average low velocity at which gases pass from the stack into the atmosphere. This visibility is lower than that which attends the discharges from the other services. Bituminous coals represent but 41 per cent of the total fuel consumed by low pressure steam and other stationary heating plants in the city of Chicago, and this bituminous coal produces practically all of the visible smoke emitted by this service.

From the standpoint of the total weight of hydrocarbons, or sooty materials condensed from the distillates of fuel emitted in smoke, low pressure steam and other stationary heating plants rank first, contributing 57 per cent of the total quantity of such materials emitted by all services into the atmosphere of the city of Chicago. This service is also responsible for 10.3 per cent of the fuel dust, 3.2 per cent of the fine cinders, 17.2 per cent of the combustible solids and 11.7 per cent of the sulphur emitted in the smoke of all services in Chicago.

GASEOUS POLLUTION OF ATMOSPHERE.

High pressure steam plants produced almost half the total gaseous pollution of the air, the exact figure being 44.96 per cent. Low pressure steam and other domestic fires produced 23 per cent, metallurgical and other industrial furnaces 21.13 per cent and steam locomotives 10.31 per cent. The total production of gases of combustion for the year from all sources was 5,008,111,106,758 cu. ft.

Notwithstanding the large volume of gaseous products of combustion which are emitted into the atmosphere of a city, the committee found that little trace of them is disclosed by a chemical analysis of the atmosphere. The explanation is, of course, to be found in the fact that while the volume of the polluting discharge is great, that of the atmosphere affected is vastly greater.

The committee's investigations convince it that the only gaseous elements which are harmful are those of sulphur which, in the air, change into sulphuric acid. The high pressure steam plants are first as sulphur producers, the metallurgical and other furnaces second, the low pressure domestic plants third and steam locomotives fourth.

AGENCIES CONTRIBUTING TO AIR POLLUTION.

Steam vessels were found to contribute the smallest total toward the pollution of Chicago air. They consume 0.46 per cent of the total amount of fuel used. They are responsible for 0.74 per cent of the visible smoke, for 0.33 per cent of the solid constituents of smoke, and for 0.60 per cent of the total gaseous products.

The steam locomotive was ascertained to hold fourth place as a coal consuming service. Of the total consumed, however, 98 per cent is bituminous, practically all of which comes from the fields of Illinois and Indiana. The steam locomotive "gets in bad" as its smoke is rather highly visible because, being emitted near the ground, the public gets the full benefit of the sulphurous fumes and because the cinders emitted, being heavy, fall close to the right of way, making somewhat intensive local pollution but adding little to the general dust of the air. The following is a summing up of the contribution of locomotives, in various services, to the smoke nuisance:

(a) Locomotives engaged in suburban passenger service contribute 1,54 per cent of the total visible smoke, 1.97 per cent of the total dust and cinders of smoke, and 0.74 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

(b) Locomotives engaged in through passenger service contribute 2.07 per cent of the total visible smoke, 1.80 per cent of the total dust and cinders of smoke, and 0.89 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

(c) Locomotives engaged in all passenger services combined, including suburban passenger, through passenger and passenger transfer, contribute 3.80 per cent of the total visible smoke, 3.81 per cent of the total dust and cinders of smoke, and 1.73 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

(d) Locomotives engaged in road freight service contribute 2.01 per cent of the total visible smoke, 1.18 per cent of the total dust and cinders of smoke, and 0.66 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

(e) Locomotives engaged in yard freight service contribute 10.25 per cent of the total visible smoke, 1.73 per cent of the total dust and cinders of smoke, and 5.17 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

(f) Locomotives engaged in all freight services, including road freight, yard freight and freight transfer services, contribute 16.85 per cent of the total visible smoke, 3.34 per cent of the total dust and cinders of smoke, and 7.57 per cent of the total polluting gases of smoke discharged annually into the atmosphere of Chicago.

The part played by the automobile toward Chicago air pollution is summed up by the committee in this paragraph:

Of the naphtha and the gasoline consumed within the area of investigation, it is estimated that fully 85 per cent of the total (approximately 437,000 barrels) is consumed in automobile service. With this amount of fuel must be included a considerable quantity of lubricating oils, the presence of which increases the smoke effects arising from the exhaust of engines. Under certain conditions automobile smoke is visible, and whether visible or not, its discharge into the atmosphere constitutes a polluting agency similar in general character, but differing much in detail, from that discharged from chimneys and stacks. The smoke from automobiles is discharged near the ground, where its presence is most objectionable to pedestrians, and being more or less surcharged with oil, it is especially offensive to those enveloped by it. Where the street traffic is most congested, the polluting effects are pronounced."

The superiority of crude oil, from the standpoint of smoke abatement, when used for industrial fires, is not questioned. The low sulphur content in the smoke from oil fires is an additional advantage. However, the use of such oils for industrial purposes, it is pointed out, involves the same possibilities in the development of smoke as attend the use of solid fuels. With the proper regulation of conditions affecting combustion, the smoke from oil fuels may be invisible, but under conditions unfavorable to perfect combustion, the smoke from oil fires becomes dense.

AVAILABILITY OF COAL.

Few of the world's great cities, the committee finds, are within such easy reach of so extensive a deposit of coal as Chicago. The Illinois-Indiana coal fields, covering an area of many thousands of square miles, extend almost to Chicago's threshold. This coal, says the report, is Chicago's coal and she must use it.

Chicago burns each year approximately eight tons of coal per capita.

DAMAGE FROM SMOKE.

As the result of a wide study, the committee reaches the following conclusions regarding damage from smoke:

There is a general agreement among sanitary authorities that polluted air is harmful to health, but at the present time there exists no accurate method of measuring this harm nor of determining the relative responsibility for it of the different elements which enter into the mixture of gases and solids commonly referred to as atmospheric air.

The direct effects of smoke or of any of its attributes, including soot, dust and gases, in amounts which may ordinarily pervade the atmosphere of a smoky city, are not shown to be detrimental to persons in normal health, but the general physical tone is lowered as the result of long continued breathing of polluted air.

The direct effect of smoke upon those who are ill has been most extensively studied in connection with tuberculosis and pneumonia. It appears that smoke does not in any way stimulate the onset of the tubercular process, nor militate against the rapidity of recovery when once this disease has been contracted, but that it has a direct antiseptic effect and tends to localize the disorder. In cases of pneumonia the effect becomes seriously detrimental.

Smoke is popularly regarded as a source of loss and damage in its effects upon building materials, objects of virtu, clothing, and other property. While these effects of smoke seem obvious, it has not been possible to estimate their extent with any degree of accuracy.

In addition to these direct results, indirect effects follow from the diminution in sunlight and the increase in fogs, clouds and haze. The great natural disinfectant of the atmosphere and our surroundings is the bactericidal action of the sun's rays. Cloudiness decreases the chemical and bactericidal effects of sunlight.

Injury to plant life was found to be definite. Sulphuric acid, formed from the soot, injured the leaves, as did also the tarry, glutinous deposit which tended to asphyxiate the plants. Vegetation also suffered directly from the diminution in the number of sunny days and in the sun's power.

AIR POLLUTION FROM SOURCES OTHER THAN SMOKE.

As a result of its investigations into air pollution in Chicago the committee finds that one-third the total defilement comes from sources other than combustion. The air is filled with vegetable, animal and mineral matter which rises from the various activities of the city.

If all the fires in Chicago were stopped, says the report, dust and dirt in the atmosphere would remain. Atmospheric pollution cannot be reduced to a minimum through attention to smoke abatement alone. In order to accomplish its reduction attention must be given to all of those processes and activities of the city which give rise to dust or which deal with the collection and disposal of city dirt and waste.

In addition to sewer gas, escaping illuminating gas and the products of animal decompositions, the committee finds that Chicago air is polluted by dust from many sources:

From unimproved streets and alleys, approximately 10 per cent of the city's area.

From bare ground areas, including playgrounds.

From back yards and roofs.

From coal yards, and the handling of crushed stone, lime, sand, cement, brick, tile, gravel and excavated material.

From building operations, particularly house wrecking. The fact that in 1912 permits were granted under which 372 buildings were wrecked, 672 moved, 14,000 repaired and 11,325 erected, the committee points out, only imperfectly suggests the extent of this source of pollution.

From street construction and repair. In 1912 Chicago laid 99 miles of new pavement, repaired 1,168.30 sq. yds. of old pavements, restored 756,488 sq. yds. and laid 242 miles of new sidewalk and 115 miles of street car track.

From materials in transit, such as coal, brick, ashes and sand.

From the abrasion of street and sidewalk surfaces. During 75 hours a single set of observers at busy corners counted 16,855 horse-drawn vehicles, 24,726 automobiles, 461 bicycles, 127 push carts and 200 equestrians.

From manufacturing operations.

From waste, bonfires and similar sources.

From dry sweeping of streets. This process, it is asserted, shows the city to be a poor housekeeper, for "every stage of it produces clouds of dust and every stage of it is imperfect as a cleaning process."

OTHER TYPES OF POWER CONSIDERED.

As a preliminary to its study of electrification for Chicago steam roads, the committee made an investigation into other methods of conducting transportation. It had been hoped that some type of self-propelling motor might be found, and the danger, engineering difficulty and expense of electrification be avoided. But this hope was not justified. The following systems were studied:

Internal combustion motor with mechanical drive, electric drive, compressed air drive, hydraulic drive, direct connected motor.

Compressed air motor.

Hot water motor.

Electric storage battery motor.

While it was found that progress had been made in adapting the gasoline engine to the requirements of light or special railroad service, the power requirements of heavy and diversified traffic, it is stated, are still beyond the gasoline driven unit. The Diesel oil burning marine engine has the power, but neither type is self-starting, an imperative requirement for switching work. A new Diesel experimental locomotive was examined in Switzerland. Much had been hoped from it, but the inventor was found doubtful of its success in such heavy yard switching work as would be required here and to limit its future to light express work with constant speeds and infrequent stops.

Much, also, had been hoped from the storage battery, but it was found to lack power, to be too expensive and to share, with electrification, the disadvantage of producing power house smoke. The internal combustion motors are also smoke producing and are regarded as adding a new hazard of operation through their fuel tanks. Compressed air and hot water motors were found impracticable, but their use is suggested on those sections of Chicago track that cannot be electrified.

EXTENT OF ELECTRIFICATION PROJECT.

Thirty-eight steam railroads would be involved in the Chicago project, as against 37 for the rest of the world. Of the Chicago roads 25 maintain passenger and freight service and 23 are classed as trunk lines, while 13 perform transfer or switching service only. Eight of the trunk lines have no main tracks within the city limits, but operate trains into the Chicago terminals over the tracks of other companies. Twelve railroads operate wholly within the area of investigation.

It was found that the Chicago mileage would be nearly twice that of all other electrically operated mileage in America, and, exclusive of foreign light service lines, would be about 15 per cent greater than all existing electrifications in the world. The committee's plan involves several times as much yard track mileage as do all existing American electrifications. The number of electric locomotives required would be approximately four times that of all now in service in America and two and a half times the number in the whole world.

REDUCTION OF SMOKE DUE TO ELECTRIFICATION.

The following table shows the net reduction in Chicago smoke that would follow complete electrification. It is to be remembered that this table refers to the smoke pollution of the air, which is only about two-thirds of the total pollution. Taking this into consideration the committee finds that the final net decreases, for instance, in the solids polluting the atmosphere would be less than 4 per cent.

		Per cent.
Visible smoke:		
Reduction through the elimination of the steam locomotive, per cent of total	22.06	
Increase arising from new electric power-plant loads, per cent of total	1.89	
Net reduction		20.17
Solid constituents of smoke:		
Reduction through the elimination of steam locomotive, per cent of total	7.47	
Increase arising from new electric power-plant loads, per cent of total	2.14	
Net reduction		5.33
Gaseous products of combustion:		
Reduction through the elimination of the steam locomotive, per cent of total	10.31	
Increase arising from new electric power-plant loads, per cent of total	4.96	
Net reduction		5.35

It will be seen that if the gaseous pollution is alone considered, the power house would take away half the advantage gained. Nor could relief be secured through long distance transmission, as both the coal fields and an adequate water power are too distant.

BEST ELECTRIFICATION SYSTEMS.

The committee, after obtaining complete engineering data on these three systems, selected the third as cheapest and most desirable:

1. Third rail contact, direct current at 600 volts.
2. Overhead contact, direct current at 2,400 volts.
3. Overhead contact, single phase current at 11,000 volts.

The third rail system was given up as the least practical of the three because of the difficulties to be met.

The difficulties of trolley installation would also be great, but less, it is believed, than those attending the use of the third rail. The great trouble found is with low bridges and other structures over the tracks.

The committee finds that it would make no practical difference whether the roads manufactured their own electric power or purchased it from public service corporations.

Electricity would, it is concluded, neither increase nor decrease the dangers of operation. Added dangers would be introduced, but compensating safety in other directions would offset these.

ADVANTAGES TO RAILROADS THROUGH ELECTRIFICATION.

The committee has made an effort to arrive at the incidental advantages that would accrue to the railroads through electrification. The change would give some increased capacity in existing trackage and terminals. In locations where operation under present day conditions is congested, it would give relief, and in locations where there is at present no congestion, electrification would constitute in effect, an enlargement of existing facilities and hence would postpone the day when additional facilities would be required.

Electrification, it is concluded, would contribute to increased celerity and reliability in train movement. It would open the way to more intensive use of railroad property, both in this manner and by making double decked freight and passenger terminal stations possible. It would also make possible the erection of buildings over tracks, but this value is regarded as speculative and, as a present day asset, small.

Electrification, it is pointed out, would give the roads an asset in the use of electric service beyond that required for trains. It would benefit the roads through the increased convenience and comfort of passengers and it would also give the roads whatever advantage accrued, entirely indeterminate, through the lessening of smoke.

COST OF ELECTRIFICATION.

In arriving at the cost of electrification the committee based its work on 1912 operation, extended to meet conditions if electrification were to begin in 1916 and be completed in 1922. The following accounting statement shows why the committee holds that electrification is financially impossible. The deficit on the minimum outlay of $178,127,230 would be too great.

Table III gives the detailed costs of this electrification of the Chicago terminals.

TABLE III.—DETAILED COST OF ELECTRIFICATION OF CHICAGO RAILROADS.

Ultimate cost of electrification		$274,440,630
Cost of 600-volt, direct-current (third rail) system, minimum plan		197,908,000
Cost of 2,400-volt, direct-current (trolley) system, minimum plan		191,666,808
Cost of 11,000-volt, alternating-current (trolley) system, minimum plan, chosen as the least expensive, in detail:		
1. Power station	$10,302,104	
2. Transmission system	1,618,693	
3. Sub-stations	2,024,736	
4. Switching stations	573,073	
5. Contact system	28,141,188	
6. Bridge warnings	1,071,989	
7. Return circuit	4,446,033	
8. Elimination of inductive effects and electrolysis	996,727	
9. Telephone system	272,052	
10. Electric locomotives, multiple-unit equipment, work and inspection equipment	91,703,557	
11. Spare parts	485,343	
12. Changes in overhead structures	834,261	
13. Changes in wire lines	2,028,007	
14. Changes in signal system	6,111,407	
15. Removal and re-establishment of locomotive terminals and new facilities	37,293,746	
		$187,902,916
Less salvage on equipment usable elsewhere		9,775,686
Net cost of committee's minimum plan		$178,127,230
Plus added costs due to betterments, improvements and changes precipitated by electrification		96,313,409
Estimated total final cost		$274,440,620
Annual charges on investment, including interest, depreciation and replacement of dissipated assets on $187,902,916		16,946,436
Annual saving through decreased costs of operation		2,336,693
Annual deficit		$ 14,609,743

The investigations show that electrified operation for all the railroads taken together and disregarding depreciation and interest, would result in a decrease in operating expenses. Under steam operation, those accounts that would be affected one way or the other by electrification show a total of $10,934,064. Under operation by the 600-volt direct current third rail system, the total would be $8,442,298, with the 2,400-volt direct current system it would be $7,355,771 and with the 11,000-volt alternating current system it would be $7,140,495. The installation of these three systems would result in a saving in operating expenses respectively of $2,491,766, $3,578,293 and $3,793,569.

This saving, however, is in part nullified by new expenses due to the operation of stations that would have to be established at the end of electrified tracks to provide for a transfer of trains from electric to steam locomotives, and also by the waste and consequent loss due to operating over shortened steam railroad divisions, which have surrendered part of their mileage to make the new terminal electric divisions. The engineers' estimates place the added expense under the first item at $1,546,113 and the added expense under the second at $450,000. This would leave the net saving in operating expenses, to follow electrification, at $495,653 for the third rail system, $1,582,180 for the direct current trolley system and $1,797,456 for the alternating current trolley system.

PERSONNEL OF COMMITTEE.

The Chicago Association of Commerce has taken part in anti-smoke work actively since Oct. 29, 1909, at which time there was appointed a committee of eight to consider the subject of electrification. This committee made its report on July 8, 1910. It was felt, however, that the subject was so important that it should be further investigated and more technical data secured. In December, 1910, it was learned that the City Council had proposed a commission to investigate the question of electrification without reference to the matter of smoke abatement. The association tendered its services to Mayor Busse as an aid in any investigation to be undertaken. As a result, in March, 1911, the following joint committee was named:

Appointed by mayor:

W. A. Evans, Paul P. Bird, T. E. Donnelley, Milton J. Foreman.

Appointed by the railroads:

W. A. Gardner, H. G. Hetzler, Darius Miller, C. E. Schaff.

Appointed by the Association of Commerce:

W. F. M. Goss, E. R. Graham, Richard C. Hall, Jesse Holdom, Frederick H. Rawson, Harrison B. Riley, John W. Scott, Francis T. Simmons, Mason B. Starring.

The following changes in the personnel of the committee took place at various times: J. J. Bernet for Mr. Schaff, Harry A. Wheeler for Mr. Starring, Howard Elting for Mr. Rawson, and Hale Holden for Mr. Miller.

The late Horace G. Burt was chief engineer for the committee until May, 1913, and was succeeded by W. F. M. Goss.

BRIDGES

Design of a 242-Ft. Arch Span Over the Pit River in Shasta County, California.

(Staff Article.)

The Pit River bridge, now under construction in Shasta County, Cal., is a reinforced concrete highway structure consisting of a 242-ft. clear arch span and two girder spans of about 37 ft. each. The bridge provides a right-angle crossing of the Pit River, the approaches forming reverse curves, as the highway parallels the river on each bank. The bridge has a vertical clearance above normal water level of 56 ft. 3 ins., the variation between the normal and extreme high water being 30 ft. 6 ins. The abutments of the arch span are founded on solid rock. The general design features of the bridge and the topography at the site are indicated in Fig. 1.

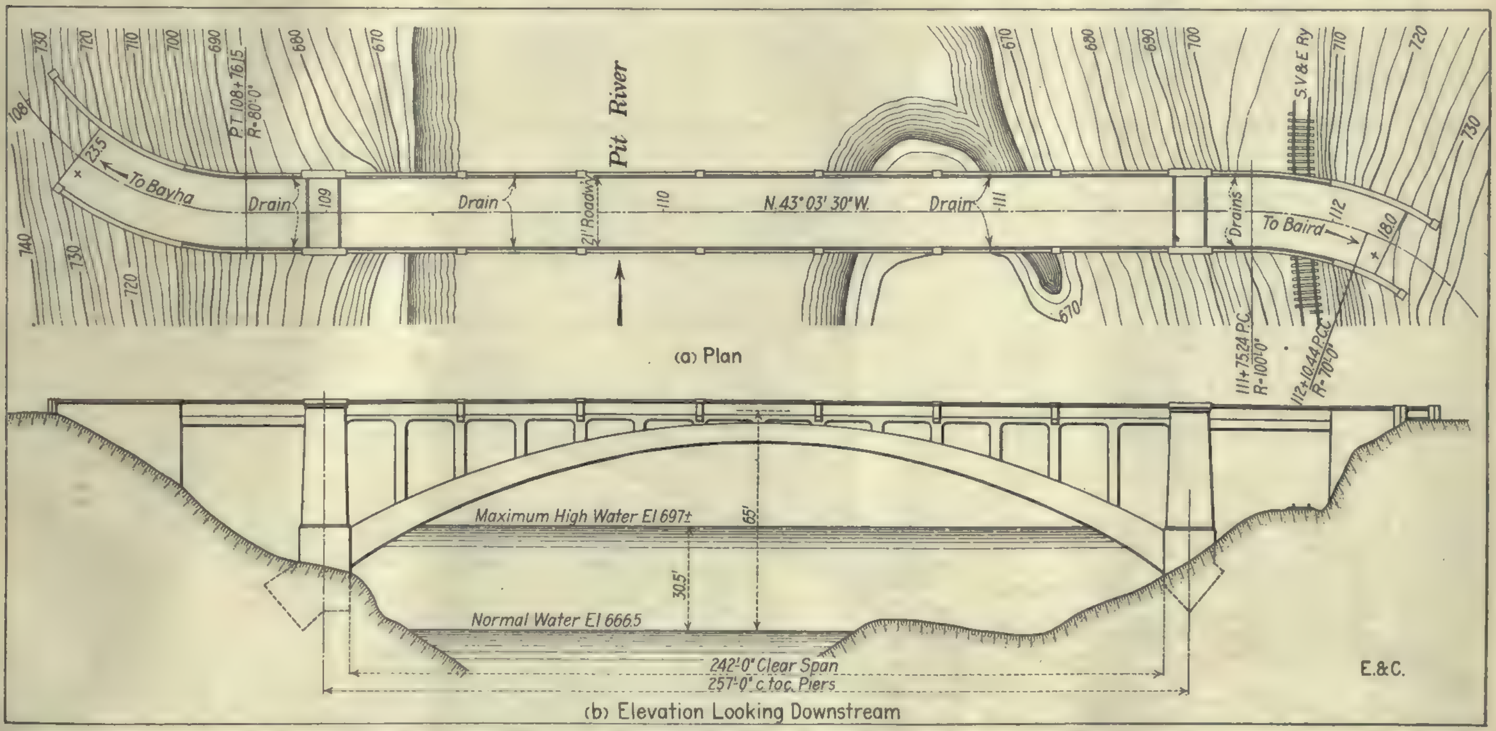

Fig. 1. General Plan and Elevation of Pit River Bridge, Shasta County, Cal.

LOADS, ALLOWABLE STRESSES AND PRINCIPLES OF DESIGN.

The structure was designed for a 20-ton traction engine load, treated both as wheel concentrations and as a live load of 20 tons distributed over an area of 8 by 15 ft., together with a uniform live load of 80 lbs. per square foot on the remaining floor area. All live loads were considered placed in such positions as to give theoretically true maximum stresses in all parts of the structure. A temperature range of 30° F. each way from the normal was used.

The computed compressive stresses in the concrete of the arch ribs do not exceed 600 lbs. per square inch for combined dead and live loads, nor 750 lbs. per square inch for the maximum combination of dead load, live load and temperature stresses. The tensile stresses in the steel are relatively small under extreme loading conditions.

The floor system was designed for the same loads as the arch ribs, the sections being proportioned on a basis of 650 lbs. per square inch compression in the concrete and 16,000 lbs. per square inch tension in the reinforcing steel.

The calculations for the arch ribs were carried out almost entirely by algebraic methods, graphical constructions being used only incidentally and as a check. The method used was similar to that given in Turneaure and Maurer's "Principles of Reinforced Concrete Construction," using unit loads, although there were some important modifications. The method was modified to include, in a theoretically correct manner, the effect of rib-shortening. Equal divisions of the arch ring also were used, with the variation of the moment of inertia figured into the formulas, instead of dividing the ring into parts of such lengths as to make ds/I a constant.

CONCRETE PROPORTIONS.

For the arch ribs, wind bracing, girders and floor slabs, columns, and railing, a 1:2:4 concrete will be used; while for the abutment walls and the foundations and walls of the piers the concrete proportions are 1:2½:5. The cement and reinforcing steel are furnished by the state.

DETAILS OF ARCH SPAN.

Arch.—The reinforced concrete arch has a clear span of 242 ft. and a rise of 38 ft. 3 ins. The arch consists of two ribs spaced 16 ft. on centers, each rib having a width of 4 ft. and a depth at the crown of 5 ft. 3 ins. The arch ribs are connected by a system of wind bracing of the Warren type, the sections of which varying from 24x24 ins. at the springing line to 12x24 ins. at the crown.

The girder-and-slab floor system is supported from the ribs by spandrel columns. These columns have a uniform cross section of 21x36 ins. and vary in length from 10½ ins. at the crown to 23 ft. 11⅝ ins. near the springing line. The columns divide the floor system into 17-ft. 8-in. panels.

At each panel point there is a floor girder 15 ins. wide and 2 ft. 6 ins. deep, including the thickness of the floor slab. These girders support three longitudinal lines of beams, one at the center of each girder and one at a distance of 8 ft. 4½ ins. on each side of the center line of the bridge. These beams have a width of 12 ins. and a depth, including the floor slab, of 1 ft. 9 ins. The floor slab, which has a uniform thickness of 7 ins., follows the curve of the finished roadway, the crown of which is 3 ins.

Figure 2 (a) is a half longitudinal section of the arch span, Fig. 2 (b) is a half plan showing the wind bracing between the arch ribs, and Fig. 2 (c) is a half plan of the floor system. These drawings give the arrangement and principal dimensions of the various members but do not show the steel reinforcement.

Figures 3 (a) and 3 (b) show reinforcing details of the arch ribs and spandrel columns. It will be noted that the reinforcement of both the intrados and extrados of each arch rib consists of two layers of bars, the individual bars in each layer being made continuous by means of turnbuckles. The bars are not upset, the efficiency of the joints being about 87 per cent. The joints in the two upper and two lower layers of bars are staggered about 3 ft. Figure 3 (c) shows reinforcing details of the wind bracing members. In casting the arch ribs, sockets are to be left for the wind bracing members and stub bars placed as shown. The wind bracing members are not to be poured until after the ribs are keyed and set.

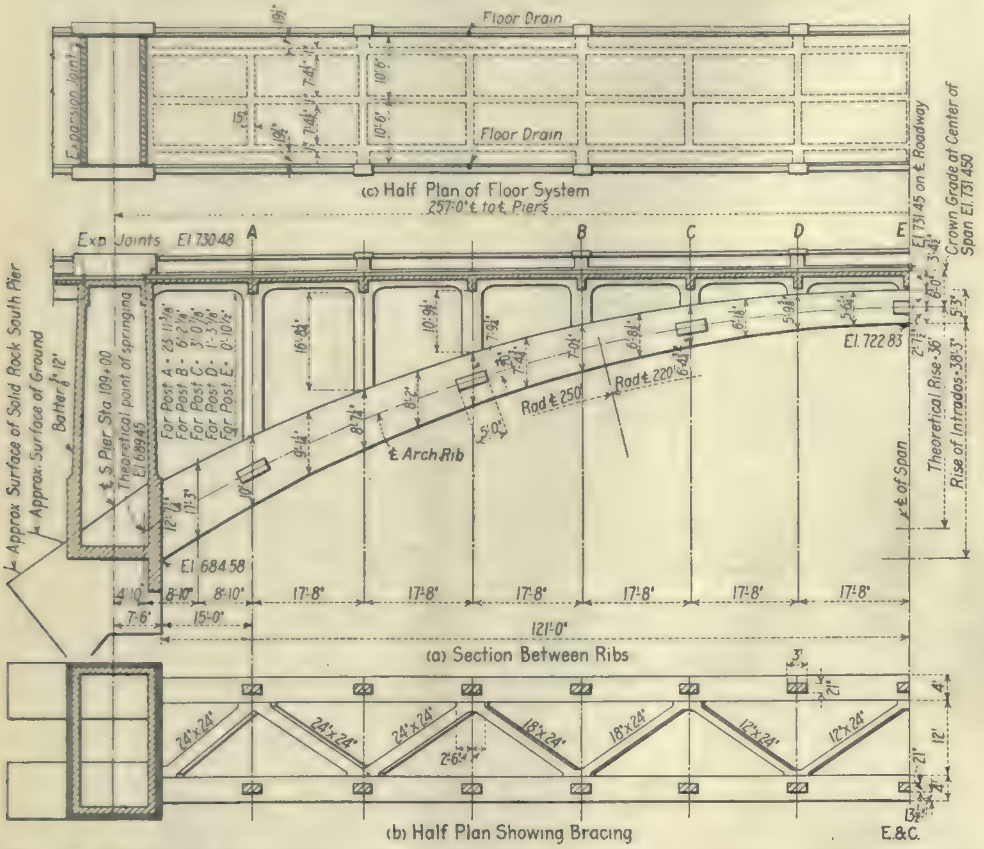

Fig. 2. Details of 242-ft. Arch Span of Pit River Bridge. For Details of Reinforcement See Fig. 3.

Figure 4 (a) is a cross section of the floor system and railing. This drawing gives the dimensions of the members and shows reinforcing details. Figure 4 (b) shows details of a typical center longitudinal beam, and Fig 4 (c) shows details of a typical outside beam. Figure 4 (d) gives details of a typical floor girder.

Piers.—The construction of the main abutment piers of the arch span is greatly simplified by the fact that they are founded on solid rock. These piers carry the loads and thrusts of the arch and also one end of the approach spans. Below the junction of the arch ribs each pier is of the divided type, the two parts being connected by a reinforced concrete diaphragm. Above this junction the pier is hollow, with reinforced concrete walls 15 ins. thick.

Details of the south pier are shown in Fig. 5. Figure 5 (a) is an end elevation of this pier, and Fig. 5 (b) is a side elevation of it. Figure 5 (c) is a longitudinal section of the south pier, and Fig. 5 (d) is a cross section of it. These drawings give the principal dimensions and show the system of reinforcement used.

The general features of the north pier are shown in Fig. 5 (e). Above elevation 697.43 the north pier is similar to the south one.

APPROACH SPANS.

At each end of the arch span there is an approach span of about 37 ft. and a short section of girder-and-slab construction, built monolithic with the enclosing retaining walls. The 37-ft. spans consist of four lines of reinforced concrete girders supporting a reinforced concrete floor slab and carrying the same type of railing used on the arch span. As has been noted, these approach spans are curved.

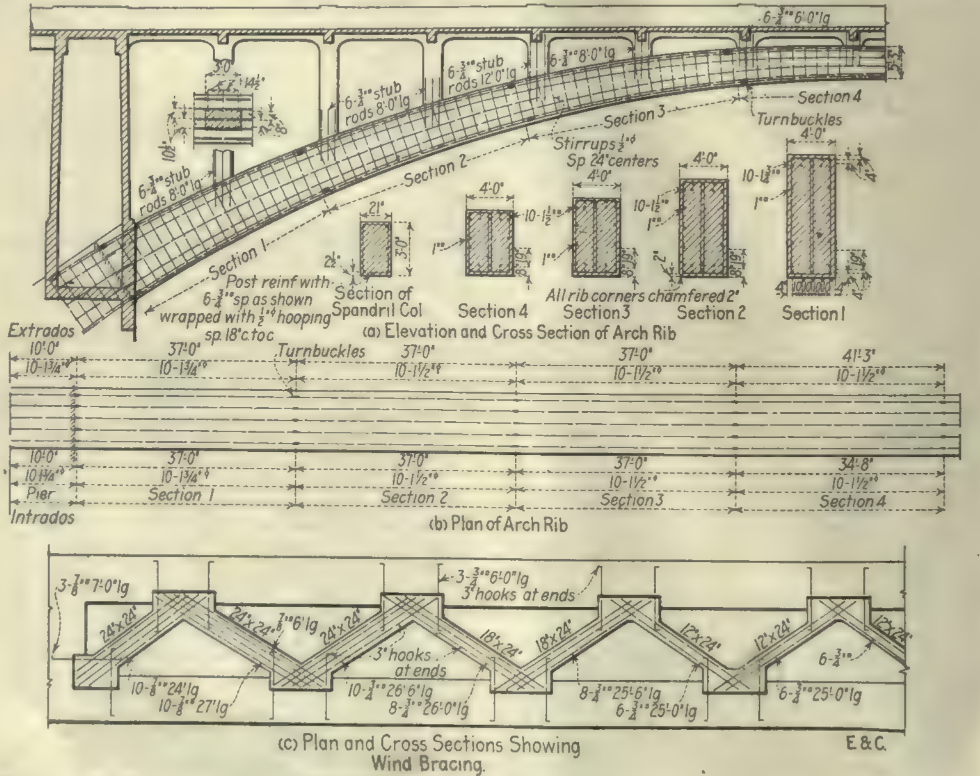

Fig. 3. Details of Reinforcement of Arch Rib, Spandrel Columns and Wind Bracing of Pit River Bridge.

FALSEWORK FOR ARCH SPAN.

The falsework for the 242-ft. span consists of a nine-panel wooden "Howe" truss span over the main channel of the river, one under each arch rib, supported on timber bents spaced 128 ft. 3 ins. on centers, and a system of timber bents and bracing for the remainder of the arch span.

The compression members of the truss are heavy round timbers cut from trees in the vicinity of the work. The top and bottom chords are each composed of three round timbers, 20 ins. in diameter at the butt and 14 ins. in diameter at the tip, framed, by means of shear pegs, to act as units. Above the horizontal top chord of the falsework truss, and between it and the soffit of the arch rib, there is a system of struts and braces supporting the concrete forms. The two falsework trusses are connected by a system of lateral bracing. To facilitate the erection of these trusses, as it was inadvisable to place even temporary bents in the main channel, six panels of the lower chord were arranged to act as a trussed beam, its outer end being supported on a bent which was left in place only until the falsework trusses were erected. Temporary erection bents were also placed under the two outer panel points not included in the trussed portion of the lower chord; these were removed as soon as the falsework trusses were erected and braced.

QUANTITIES OF MATERIALS AND CONTRACT PRICE.

The estimated quantities of the principal materials are as follows:

Concrete, 1:2:4 mix, 1,010 cu. yds.
Concrete, 1:2½:5 mix, 978 cu. yds.
Reinforcing steel, 184,000 lbs.
Rock excavation, 400 cu. yds.

The state furnished the cement and the reinforcing steel. The contract price for furnishing all other materials and for constructing the bridge was $28,235. The materials furnished by the state cost $10,002, the total cost of the bridge thus being $38,237.

PERSONNEL.

The bridge was designed by the engineering department of the California Highway Commission, A. B. Fletcher, highway engineer. It is being constructed by the Ross Construction Co., of Sacramento, Cal.

Some Data on Waterway Areas Required for Highway Bridges.

(Staff Abstract.)

When conditions are such that all of the water from a given drainage area must be carried under a bridge the required area of the waterway can be determined approximately if the size, slope and character of the drainage area are known. The area of the watershed can often be determined with reasonable accuracy from the United States topographical maps, or, in case these are not available, from a survey of the watershed.

Table I gives the waterway areas for different sized drainage areas used by a number of railroads in designing their drainage structures in Kansas, Missouri, Oklahoma, Arkansas, Iowa and Illinois. Years of experience have demonstrated that the data given in this table, when used with due consideration for the local conditions, are an excellent guide.

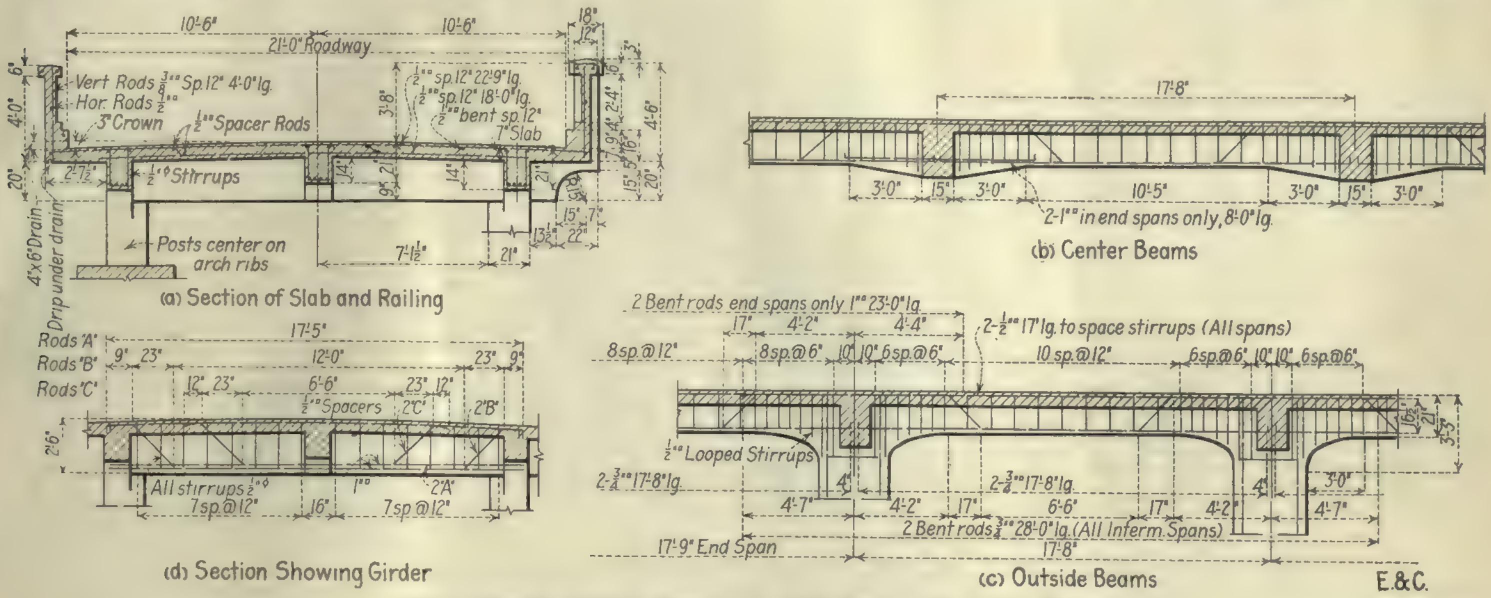
(a) Section of Slab and Railing
(b) Center Beams
(c) Outside Beams
(d) Section Showing Girder
21'-0" Roadway
Vert Rods 3/8" Sp. 12" 4'-0" lg.
Hor. Rods 1/2"
3" Crown
1/2" Spacer Rods
7" Slab
1/2" Stirrups
Posts center on arch ribs
4"x6" Drain
Drip under drain
2-1" in end spans only, 8'-0" lg.
2 Bent rods end spans only 1" 23'-0" lg.
2-1/2" 17' lg. to space stirrups (All spans)
1/2" Looped Stirrups
2 Bent rods 3/4" 28'-0" lg. (All Interm. Spans)
17'-9" End Span
Rods 'A'
Rods 'B'
Rods 'C'
1/2" Spacers
All stirrups 1/2"
E.&C.

Fig. 4. Details of Floor System of Arch Span of Pit River Bridge.

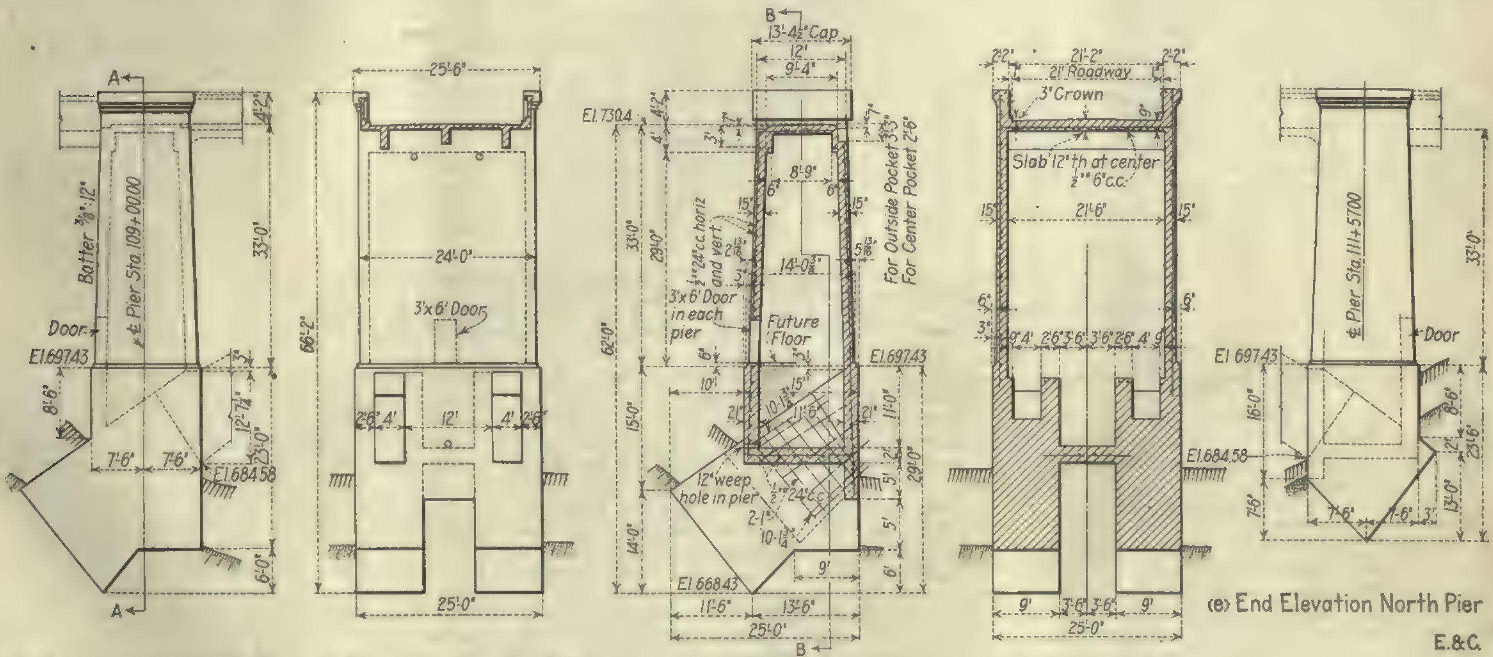

Fig. 5. Details of Abutment Piers of Pit River Bridge.

In the prairie country the natural stream channels will not ordinarily carry all of the water, and in flood time the whole bottom is overflowed. Generally no attempt is made in constructing and maintaining highways in these valleys to throw up an embankment above the natural ground level or above the high water as the railroads have done, except at the bridge approaches. This condition does not affect the height at which the bridges should be located, but it does make it impracticable and unnecessary to carry all of the flood water under these structures. It also renders any drainage area tables more or less useless and complicates the problem of deciding the proper length of bridge to use and the waterway area to provide.

It has been the writer's practice, under such circumstances, to design the bridges with sufficient length to span the natural or normal stream channel and to provide enough waterway area to carry the maximum flow or capacity of such channel; also to place the bridge at an elevation well above high water, and to use no piers near the center of the main channel if they can possibly be avoided. It must be remembered, however, that the bridge and its approaches should be designed in such a manner as to obstruct the stream a minimum amount, for any congestion or damming up of the water may endanger the bridge, cut out the approach fills, and damage private property. In every case the local conditions require keen engineering insight and judgment.

An inspection of the old bridges on the stream above and below the new site may furnish some valuable data, but too much reliance should not be placed on the length of spans used and the amount of waterway provided at these old bridges in determining the dimensions of the new structures, for by following the stream a few miles it is not uncommon to find the lengths of the different highway bridges and their waterway areas varying from 100 to 400 per cent under practically the same conditions. These variations are largely due to the amount of funds that were vailable when the different structures were built, to the whims of the different officials who had charge of the work at the time, to the local materials available at the bridge site, and to the other local conditions.

By inspecting the stream channel for a mile or two above and below the proposed bridge site and taking a number of cross sections the natural or normal channel area can be determined. From this and the other known conditions the length of span required can also be determined.

The height of a bridge over a stream of this kind is even more important than its length or waterway area, and the high-water marks are generally difficult to locate accur-

TABLE I.—AREA OF BRIDGE OPENINGS REQUIRED FOR VARIOUS DRAINAGE AREAS.

Acres drained.	—Area of openings in square feet, required by—						
	C., B. & Q. R. R.	A., T. & S. Fe and C., R. I. & P. R. R. (†Duns's table.)	—Union Pacific Railway.— $^*W = C. A^{\frac{3}{4}}$				
			C = 1.	C = 2/3.	C = 1/3.	C = 1/5.	C = 1/6.
10	2.0	3.2	5.6	4.0	1.9	1.1	1.0
20	4.0	5.9	9.46	6.0	3.15	2.0	1.6
30	5.5	8.4	12.8	8.5	4.2	2.6	2.1
40	7.0	10.9	15.9	10.6	5.8	3.2	2.7
50	8.0	13.4	19.0	12.7	6.3	4.0	3.2
100	14.0	25.9	32.0	21.4	10.7	6.4	5.4
200	24.5	45.7	54.0	36.0	18.0	11.0	9.0
300	34.0	64.4	72.0	48.0	24.0	14.4	12.0
400	42.5	76.0	92.0	62.0	30.7	18.4	15.4
500	51.0	87.0	165.0	70.0	35.0	21.0	17.5
1,000	100	156	178	120	57	36	36
2,000	160	312	260	166	83	52	42
3,000	210	435	400	266	133	80	67
4,000	252	522	510	340	170	102	85
5,000	292	595	540	360	180	108	90
10,000	482	853	1,000	866	333	200	167
20,000	740	1,205	1,758	1,200	600	350	300
30,000	965	1,470	2,240	1,500	750	450	375
40,000	...	1,685	2,900	2,000	1,000	580	500
50,000	...	1,876	3,320	2,200	1,100	664	550
100,000	...	2,716	5,630	3,740	1,870	1,126	935
200,000	...	3,696	9,500	6,400	3,200	1,900	1,600
300,000	...	4,453	12,800	8,600	4,300	2,560	2,150
400,000	...	5,130	16,000	10,600	5,300	3,333	2,650
500,000	...	5,728	18,700	12,600	6,300	3,780	3,150
1,000,000	...	7,870	31,700	22,000	11,000	6,340	5,500
5,000,000	...	.....	105,000	70,000	35,000	21,000	17,500

*In this formula: C = 2/3 to 1 for steep, rocky ground; C = 1/3 for rolling ground, and C = 1/6 to 1/5 for long, narrow, flat valleys.

†Dun's table was prepared from observations of streams in southwestern Missouri, eastern Kansas, western Arkansas, and the south-central portions of Oklahoma. In all of this region steep, rocky slopes prevail, and the soil absorbs only a small percentage of the rainfall. This table indicates larger waterways than are required in western Kansas, the level portions of Missouri, Colorado, New Mexico and eastern Texas. The table is based on data obtained from different western railroads and from actual surveys on a 6-in. rainfall in 24 hours taken from government statistics, considering that most of it falls in 6 to 8 hours with a run-off of 172 cu. ft. per second and a velocity of 4 miles per hour, or 6 ft. per second.

ately. The old residents can furnish valuable information concerning the height of different floods, but the elevations given should not be accepted as accurate until checked by some other means. Marks or indications can generally be found about the old bridges and elevations given on these old structures by the local people are much more accurate than the elevation designated by them on trees, posts or other objects. Drainage tables should be used as a check when there is any doubt about the information available.

Where the stream will probably be levied in the near future it may be advisable to design the bridge abutments so they can be altered at small cost and used as piers.

In the arid country the highway bridge problem is a serious matter, even though many of the stream beds are dry most of the time. The streams generally have a heavy fall, the rainfall is violent, and the percentage of run-off is very large. The floods come like torrents and in a few hours are gone. The Russian thistles accumulate in the ravines in great quantities and during floods the streams carry tons of this debris. It is impracticable in many cases to bridge these streams with a high structure on account of the lack of funds, to the difficulty in maintaining the approach fills, and to the danger of the structure being swept away by accumulations of drift. These stream beds are sandy and cannot be forded without great difficulty. There are no ice flows so that low-water wood-pile bridges have been used successfully for these crossings. Concrete and reinforced concrete pavings have also been used, but it is the writer's observation that they are not satisfactory because the pavings undermine and break up, even when deep curtain walls are used on both the upstream and downstream sides of the paving.

The writer designed and supervised the construction of a low-water reinforced concrete slab bridge at Ashland, Kan., in 1910. The overall length of the structure is 60 ft., and it is composed of two plain concrete abutments, two piers, and three reinforced concrete slabs. The clear width of the roadway is 18 ft. The footings of the abutments and piers were carried about 5 ft. below the bed of the stream and into the soapstone from 6 to 12 ins. to prevent undermining. The wing walls were carried well back into the bank.

The bottom of the slabs is about 16 ins. above the bed of the stream, and the total height of the bridge above the bed of stream is less than 3 ft. The opening is just high enough to carry the ordinary flow and to permit the removal of any accumulation of debris, while the top of the bridge is below the elevation at which the stream carries drift. In other words the water flows over the top of the structure before the drift begins to run. Otherwise the bridge would act as a dam, there would be large quantities of drift to remove after each flood, and the approach fills would be cut out. This bridge has been under from 10 to 12 ft. of water five or six times during the past five years and it has not been damaged.

The floods are of short duration, so that the bridge is never under water to exceed six to ten hours at any one time, and this does not occur more than once or twice in a year. The actual cost of this bridge was $1,220. A high steel bridge would have cost not less than $2,500. At the present time there are ten or fifteen of these low-water reinforced concrete slab bridges in the state, and the writer has just completed plans for another one 574 ft. long.

Where the steel highway bridges have been placed well above high water so that the drift does not pile up against the spans, and where the superstructures were securely anchored to the foundations, practically all of the flood damages have been due to the use of improperly designed and poorly constructed tubular piers or steel-leg and mud-sill foundations. The ice floods have been particularly disastrous to the latter type of foundation.

Many examples of reinforced concrete bridges having spans of 50 ft. or less could be cited which have been entirely submerged in violent floods without injury except the washing out of the earth approaches. These approach fills can be protected by concrete or stone masonry retaining walls or by riprapping the side slopes.

The stream banks immediately above the highway bridges are seldom protected and much damage is done in the alluvial valleys by the water cutting around the bridges or forming new channels. This can be prevented effectively by the use of jetties to direct the current under the bridge and by revetment to prevent errosion.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by W. S. Gearhart, state engineer of Kansas, presented before the Pan-American Road Congress, Oakland, Cal.

ROADS AND STREETS

System of Convict Road Construction in Virginia.

The legislature of 1906, realizing that some definite action must be taken by it for the upbuilding and improvement of the public highways of the state, passed what is known as the Withers-Lassiter law and created the present state convict road force. Under this law, the road authorities of a county desiring to improve their roads, make application to the State Highway Commissioner for a camp of prisoners. The commissioner makes requisition on the superintendent of the penitentiary for the number of men he thinks it advisable to employ on the particular piece of construction.

The camps vary in size from 35 to 85 men, a sergeant with from three to five guards is sent out with each camp. These sergeants and guards are selected from a list furnished the superintendent of the penitentiary by the highway commissioner, and must be discharged on his written request. The sergeant receives from $600 to $900 and board per annum, and the guards from $300 to $420 and board per annum. These salaries compare favorably with those paid in other states.

The camp is composed of three buildings divided into a sergeant's and guard's house of two rooms; a sleeping house for the men, composed of two rows of bunks with an 8 ft. passageway down the center, and a guard's stand at one end; a dining house, divided into a dining-room for the men, a dining-room for the sergeant and guards, a storeroom for supplies and the kitchen. Camp sites are selected with a great deal of care, particularly with a view to a plentiful supply of pure water and proper drainage; also that the walk to and from work may be reduced to a minimum. This, in the most extreme cases, should not exceed two miles. The cooking and washing, in fact all the work about the camp, is done by prisoners, from three to five men being assigned to this work. These are taken from the men who are not capable of doing the heavier classes of road work.

The men are divided into gangs of from eight to fifteen, each gang being in charge of a guard of foreman. When possible, guards should be used as foremen. This system—that is, working prisoners under guard—is generally followed in the southern states. In the northern and western states the men for road work are selected from the entire convict body and only the better class of men are used. As a matter of fact, in Virginia the percentage of trusties to the entire prison population is greater than in any other state, ranging from 30 to 40 per cent. And during the past eight months the percentage has actually been .356 per cent. The escapes amount to little less than .035 per cent. As a matter of fact there were 132 escapes and 88 recaptures out of a total of 3,509 men handled.

The road work proper is in charge of an engineer or superintendent, appointed by the highway commissioner, who receives from $900 to $1,500 per annum. We have found that in many of our camps we can combine the duties of sergeant and superintendent in one man, saving something in salary, and a great deal in conflict of authority, since we have found it very difficult to accurately define the line between the two.

The prisoners are trained in all classes of road work. Trusties are made into rollermen, firemen, blacksmiths, carpenters, drill runners, concrete men, etc., the trusties being selected by the sergeant from the better class of prisoners. The state convict road force is composed of all male convicts, who are considered safe by the superintendent of the penitentiary and all male jail men over 16 years of age, and this force when placed on a county road or in a county quarry is clothed, fed, guarded and transported by the state and placed on the road each morning free of all cost or expense to the county. Prisoners working on the road force shall have for good behavior a reduction of four days per month from the time for which they were sentenced. The last legislature appropriated $200,000 and the jail fees for that purpose. The men cost a little less than 53 cts. per ten hour working day, which is divided about as follows:

Provisions	$0.213
Clothing	.048
Salaries	.193
Mileage	.007
All other expenses	.067
Total	$0.528

By combining the duties of the sergeant and superintendent of construction we hope to very much reduce the salary charge.

Extracts from a paper by G. P. Coleman, Pan-American Road Congress.

Road Surfaces and Traffic Speeds.

The question as to what constitutes heavy traffic and light traffic is not definitely settled and there are many opinions as to what these terms mean. It is my opinion that not enough importance has been placed on swiftly moving traffic, as against slow moving traffic. For instance there are many small towns and cities where the plaza about the railroad station is paved with ordinary macadam. The traffic over this pavement may be greater in number of vehicles per day than any other street in the city. It is, however, slow moving traffic and the result is that the macadam pavement will remain in very fair order for long periods without very much repair. Take the same vehicles and run them swiftly over a 16-ft. wide country road built of macadam and the result will probably be the disintegration of the macadam surface so that it is in bad shape for nearly all the time. Thus on residential streets that are not thoroughfares it may very often happen that a macadam roadway treated with a surface binder and dust layer will furnish a good driveway and may be maintained at a very small expense, even though there is a considerable traffic, including even heavy traffic.

It is my opinion that a main county road paved, say, for the width of from 16 ft. to 20 ft. and carrying a maximum traffic of 2,000 vehicles in 24 hours, running at high rates of speed, receives a much greater pounding and a much greater wear than a main city street carrying twice the number of vehicles per day. This question of traffic, slow moving and fast moving, over city streets and county roads has not as yet been worked out on a basis that has any great value in the determination of kinds of pavement to be used. Extract from remarks by Jacob L. Bauer on Maintenance of Pavements, Pan-American Road Cougress.

Classification of Pavements in Kansas City, Mo.

Considering Kansas City and similar city conditions, says City Engineer Curtis Hill, it is my opinion that practically three classes of pavement apply as follows:

(a) Where the traffic is very heavy such as in wholesale and freighting sections, granite blocks and some (*not all*) sandstone blocks are suitable on a concrete base of not less than 8 ins.

(b) On medium traffic streets such as the retail sections, creosoted wood blocks or brick blocks with a possible substitution of a small granite block in some places and a granite block on heavy grades, all on not less than an 8-in. concrete base.

(c) For light traffic and residence streets, brick asphalt and concrete will apply. The brick on those streets of a semi-business class, asphalt in the more valuable residence sections and concrete where a lower cost pavement is applicable. A broken rock of the bituminous bound or oiled (but never simply water bound) type can be added to this class for residence streets only when excellent facilities prevail for a constant maintenance. When properly maintained it is a good residence street.

Gravel Road Section; Town Trench Method of Construction.

Methods of constructing gravel roads in Iowa were discussed in our issue of Dec. 1, 1915. An illustration of the trench type of road section used, taken from the *Iowa Engineer*, is shown by Fig. 1. This design presupposes that vehicles will use the middle of the road except when passing other vehicles; hence the extra depth in the middle—nine feet. The 16 ft. width of the top course gives ample room for passing vehicles. This particular section requires approximately 2,300 cu. yds. of gravel per mile.

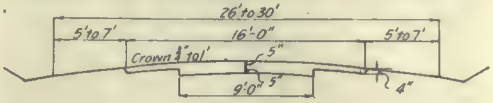

Fig. 1.

Proportioning Concrete for Road Construction.

To the Editors: We have been interested in the editorial in your issue of Nov. 19, entitled "A New Section in Concrete Road Specifications," and we wish to take this occasion to make certain remarks with regard to the editorial which we consider to be pertinent, as your editorial will undoubtedly carry great weight with a certain number of engineers who will give some consideration to the use of a method of proportioning which is out of date, rather than new.

When I say that this method of proportioning is out of date, I might refer you to page 154 of the Proceedings of the National Association of Cement Users for 1908. At the bottom of this page you will find that, under Proportioning, the following statement is made:

> The concrete for the base shall be so proportioned that the cement shall overfill the voids in the sand by at least 5 per cent and mortar shall overfill the voids in the stone or gravel by at least 10 per cent.

This method of proportioning sounds very good on paper, but when it comes to being of practical value it is not there. The trouble is, there are half a dozen different ways of determining voids, and no method gives very accurate results. This leads to controversy between the engineer and contractor. In addition, the method of determining the proportions by voids is not a correct one, as it does not give the maximum density of concrete, which is the desirable feature. If it were possible to specify that proportions should be used which would give the minimum amount of concrete for a certain amount of materials, then we might be taking a step in advance. However, this again involves argument between the engineer and contractor, and it is far better to state definitely that a certain amount of cement, a certain amount of sand and a certain amount of gravel should be used.

The General Committee of the American Society for Municipal Improvements appreciated this condition when they added clause 6 (a) under Proportions, to counteract the ill effects of clauses 4, 5 and 6, as prepared by Mr. Crosby. There will be many cases where the proportioning of concrete under paragraphs 4, 5 and 6 would permit of mixtures such as 1:2:4½, 1:2½:4 and other mixtures of equally lean proportions. We know that such mixtures do not give satisfactory results in road work. Experience, and not theory, has taught us that. We do know that a 1:2:3 mixture, under average conditions, will give us a satisfactory road surface, and therefore why not specify such a mixture?

With regard to your statement preceding the publication of the proposed specifications for one-course concrete street pavement, we wish to call your attention to the fact that the specificatians for fine and coarse aggregate are the same, and not in any sense different than the specification of the American Concrete Institute. Your article would give the impression that they are new.

Yours very truly,
Wm. M. Kinney,
Inspecting Engineer, Universal Portland Cement Co.
Chicago, Ill., November 24, 1915.

The Extreme Safety of Municipal Bonds as an Investment.

The extreme safety of municipal bonds is indicated by data given in a recent issue of *The Bond Buyer*. Since 1893 there have been defaults amounting to only $281,000, which is a loss of only .003 of 1 per cent, i. e., 3 cts. per $100. It is probable also that most of these losses occurred on bonds which were not properly safeguarded as to legality and had not been approved by competent attorneys, and also it is true that none of these defaults occurred in states having serial bonds. The three main causes for defaults of municipal bonds are:

First. Improper purpose of issuance, i. e., many bonds defaulted which were issued to foster some private enterprise, such as the construction of a railroad which failed to come after it had received payment.

Second. Irregularities in proceedings incident to the issuance.

Third. Maturity of large amount of bonds. Very often these bonds mature long after the improvement which they were issued to create has become useless. It is not strange that people should object to paying by direct levy the bill of a former generation.

Nearly all the defaults in this country can be traced back to one of these three causes. Eliminate these causes and municipal bonds become about as safe an obligation as it is possible to conceive.

List of Cities Having Commission-Manager Form of Government.

The following information relative to cities having the commission-manager form of government is from a recent issue of the Short Ballot Bulletin:

City.	Population.
Sumter, S. C.	8,109
Hickory, N. C.	3,706
Morganton, N. C.	2,712
Dayton, Ohio	116,577
Springfield, Ohio	46,921
Phoenix, Ariz.	11,134
La Grande, Ore.	4,843
Amarillo, Tex.	9,957
Cadillac, Mich.	8,375
Manistee, Mich.	12,381
Montrose, Colo.	3,252
Taylor, Tex.	5,314
Denton, Tex.	4,732
Collinsville, Okla.	1,324
Lakeland, Fla.	3,719
Big Rapids, Mich.	5,519
Jackson, Mich.	31,433
Sherman, Tex.	12,412
Bakersfield, Cal.	12,727
Tyler, Tex.	10,400
Newburgh, N. Y.	27,805
Sandusky, Ohio	19,989
Ashtabula, Ohio	18,266
Niagara Falls, N. Y.	30,445
Wheeling, W. Va.	41,641
Alpena, Mich.	12,706
Santa Barbara, Cal.	11,659
San Angelo, Tex.	10,321

In addition there are officers called managers in the following towns, which do not have commission-manager charters or lack some of the fundamental features of the plan: Staunton and Fredericksburg, Va.; Norwood, Mass.; Inglewood and San Diego, Cal.; Glencoe and River Forest, Ill.; Grove City and Titusville, Pa.; Morris, Minn.; Clarinda and Iowa Falls, Iowa; Clark, S. D.; Beaufort, S. C.; Tucson, Ariz., and Roswell, N. Mex.; Terrell, Tex.; Grand Haven, Mich.; Alhambra, Cal. In Canada: Port Arthur, Ontario, and Maissonneuve, P. Q.

There are state-wide laws permitting cities to adopt this plan in Massachusetts, New York, Virginia, Ohio and Iowa.

SEWERAGE AND SANITATION

Some Experiences With and Suggested Specifications For Vitrified Segment Block Sewers.

In 1912 the American Sewer Pipe Co. first put on the market a hollow segment block for use in the construction of sewers of large diameter, manufactured out of the same kind of clay that is used for making vitrified pipe.

These blocks are manufactured with a lug on one side which fits into a corresponding groove in the adjoining block. For large sizes from 84 ins. up, there is a double lug. All these blocks have an end lap. This end lap is about 2 ins. in length.

The blocks are made in widths of about 11 ins. and lengths of 2 ft.; the thickness varies according to the diameter of opening. The blocks range in weight from about 45 lbs. to about 120 lbs. They are quite easy to handle and in shipping take the same commodity rate as brick, while sewer pipe take a rate about 20 per cent greater.

The writer has had experience in the construction of two jobs where segment blocks were used, and it has been his observation that there are very few blocks broken in transit or on the job, and that they can be delivered on the work from the car for about two-thirds the price per ton, that sewer pipe 24 ins. and less is handled and one-half the price per ton that pipe of 30 ins. to 36 ins. is handled.

I have found that this material as manufactured by the Red Wing Sewer Pipe Company is very strong. I have not made any tests personally to ascertain the crushing strength but think from my experience with sizes of 54 ins. and less, that where there are no fire cracks that they will carry all the load that ordinary construction will require.

The largest load I have ever put on a sewer of this construction was at Stillwater, where the surface of the street was 26 ft. above the invert of a 33-in. opening; there was no distortion apparent in this case after the trench was filled.

In placing blocks in the work it is necessary to have a handy man, not necessarily a brick layer; in fact I have never had a brick layer place these blocks. We generally have a form which we set from 15 to 25 ft. ahead of the completed invert. Sometimes we use two forms, one about the above distance ahead and another at twice that distance. These forms are made to conform to one-half the section of the completed pipe, the inner side of the form to the inner circle of the sewer and the outer side of the form to the outer circle. In these forms are driven nails to which we draw lines from the outer or upper edge of the last block laid, the blocks all to be laid to these lines. The invert can be laid very readily in this manner where soil conditions are dry.

In placing the blocks, thin joints of mortar should be used between the sides; at the ends it will take considerable mortar if the work is to be left practically watertight. Where this is expected, it is best not to pay particular attention to the leaks until the cement is well set, then go through calking joints with jute and mortar. In this way very good results can be obtained.

Where a wet trench or quick-sand is encountered there will be trouble. In some cases it is necessary to put a plank foundation under the blocks, but even in this event there will be less trouble than there would be with a brick sewer.

In laying the arch we have a form made 8 to 10 ft. long, with removable slats in the center so that a man can stand in the form while laying the blocks. The form rests on wedges so that the height can be adjusted. In some cases we have laid the arch without any form, but in this case we have to have a light bar with an extra man to help spring out the adjacent blocks when the key block is inserted. This mode we use where we wish to keep the finished section close up to the face of our excavation.

ADVANTAGES OF SEGMENT BLOCKS IN SEWER CONSTRUCTION.

Some of the advantages of the segment blocks in sewer construction are as follows:

In wet work they can be laid without leaving sheeting permanently in the trench as is necessary with concrete or brick. They can be placed by any handy common labor. It is possible to keep the completed sewer up to the face of the excavation. As they have a regular and smooth surface, they have a greater capacity than sewers made with brick. They can be laid at a greatly reduced cost when compared with brick. I think segment blocks can be used to advantage for large openings under highways, also that they will be very efficient for sewer tunnel linings, and I would advise engineers having work of this nature, to investigate further.

SPECIFICATIONS FOR VITRIFIED SEGMENT SEWER BLOCKS.

I submit the following specifications which can be used for work of this nature.

1. Vitrified segment sewer blocks shall be of such a type that each segment shall consist of one piece of hollow tile, extending from the inner to the outer face of the wall; there shall be a groove along one side of each segment and a rib along the other side, so that each block keys to the adjacent one on each side, and each block shall have a portion of its ends cut away, leaving shoulders so that blocks lap over abutting blocks.

2. All blocks shall be of the best material, perfectly and uniformly made, hard burned throughout, smooth and perfectly glazed, true to pattern, and such that a straight edge laid along the joint edges or the wearing surface of the same shall not vary more than ⅜ in. They shall be free from warps, cracks, flaws, blow-holes or any other imperfections, and shall stand or meet such tests as may be required by the City Engineer. All condemned blocks shall be immediately removed from the work.

3. The blocks shall be laid to correct lines, grades and form by means of templates and forms.

4. The mortar used for the block joints shall be composed of one part cement and two parts clean sharp sand. A little lime may be added at the discretion of the engineer.

5. The smoothest and hardest burned blocks shall be selected for the invert of the sewer, and shall be thoroughly cleaned before laying. Each block shall be carefully laid to a line in a full joint of mortar at one operation. All blocks breaking joints with those of adjoining courses.

6. The mortar joints on the inside, and below the spring line, shall be carefully struck when laid, and those laid above carefully scraped smooth with the blocks immediately after the centers are drawn, and any mortar scraped off shall be removed from the sewer leaving it perfectly clean.

7. Joints between courses shall not exceed ½ in. in thickness and the sewer when completed shall be true to grade, form and dimensions.

8. All work shall be protected from injury, and if any part be injured or damaged from any cause whatever, the part so injured or so damaged shall be taken down and replaced by the contractor at his own expense.

9. The material shall be thoroughly tamped in place, back of the blocks around the spring line of the sewer, so there will be no settlement when the load is placed on the arch.

ACKNOWLEDGMENT.

From a paper before the Minnesota Surveyors and Engineers Society, by William Danforth, Municipal Engineer, St. Paul, Minn.

The Collection and Disposal of Garbage in Dayton, O.—Description of New Reduction Plant Having Novel Features.

Prior to 1914, the garbage of Dayton, required by ordinance to be placed in separate receptacles, had been collected by the city and delivered to a privately owned reduction plant which disposed of it without compensation under a ten-year contract which expired Dec. 23, 1913. This arrangement proved hardly satisfactory as the Reduction Co. claimed that it did not get all of the garbage, the best being collected by private scavangers, and that the city allowed the householders to put in too much water and rubbish. The Reduction Co. sued the city and obtained judgment for $30,500. Dayton's experience in this matter gives substantial testimony to the desirability of having the authority and responsibility for the collection, disposal and enforcement of the ordinances requiring proper separation of the garbage, concentrated—all of which leads to municipal ownership.

Just before the expiration of the abovementioned contract, the city, after having received and rejected bids several times, again received bids for a contract covering both collection and disposal of the garbage to take effect Dec. 23, 1913, but awarded no contract. When the operation of the city under the charter took effect in January, 1914, the time for the beginning of the contract had lapsed and furthermore a legal question was raised as to the power of the city to let a contract for a service extending over a period in excess of one year without all the money for the full term of the contract being in the fund. This resulted in the rejection of all the bids.

The city then employed the firm of Hering & Gregory, sanitary engineers, of New York City, to make an investigation and report on the whole subject of collection and disposal of the city's wastes, including ashes, rubbish, garbage and manure. A comprehensive report was made in March, 1914, recommending a combined collection and an incinerating plant. Careful consideration was given to this report but with so many problems requiring large expenditures facing the city, it was felt that the city could not then undertake the recommended plan.

DISPOSAL BY BURIAL.

In the meantime the old Reduction Co. continued to receive and dispose of the city's garbage, which arrangement continued until June, 1914. The Reduction Co. then notified the city that the cost of repairs to the plant was excessive and that they would require a payment of $500 per month to continue further. In the meantime, constant and strenuous complaints from neighboring residents were received, protesting against the odors emanating from the plant. Confronted with the above situation, some temporary expedient had to be adopted and recourse was had to the burial of the garbage. Thus to dispose of the garbage from a population of 130,000 people sounds a rather formidable proposition, but it has proved comparatively easy and quite satisfactory. The site selected for the burial ground was an old gravel pit alongside the railroad tracks north of the city. The garbage is shipped out in gondola cars and there unloaded and covered over with gravel by workhouse prisoners. Several "knights of the road" who were temporary guests at this city institution and who were used on this work threatened to give the city of Dayton a wide berth in their future wanderings, and so this method may effectively dispose of nuisances other than garbage. This method of disposal will continue to be used until the new reduction plant is in operation.

NEW MUNICIPALLY OWNED REDUCTION PLANT.

As stated before, the city had several times during 1913 taken bids on a contract covering both the collection and disposal of the city's garbage. In each case Stephen E. Wilson, who had had wide experience in the construction and operation of reduction plants had been the low bidder. The bids submitted by Mr. Wilson had appeared to be very reasonable and several conferences were held with him in which the type and cost of the plant which he had proposed to erect were discussed. Finally, in the latter part of last year, it was decided to employ Mr. Wilson to design for the city and superintend the construction of a reduction plant such as he had intended to build for himself and to him is due the design of the plant which is now nearing completion.

In adopting the reduction method of disposal we believe that the plant can be easily made entirely self-supporting, i. e., the revenue from the grease and tankage will pay all the plant operating and investment charges but will not pay for the collection. In other words, the city will not be put to any expense for the disposal of its garbage and valuable by-products will be conserved. This belief is based on the following estimates:

Population, Dayton, 1914	130,000
Production of garbage per year (based on .09 ton per capita per year), tons	11,700
Production of grease at 3 per cent, tons.	351
Production of tankage at 11 per cent, tons	1,287
Estimated yearly value of grease at $70 per ton	$24,570
Estimated yearly value of tankage at $6 per ton	7,723
Estimated toal year's revenue	$32,292
Estimated complete cost of plant, including land, sidetrack, etc.	55,000
Estimated yearly operating expenses	25,000
Estimated investment charge at 10 per cent gross	5,500

This estimate thus shows a narrow margin of profit amounting to about $1,800 per year. There is no allowance made for taxes nor for freight on the garbage to the plant.

The above estimates are believed to be very conservative. It is realized, of course, that there is some hazard involved. "Hard times" and "high cost of living" are reflected in a reduced quantity of grease in the garbage. The price of grease and tankage fluctuates. The present war has upset the market for grease. Nevertheless, we believe, under local conditions, that the reduction process was the proper method to be adopted. A recent report of the Columbus reduction plant shows for 1914 a gross revenue of $3.08 per ton of garbage and an operating expense of $1.86 per ton. Our estimates, though not exactly comparable, show a revenue of $2.76 per ton and an operating expense of $2.14.

The site finally selected for the reduction plant is located on the Cincinnati, Hamilton & Dayton Railroad, about seven miles below the city. Two tracts of land were purchased, one covering an area of about 6 acres, on which the plant proper is located, and the other a tract of about 32 acres of low land lying between the plant and the river. A sidetrack about 2,000 ft. long has been constructed into the plant.

The type of reduction equipment adopted is what might be called the cooking, pressing, drying and percolating process. The capacity of the plant will be 50 tons of garbage per day with one 8-hour shift. The capacity, however, with continuous operation would be about 125 tons per day. This would make the total cost of the plant about $440 per ton of capacity.

The buildings are of one story with the exception of the digester building, and are of concrete having steel roof supports with wooden covering. They are not showy, but they are substantial and practically fireproof.

The lowest floor is about 10 ft. below the height of the 1913 flood. The damage that can be done to the plant by high water is not serious and it was felt that the expense necessary to raise the grade of the whole ravine would not be justified. The flood prevention plans will also greatly reduce the maximum flow of the river.

STEPS IN GARBAGE HANDLING IN DAYTON.

The various steps in the complete handling of the garbage locally are as follows:

The collections at present are made in large iron boxes which are taken bodily from the wagons and loaded at the loading station on flat cars, owned by the city, on which the tanks are shipped to the plant.

In passing I would state that garbage, except in the business section of the city is only collected once per week—this costs about $22,000 per year. It is, of course, our intention, if money can be secured, to collect more frequently which incidentally would improve the quality of the garbage for reduction purposes.

The garbage boxes will be taken from the flat cars at the plant by means of a crane and dumped in the receiving pit. Some saving could be effected by the use of special garbage dump cars, but this would also involve questions at the loading station and likely relocation of same. This green garbage pit has a sloping side from the track down to the conveyor so that a man can readily rake the garbage onto the conveyor and at the same time pull out any large foreign materials. The garbage is spouted from the conveyor to the digesters—there are ten of these vertical tanks, each holding five tons. There is room in the digester building for the installation of two more tanks.

After cooking with live steam at about 65-75 lbs. pressure, the cooked garbage is pressed by means of live steam so that the cooked garbage contains about 55 to 65 per cent moisture.

The pressed tankage is then taken by means of two conveyors and a cross conveyor from the digesters to the direct fire dryer. This fire dryer differs from the ordinary dryer in that the feed end is at the cooler end of the dryer. It is believed that better results will be secured with less loss of material through burning. There is also a device for controlling the temperature by means of an induced draught of air.

The tankage after drying is conveyed from the dryer to the percolator where it is treated with gasoline to remove the grease. The percolator is of the horizontal, revolving type and has a capacity of about six tons.

A small dryer is provided for redrying the tankage should any moisture be absorbed in the percolating process. The gasoline and grease in the washings from the percolator are separated by distilling off the gasoline which is, of course, condensed and used over again.

The power plant consists of three 80 HP. horizontal tubular boilers. All the machinery will be motor driven, power being purchased from the local power company. The full connected load will only be about 68 HP.

One deep 8-in. well has been driven, from which we expect to get an ample supply of water for the operation of the plant. Should continuous pumping prove this supply inadequate, the river, close by, offers an inexhaustible supply. This well water is very cold and hence will be especially good for use in condensing vapors and gases from the settling boxes, digesters and dryers. This is being relied upon for the control of odors rather than burning the gases which latter may result merely in spreading the unburned odorous gases broadcast.

Although some claim is made that it is profitable to install evaporators and thus recover the so-called "stick," it is not our intention to do so. Instead, it is planned to allow this tail water to flow over our 32 acre tract of land which is underlain with gravel and which will be planted to corn and other crops and thus secure the benefits of whatever fertilizer ingredients it may have.

The features in which this plant differs from others is the general arrangement of low, separated buildings of substantial construction, the receiving pit, the novel direct fire dryer, the layout of the equipment and the low cost of the plant. It is, in fact, a contractors' plant built for economical operation.

ACKNOWLEDGMENT.

Major portion of paper by J. E. Barlow, Director of Public Service, Dayton, Ohio, before American Society of Municipal Improvements.

WATER WORKS

A Notable Artesian Water Supply Development at Ogden, Utah.

Contributed by Frank J. Hendershot, Assistant Superintendent of Water Supply and Water Works, Ogden, Utah.

A notable supply of artesian water was recently developed for domestic purposes at Ogden, Utah. When the old supply from the mountain streams became inadequate to meet the demand imposed by the rapidly growing city Mayor A. F. Fell suggested the development of the ground water supplies known to exist in Ogden Valley, which is located six or seven miles east of the city.

In October, 1914, a 2-in. test well was put down and water was encountered at a depth of 100 ft. The water was tested for impurities and found to be absolutely free from bacteria; it was also the opinion of Prof. G. W. Bailey, bacteriologist, that it could not become contaminated. State Chemist Herman Harms in his analysis reported the water to be of "first-class organic purity" desirable for drinking and household purposes, boilers and laundries.

Subsequently a number of 4-in. wells were driven, each encountering water at levels of 125 to 150 ft.

The fact having been finally established that a plentiful supply of water existed, the city purchased a well-boring machine and drilled more 4-in. wells and also a number of 6-in. wells, the last two of which were sunk to a depth of 190 ft., 40 ft. lower than the point where the flow was encountered.

Geologically, the location of the wells is perfect. In referring to the wells of Ogden, Dr. Fred J. Pack of the University of Utah, says: "Ogden Valley presents as nearly ideal conditions for the existence of artesian water as can well be imagined. The valley proper is somewhat circular in form and contains the towns of Huntsville, Liberty and Eden. Abundant streams of water drain in from the north, east and southeast, and all converge toward a point near the southwestern part of the valley, where they unite, and then pass from it through the narrow defiles of Ogden Canyon. It is just at this convergent point the wells have been drilled."

The wells now number 22, and no diminution is caused by drilling additional wells. The wells produce between 6,000,000 and 7,000,000 gals. of water a day of 24 hours, aggregate. The temperature remains about 46° F. the year round.

The 4-in. wells were tested by measuring the time of the actual flow into a 9-ft. cubical box. The 6-in. wells were measured by floats placed in a measured channel.

The wells having been drilled in a somewhat irregular semi-circle of several hundred yards in diameter, a circular intake reservoir of concrete was constructed at a point nearest a common center. This collecting tank measures 21½ ft. in diameter, 9 ft. deep, with a weir capacity of 25 second-feet.

The wells are connected with each othe

in groups of twos and threes according to their location and about 15 of these common pipes enter the intake in a semicircle at a point about 4½ ft. above ground level; each well is controlled by an individual valve.

From the collecting tank, a 36-in. wood stave pipe carries the water 2.12 miles toward the city, through Ogden canyon; this pipe connects with a 24-in. Mathison joint pipe, which continues an additional 5.4 miles to the distributing reservoir.

The total cost of developing the wells to Oct. 30, 1915, was $16,249.46, and the cost of the conduit and laying was $103,850.89, totaling $120,100.35, for a supply of absolutely pure water that will take care of Ogden City for years to come.

Following is the log of a typical well which shows the nature of the geological formation traversed:

Formation.	Thickness, ft.
Top soil and sand	68
Sand and clay	20
Coarse sand	9
Clay	7
Gravel	3.5
Total depth	107.5

Results of Questionnaire on Life and Depreciation of Cast Iron Water Pipe in 14 Large American Cities.

The life of cast iron pipe and the procedure in charging off depreciation of this class of pipe in 14 large American cities was brought out in a letter inquiry recently conducted by Mr. Thomas H. Hooper, Superintendent of Water Works at Winnipeg, Manitoba. The substance of the replies to Mr. Hooper's letter is here given. A conspicuous disclosure of the inquiry is the lack of uniformity in writing off depreciation. This is not wholly accounted for by variations in the nature of the soil traversed.

Montreal.—(Reported by T. W. Lesage, Engineer-Superintendent of Water Works.) About 300 miles of cast iron pipe in use. First laid 1852-1854. Cast iron in old pipe in good condition. No system of writing off depreciation.

For the past three or four years the city of Montreal, in view of the paving of its streets, has been taking out and renewing many of the old 4 and 6-in. water pipes in the center of the city and replacing them by pipes of larger diameter to meet the increased demands due to the growth of the city. These old pipes were laid in the years 1854 and 1858, and when taken out had been in use over 55 years.

The cast iron was found in good condition, and the outside appearance was almost perfect. In many parts the tar surface exterior coating was in a good state of preservation, and the pipes showed little or no deterioration from rust on the outside.

On the inside the pipes were in places much reduced in flow capacity by tubercules of rust or calcareous deposit and silty matter. When cleaned and the tuberculous matter removed most of these pipes were in very good condition. and while no definite measurements of thickness of metal were made to determine the amount of wear of the metal, it is safe to say the pipes had deteriorated very little in thickness in the fifty years' service.

On the whole. with the nature of Montreal soil. and leaving out the particular cases where electrolysis (due to electric tramways) may affect condition, it is safe to say that cast iron as a material for water pipes underground has proven most lasting and durable, and may be said to last as long as their usefulness will warrant: that is, they will have become too small, due to growth of population and requirements, long before they will have depreciated with wear or rust.

Minneapolis.—(Reported by J. A. Jensen, Superintendent of Water Works.) Minneapolis has 550 miles of cast iron pipe. The plant was originally constructed in the early 70's, using some wooden pipe which was later replaced with cast iron. The earliest records of cast iron pipe are about 1874. We are using no system of depreciation.

I have personally examined and always take note of our old pipe when it is exposed for connection or changes, and have found in all cases that there appears to be no depreciation whatever. One case in particular was a 12-in. pipe cut out to pass under a 48-in. pipe then being laid. The cut out portion appeared to be a piece of new pipe. The coating even had its original lustre. It had been in the ground 32 years.

Proceedings of the Am. S. C. E., October, 1908, gives by several authorities on water works valuation, a range of 50 to 75 years of life to cast iron pipe. This would be equivalent to 2 per cent to 1.33 per cent depreciation.

Our soil is very favorable to long life, and when figuring life of water mains as a whole, we generally say about 1 per cent depreciation.

Philadelphia.—(Reported by Carlton E. Davis, Chief of Bureau of Water). The city of Philadelphia has about 1,800 miles of cast iron water pipe in service. The first cast iron pipe was laid in 1817. We have recently taken up a few lengths of pipe laid in 1817 and 1827. The condition of the pipe was good, and it was removed for obsolescence rather than because it could no longer perform its service. Of course tubercules and incrustations were found on the interior, but the iron showed no evidence of deterioration.

Philadelphia is considering the adoption of definite lists for depreciation, but as yet has not reached a conclusion.

Edmonton, Alta.—(Reported by J. W. Turner, Superintendent of Water Works). Edmonton has about 104 miles of cast iron pipes. The first pipe was laid in 1902. The old pipe was found sound on examination. The only depreciation discovered was due to electrolytic action.

I may say that the whole question of depreciation has been under discussion here for the last few years, and different authorities recommended different methods of reckoning depreciation. Finally, after much discussion, the method suggested by the firm of McIntosh and Hyde (who completed a seven years' audit of the city books in 1914) was adopted. This system I can only describe in general terms as a combination; that is to say, it is based on the term of the debenture, but takes into consideration also the estimated life of the asset.

I may further say that in estimating the life of the various assets of our department we placed the life of the cast iron pipe as 40 years, which was the term of the debentures for same, as we were convinced that, but for some slight deterioration due to electrolytic action in certain localities, the cast iron pipe would not only last 40 years, but would be in good serviceable condition at the end of that period.

Boston.—(Reported by F. A. McInnes, Division Engineer, Public Works Department). There are about 850 miles of cast iron pipe in Boston. The oldest of it was laid in 1848. The condition of the old pipe depends on the soil in which it was laid. Have taken out pipe in practically perfect condition, as far as condition of iron goes, after 60 years' use. In other cases, in bad ground, or where electrolysis exists, pipe has been destroyed in half that time. The carrying power, of course, is always reduced by age, owing to tuberculation which forms from the Boston water. The city has no system for writing off depreciation.

To my mind each question of depreciation of cast iron water pipe must be settled as a problem in itself, owing to the fact that so much depends upon the character of the soil in which the pipe is laid, and upon the conditions under which it operates. We usually consider a fair estimate of the life of our pipe to be 60 years, and I have seen nothing of late years to cause me to consider this estimate an unreasonable one.

St. Louis.—(Reported by Francis T. Cutts, Asst. Water Commissioner). About 1,000 miles of cast iron pipe now in use. Some of it has been in the ground over 60 years. The water division has frequent occasion to examine the pipe, and in almost every instance its physical condition has been found to be good. The depreciation of the water works as an entirety would hardly be a fair figure to use when considering only the cast iron pipe distribution system. The life of cast iron pipe has been variously estimated, but is generally taken here at 100 years.

Toronto.—(Reported by R. C. Harris, Commissioner of Works). About 576 miles in service. First laid in 1854 and this old pipe still in use. Upon examination old pipe shows little depreciation except where electrolysis had take place. Here we consider the pipe good for 100 years at least.

Chicago.—(Reported by John Ericson, City Engineer). First cast pipe laid in 1852. Now 2,524 miles are in use. Some of the oldest pipe has been found in excellent condition when examined. Very little deterioration has been observed unless pipe has been attacked by cinders or slag filling or electrolysis. These cases are comparatively rare. The system of depreciation used is based on the life of pipe and is 2½ per cent compounded.

St. Paul.—(Reported by J. C. Flanagan, Chief Accountant, Bureau of Water). On Jan. 1, 1915, 392 miles in use. City acquired works in 1882. Records do not indicate the exact date at which the old company laid its cast mains. Old pipe found generally good.

Out of the revenues of the water department all operating and maintenance charges and repairs and replacements are provided, as well as the interest on its funded debt and a sinking fund for the redemption of its bonds, which are retired at maturity, which is considered sufficient depreciation and without question one of the best methods, as all bonds are issued for a period shorter than the life of the property to be acquired, consequently the liability in acquiring it will have been liquidated before the property will have become obsolete. The aim here also, is to keep the physical property up to its standard out of the revenues of the department. Deterioration which is taking place here is due to electrolysis and soil corrosion.

New Orleans.—(Reported by George Earl, General Superintendent Sewerage and Water Board). The 570 miles of cast iron pipe lines in use in New Orleans are all new, having been laid since 1906. Prior to 1900 the New Orleans Water Works Co. operated a system of 125 miles of cast iron mains which had been a gradual growth since 1836. With the exception of some of the smaller lines, which were laid in the first 10 or 15 years of this period, these pipes appeared to be in first class condition. The smaller mains. 4 in. mostly, laid in the very first construction, were in many cases very perceptibly softened, having something of the appearance of graphite.

The soil of New Orleans is of a very soft clay, with large amounts of peat and vegetable matter, and was, before effective drainage existed, of a most corrosive character, and still possesses this quality in certain areas, showing a tendency toward a kind of gradual chemical electrolytic action. So, I do not regard the life of iron pipe laid in 1836 to 1845 as being at all a fair basis upon which to judge the life of pipe laid today with good drainage conditions in New Orleans, and still less as a basis upon which to judge the life of iron pipe laid in other cities with different soil conditions. I have always assumed 80 years as about the fair life to estimate for cast iron pipe in New Orleans, where it is not injuriously affected by electrolysis from stray street railway currents, which are equally destructive here. We do not carry any depreciation account as yet, though we are doing what we can toward setting aside a sinking fund to take care of actual depreciation.

Under the Sewerage and Water Board's finance plan, the three systems of sewerage, water supply and drainage will have cost the city about $29,500,000 by the end of 1917, and will carry a bonded debt of $20,000,000 at 4 per cent. Of this debt $8,000,000 will be liquidated between 1928 and 1942, and the remaining $12,000,000 between 1942 and 1950; all out of a specific tax; the surplus from which, after payment of interest and sinking fund for redemption of bonds, is available for extensions to the three systems. The water rates go to the operation and maintenance of the sewerage and water works systems, and any surplus is set aside for the renewal of parts as may be needed.

Hamilton, Ont.—(Reported by Thomas Towers, Superintendent of Water Works). Hamilton has about 200 miles of cast iron water pipe. The first pipe was laid in 1859. Examinations of the old pipe have shown it to be in good condition. The only deterioration has been from electrolysis. The city has no system of charging off depreciation.

Rochester, N. Y.—(Reported by B. C. Little, Superintendent of Water Works). Up to July 1, 1915, about 424 miles of cast iron pipe, 25 miles of which is for delivery of non-potable water for fire purposes only, were laid in Rochester. The first pipe was laid in 1872.

The pipe in both systems have been examined at frequent intervals and has been found to be practically in as good condition as at time of laying. Of course, some deposit has been noted in the nature of fine silt but no evidence of deterioration has been found. This last refers in particular to the potable water system. In the non-potable system some few tubercules have been noted, but not in sufficient numbers to in any way impair the efficiency of the mains. We have no system of depreciation.

Baltimore.—(Reported by Robert L. Clemmitt, Acting Water Engineer). At the end of 1914 Baltimore had 775 miles of cast iron pipe in service. Cast iron pipe was laid in Baltimore as early as 1805. The old pipe has been found in good condition. There is no system of depreciation in use. Electrolysis has been found the worst enemy of cast iron pipe.

New York City.—(Reported by Merritt H. Smith, Chief Engineer, Bureau of Water.) Including 172 miles of high pressure mains, the total length of cast iron mains in place Dec. 31, 1914, amounted to 3,015 miles. Cast iron pipes were introduced in New York in 1815. In connection with an investigation of a break which occurred early in 1915 on a 30-in. main some of the old pipe was examined. After chemical and physical tests were made on a section of the cast iron pipe it was found that the material was in good condition and showed hardly any depreciation. It was estimated that this main was of what is known as Scotch iron and was laid about 1830.

The Bureau generally uses what is known as the straight line method in order to determine depreciation in connection with the valuation of the water supply system. Based upon the usual life of the bond, which is 50 years, the 2 per cent rate of depreciation is used.

Girardville, Pa., Water Supply Contract a Model of One-Sidedness.

Fortunately for the citizens of Girardville, there is a Public Service Commission of the Commonwealth of Pennsylvania. The borough was recently a party to a water supply contract the provisions of which warrant the conclusion that the municipality needs a guardian. The contract was approved by the Public Service Commission only for the reason that for the current year the municipality has no other means of getting a supply of water, and with the suggestion that the municipality for future years either provide another source of supply or arrange a contract upon terms which will protect it and its citizens. The contract appears to be a reversion to a type thought vanished, a recrudescence of the worst in the treatment of the public by a public service corporation, a survival of the unfit.

The following gives the essential features of the report on this unusual contract by Commissioner Pennypacker:

Application is made by the Girard Water Co. asking for an approval by the commission of a contract made by it March 11, 1915, with the Borough of Girardville. It may be inferred from the terms of the application that the purpose of the contract is to provide the borough with a supply of water, because it sets forth that unless the contract be approved the borough will be "without an adequate available source of supply of water," and that it is necessary for the convenience of the public that the contract "for a supply of water for domestic and municipal purposes be approved." Unfortunately, the contract as submitted for approval does not provide that the water company shall supply the borough with an adequate or any other supply of water. It is so drawn that under its provisions the municipality is required to pay a monthly rental, and there is no requirement that the company shall furnish the water. The provision upon this material subject is that the borough "will pay to the party of the first part, at its office, in the Borough of Girardville, a monthly rental of $50," provided, "that if the party of the first part shall in any one month be unable or unwilling to furnish the party of the second part at least 500,000 gals. of water, then the said monthly rental of $50 shall be reduced to the proportion which the quantity of water which the party of the first part is able and willing to furnish shall bear to 500,000 gals." Should the company be unable or unwilling, no water need be furnished, and the municipality would be left to get along as best it could. In a letter written by counsel for the Water Co. to the commission, June 18, 1915, it seems to be conceded that the words "or unwilling" and "willing" ought to have been eliminated. It is further provided in Section VIII, "That nothing herein contained shall give the party of the second part any right of action, claim or demand for damages, compensation or reduction in the price or rate for water, except as provided in Article I herein, by reason of any curtailment or limiting of the supply of water during a season of drouth, or while repairs or extensions are being made to the reservoirs, works, pipe lines or pumping stations of the Girard Water Co., *or at any other time,* the right to any such action or actions, claims or demands being hereby expressly waived by the said party of the second part." The effect of this provision is to permit the water company at any time to curtail the supply without liability. Section X provides: "That in case any question or dispute between the parties hereto shall arise under this agreement, it shall be referred to the General Manager of the Girard Water Co., whose decision shall be final and binding upon the parties thereto, who hereby respectively agree to submit to and be finally concluded by the said award or decision, and who hereby waive all rights to an appeal, exception, motion or rule, as well as all rights of action or suits of law or in equity to open, set aside, change or modify such award or decision." The purpose of this provision appears to be to place the entire control of the subject matter of the contract within the power of one of the parties to it. A more one-sided arrangement ingenuity could only with great difficulty devise.

How to Take and Transport Samples of Water for Analysis.

In order that a water supply may be examined fairly it is of primary importance that a true sample be submitted to the analyst for examination. Anything which might result in the introduction of foreign material, especially bacteria, may easily result in improper findings which would usually be to the disadvantage of the supply.

THE CONTAINER.

The first requisite for the collection of the sample is a properly prepared bottle. Any bottle or jug will not do. It must be chemically clean, and if there is a bacteriological examination made it must be sterile. Any cleaning solution used should be thoroughly removed, since many solutions are germicidal in character. The sterilization of the bottle should be accomplished by boiling in water, steaming, or by the use of dry heat. To attempt to sterilize a bottle by means of chemical disinfectants may lead to erroneous results unless the greatest care is taken to rinse out the last traces of the chemical. Even then the repeated rinsings may defeat the sterilization by introducing contaminating material.

The bottle should be closed with a glass stopper because cork stoppers are difficult to sterilize by the means usually at hand outside of the laboratory and have the additional disadvantage of yielding various substances to the water from the many cracks and crevices. The use of corncobs, rolled paper and such substances is naturally to be avoided.

Jugs should never be used because the roughness of their interiors is likely to cause adhering materials to be much more difficult to remove. It is also impossible to see whether or not the jug is clean. Supposedly clean, new jugs frequently contain straw or other similar substances. Many jugs are glazed by the use of salt, which may add to the chlorine content of the water.

It is best in all cases to send to the examining laboratory for the collecting bottles, because any such laboratory will be found equipped with suitable apparatus for the cleaning and sterilization of the sample bottles. The laboratory should provide some means of sealing sterile glassware and you should receive it with the seals intact, thus assuring you that the bottles are in condition for use.

Having received the sterile bottles, the collection of the water must be carefully made. It is easy to set at naught the pains that have been taken to furnish a clean, sterile container. It is usually a waste of time and money to entrust the collection of samples of water to an uninstructed workman. The collector should be familiar with the usual precautions to be observed in taking a sample of water since everyone does not appreciate the ease with which bacteria may be introduced or a measurable quantity of foreign matter added. When chemical tests are made to one part in a hundred or a thousand million in routine examination and bacteria are counted the ubiquity of bacteria and the great influence of an almost imperceptible amount of dirt must be taken into consideration.

PRECAUTIONS TO BE OBSERVED IN SAMPLING.

The usual precautions are as follows:

1. Allow the water to flow until the water which has stood in the pipe has wasted, because since it has stood in a more or less warm place for some time the bacteria have probably increased in number and chemical changes have gone on. If the sample is taken from a street hydrant or similar source an accumulation of iron will need to be flushed out.

2. Remove the cover from the top of the bottle, holding it in such a way that the inside of it is not soiled by contact with the hand or any other object. Open the bottle while the water is running; fill it nearly full; rinse; refill; rinse the ground part of the stopper, and insert the stopper. Take great care throughout that the stopper, the inside of the neck of the bottle and the water collected are kept from contact with the outside of the faucet, the hand, a cloth or any other object.

3. Protect the top of the bottle from dust and other contaminating substances by replacing its cover of tinfoil or cloth.

MANNER OF SHIPMENT.

When a sample of water has been properly collected in a proper sort of container the manner of shipment to the laboratory must be considered. Chemical and bacterial changes take place with varying rapidity, depending on the character of the water, the temperature at which it is kept, the exposure to light, etc. To secure the best results—that is, to deliver it to the laboratory in as nearly unchanged condition as possible—the time consumed in transit should be short and the temperature of the water should be kept low. The low temperature retards the multiplication of bacteria and minimizes the chemical changes.

THE 1-GAL. BOTTLE OUTFIT OF THE IOWA STATE BOARD OF HEALTH.

For some time the Iowa State Board of Health water laboratory has been using 1-gal. glass-stoppered bottles for the collection of water samples. The bottle is slipped into a felt-lined case, open at the top. It fits tightly in the case and the felt lining serves to protect the bottle from breakage and to protect its contents to a certain extent from extremes of temperature. The case is left open at the top so that the expressmen can see what they are handling and use suitable caution. Concerning the breakage of bottles in shipment it is only fair to state that our breakage has been less than 1 per cent.

The bottle is prepared for use by cleaning with a strong solution of potassium bichromate and sulphuric acid as directed in the Standard Methods of Water Analysis of the American Public Health Association, and then sterilized by steam. A sterilized muslin cloth is tied over the top by a stout cord, the ends of which are then sealed upon the top of the stopper by an official wax seal. Owing to the fact that the bottles are necessarily of a rather thin glass, they are often cracked during sterilization. This occasions most of our breakage of bottles. It is a factor of consequence since the bottles cost about 80 cts. apiece.

The gallon-bottle outfit was adopted when the laboratory was first established because the investigations of Whipple and others (as well as some work in our own laboratory) had shown that chemical and bacterial changes are less in a large bottle of water than in a small bottle of the same water, given the same temperature conditions.

A long series of experiments carried out during the summer months has shown us that, while we are able to get bacteriological results of considerable diagnostic value from samples so collected, the bacterial counts are not rigidly exact enough to be of great value in checking up the operation of the water works filter plant. For this purpose we have used a smaller bottle packed in a case which may be iced.

Although the bacterial examination is the chief requirement in such cases, it may often be that a chemical examination is required as well. To collect the large sample as well as a small one is inconvenient and the extra expressage is not an inconsiderable item.

For field work the large bottle is unhandy. It is difficult to collect a sample from streams or ponds, especially if they be shallow. Although the bottle contains 3,700 to 3,800 c.c., only about 800 c.c. of water are used in the routine procedure. The excess is of value only as it helps to retard the changes in the sample.

Penniman and Enslow of the Maryland State Board of Health have recently reported on their successful use of a one-pint sample for chemical analysis.

This container was not intended to furnish a bacteriological sample as well. Since only a few more cubic centimeters are required for the ordinary bacterial counts and fermentation tubes, it occurred to us that we might use a similar sized bottle and send the sample packed in ice in a case slightly smaller than the old bacteriological case which we had been using. The ice packing should serve to retard chemical and bacterial changes even more than the use of such a container as our old one. Under such conditions it is necessary to collect only a small extra quantity of water to allow for accidents and for rinsing of the measuring vessels.

By reducing the quantity of water used in the ammonia determinations from 500 c.c. to 100 c.c. the amount of water collected may be reduced to 500 c.c. and yet leave a margin of 100 c.c. to provide for an emergency. Penniman and Enslow claim to be able to do this without reducing the accuracy of the method. Our preliminary work has verified their results in a general way, although we find that it is more difficult to read low ammonias. This is due to the fact that our first tube of 25 c.c. of distillate represents a concentration of most of the ammonia in an amount of water equal to ¼ the volume of water used in the determination, while in the old method we have a concentration of 1/10 the volume.

Penniman and Enslow used short shell vials for nessler jars which they graduated themselves. We have used home-made nessler jars blown out of ½-in. glass tube. These provide a longer column of liquid. We have used small Kjeldahl flasks instead of small retorts such as were used by Penniman and Enslow. Our routine chemical examination includes nitrogen as free and albuminoid ammonias, nitrites and nitrates and chlorine. It is not necessary to reduce the quantities of water taken for the other tests.

The new case is in the form of a box about 8½x8½x11 ins., furnished with hinged cover, hasp and handle. The inside dimensions are 7x7x9½ ins. It is lined with galvanized iron. The bottle is enclosed in a galvanized cylinder 4 ins. in diameter and 9 ins. high, which on account of its dimensions cannot fall over in the box and fill with water produced from the melting ice. A lead seal securing the hasp of the box insures the sterility of the bottle.

It requires about 6 lbs. of ice to fill the container properly. A few ounces of excelsior or sawdust should be added with the ice so that the bottle may carry well and the ice be kept from rapid melting. Excelsior is cleaner to handle than sawdust but it does not protect the ice as well.

Most of our samples reach us within 48 hours after collection. Our experiments at the laboratory, using the very inferior natural ice which has been available, show that this container will keep the temperature of the sample for such a period several degrees centigrade below the ordinary room temperature even in hot weather.

The box, metal fittings and bottle complete cost in the neighborhood of $1.75 or $2. This is considerably less than the cost of bottle container of the fireless cooker type.

ACKNOWLEDGMENT.

Paper before the Iowa section of the American Water Works Association by Jack J. Hinman, Jr., Senior Water Bacteriologist and Chemist for Iowa State Board of Health, State University of Iowa, Iowa City.

Use of 4-in. Flexible Bronze Submerged Water Pipe at St. John, New Brunswick.

The problem of supplying water to Partridge Island, which lies 3,250 ft. off the mainland at St. John, New Brunswick, has apparently been solved satisfactorily and permanently by using flexible bronze tubing 4 ins. in diameter, as described in a recent issue of *Popular Mechanics*. The tidal range at the point where this main is located is about 28 ft., and there is usually a current of from two to three miles per hour. These conditions make the site a difficult one at which to lay and maintain a submerged main. A 6-in. galvanized wrought-iron pipe with ball-and-socket joints, laid several years ago, soon developed leaks, and an exposed portion was finally caught by an anchor and seriously damaged. Recourse was then had to flexible tubing, which could be reeled from a barge without danger of injury. This tubing consists of a strip of bronze wound helically, each winding overlapping and interlocking with the one preceding it, and the joints thus formed being packed with asbestos. The tubing was supplied in lengths of from 30 to 40 ft., with couplings attached. It was laid from a steam scow on which a wooden reel, 12 ft. in diameter, had been erected, the tubing being connected in lengths of about 200 ft. and wound around this reel. As each section was prepared for laying, it was securely jointed to the one preceding it. The entire line was laid in a trench which was dredged as the pipe laying proceeded. In most cases the trench filled in quickly from the action of the current, and only at a few points was it necessary to dump in material for back filling.

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New Tunnel Under East River, New York City.—Bids were opened last week by the Public Service Commission of the First District, New York City, for the construction of a new tunnel under the East River. The contract covers Section 3 of Route 8 of the Dual system of Rapid Transit, and is the first portion of the new line on which bids have been opened. The route extends from 14th St. and 6th Ave., Manhattan, under 14th St., and under the East River to Brooklyn, and through the eastern district of that borough to a connection with the Broadway elevated line. Booth & Flinn, Ltd., New York City, at $6,639,000 was low bidder.

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The Lighter Side of Engineering and Contracting

A Herculean Task.

A LARGE coal mining company delivering supplies from a central warehouse by wagons required the top foreman at each mine to receipt for all supplies delivered. The storekeeper desiring to test the efficiency of the system sent a few small machine repairs to one mine by an old negro driver and added at the bottom of the list to be receipted, "one return tubular boiler." The driver soon returned with the receipted order which was sent to the general superintendent, who immediately called all concerned into his office. The top foreman pleaded ignorance and when shown his own signature, denied having signed for the boiler. This was more than the driver Rastus could stand, springing up, he exclaimed, "Yes, he did get that boiler, Boss, 'cause I done loaded and unloaded it off dat wagon myself."—R. D. B., Harrisburg, Ill.

Close Figuring.

WHEN the Louisville & Nashville R. R. was double tracking its line from Decatur, Ala., to Birmingham, Ala., a new town named White City was opened. A merchant decided to locate in the new place and accordingly purchased a parcel of land as a site for a general store. The tradesman called upon a grader who had a "Jippo" outfit working nearby. Now this contractor's foreman was a very officious fellow who had had very little education. The merchant asked the foreman if he could not spare teams to excavate for the cellar and foundation. The foreman asked the merchant to come and see him the next day and bring the dimensions of the basement. Said he was too busy and could not give him a figure on the work until he had time to think it over. That evening the foreman took it up with the contractor, who told him to make a flat price of $175 for the job. The next day the merchant came to the foreman. "How is it, friend, got the dimensions?" inquired the latter. The merchant replied that he hadn't much "book larnin' himself, but with the aid of a friend he was able to get the measurements." They were 33½x36½x8 ft. deep. "Well," said the foreman, stretching and taking a book and pencil from his pocket, "You say 33½x36½ x8 ft. deep?" The foreman stretched again and scratched his head and started to figure in his book. Finally he said, "Naught times naught is oughty ought; eight into six won't go; I will take the job for $175."—J. F. L., Toledo, O.

A Deep Shaft.

HERE is a yarn I heard while acting as inspector on the Catskill aqueduct. Two miners were arguing about deep shafts they had seen. Finally one said: "Aw! you don't know what a deep shaft is. Why, when I was out west I struck a town where they said there was a deep shaft, so I went to look her over. When I got to the location I found the hoist house was made of cut stone and inside it had a marble floor. I went in and there was the biggest hoist I ever saw running like hell and the hoist runner was sitting in a chair sound asleep. I ran over and woke him up and I says, 'You will be pulling the skipp through the head house if you don't stop her.' He says, 'What day of the week is it?' and I says, 'Tuesday. 'Oh, hell!' he says, 'she won't be up till Friday.' That's what I call a deep shaft."—H. S., Bronxville, N. Y.

The Activated Sludge.

I always read Doc Evans' stuff; it cheers me by the way;
It gets me through the breakfast, and it irons out the day.
I like to read of remedies for falling of the hair,
And how to add humidity to desiccated air.
There's always something new to learn of this or that disease,
And helpful hints on how one may defer one's obsequies.
I'm reading now his latest (with what interest, you may judge)—
A sanitary something called the Activated Sludge.

A word or phrase gets in one's head, ridic'lous or sublime,
And seems to call for treatment in a singing, ringing rime.
But Sludge declines to ring or sing, and rimes to 'udge' are few,
So this engaging topic I'm unable to pursue.
A realistic poet might be moved to longer flight,
And writers of *vers libre* would be activated right.
I can only think of Mandalay, and teak, and creek, and squudge,
When I read about the wonders of the Activated Sludge.

We quote this stuff from B. L. T., the man who runs the line.
It formed his colyum's capital in the Trib', December nine.
But he's just an iconoclast who jokes on awful things,
And finds fault with how T. R. talks and how an angel sings.
While we who know that which he gibes hold it in high esteem
As residue of all that fills the sewer's limpid stream.
There're corned beef, cabbage, cats and dogs, ice cream and cakes and fudge,
And other things—but there's no joke in Activated Sludge.

A Mere Trifle, To Be Sure.

IN the early days of the "Safety First" movement a big western contracting firm was desirous of analyzing the conditions surrounding all accidents occurring on their work with a view to taking steps toward the correction of any methods and equipment that might be found "unsafe." To get at the matter properly they required each of their superintendents to report the details of every accident which befell any member of their respective crews while at work, adding such comments as they might deem interesting. One day a 10-ton boulder on a ledge undermined by a steam shovel came down among a crew, and after the dust had settled it was found that one perfectly good bohunk, less nimble than his fellows, had been neatly obliterated. In accordance with the general rule the young engineer in charge of the work sent in to headquarters his report of the accident, concluding with the following weird, but doubtless well intentioned, comment: "Fortunately the victim, who had been for several weeks carrying six months' wages on his person, only yesterday deposited the money in a savings bank; so all that he lost was his life."

Looked Like Easy Money.

"KANSAS JACK" is a ne'er do-well, always looking for a job—that suits him—and picking up charity and other easy money. The other morning he loafed within range of the manager of a sand company. "Jack, you poor unfortunate cuss, you're always behind time! Yesterday I had some trouble with a nigger skinner. I was mad enough to kill him, but for various reasons, I didn't. Now if you had been here I would have given you five dollars to beat him up good and the judge would give you about five or ten days of good eats and warm sleeps. But you're a poor unfortunate, Jack, d——d unlucky!" Shortly afterwards a policeman was struck dumb to see Jack hustling—actually hurrying—down the street. Recovering himself he yelled: "Hey, Jack! Come here. What's your hurry?" "Please don't stop me, Bo. 'Portant business fur Miste' Don'van. I'm lookin' fer a nigger, five dollars, ten days in the Works and I'm a day behind time."—W. B. H., St. Joseph, Mo.

Skinner Mulvey says: Bud Connors will deliver a lecture on the Panama Canal. It will be illustrated with slides. Old Pop Hilsey has shaved off his mustache so's he can smoke his cigars closer.

CURRENT NEWS

The Doings of the Week.

Commercial reports, bank clearings and railroad earnings of the past week all testified to the expansive movement in trade. Bank clearings were 20 per cent over those of the corresponding week of 1914 and well above those for 1913. Industrial financing showed an increase and there were indications that heavy investments will be made soon. Outputs of furnaces, rolling mills and car and equipment plants were at the highest level of the year. Cement companies are now reported to be doing a normal summer business in the month of December. In the two zones contiguous to New York shipments for November showed an increase of 55,000 bbls. over the same month last year. This was the largest movement of this commodity, with one exception, in any November in the last 8 years. The lumber business made further gains during the week. In the Eastern market it is believed that prices on all basic building commodities in this line are probably now at lowest levels that will prevail east of the Mississippi River for some time to come. In the Middle West there are indications of an early buying movement by the railroads for their 1916 lumber requirements. Already the Chicago & Northwestern Ry. has sent out specifications for material for its regular repair work. In the construction field very little new work of any importance reached the call for bids stage. A considerable number of fair-sized municipal projects are reported for early letting next year. Building reports for November indicate an increase of operations of 80 per cent over the corresponding month of last year. In the iron and steel trade one prominent feature of the week was the unfilled orders statement of the U. S. Steel Corporation, showing a gain of more than 1,000,000 tons during November, *The Iron Age* reports that transactions in Lake Superior iron ore are on the verge of closing, which it is believed will establish a price of $4.25 for Mesaba Bessemer and $3.55 for Mesaba non-Bessemer ore, an advance of 80 cts. and 70 cts. respectively. Principal advances at Pittsburgh apart from pig iron were $3 on bar iron, $2 on light rails, $2 on shafting, and 50 cts. to $1 on scrap. Rail orders included 43,000 tons for the St. Louis & San Francisco R. R. and 5,000 tons for the Nickel Plate. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Dec. 8 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Dec. 8. Cts.	Dec. 1. Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.959	1.859
Iron bars, Pittsburgh	1.80	1.65
Iron bars, Chicago	1.60	1.60
Steel bars, Pittsburgh	1.70	1.70
Steel bars, New York	1.869	1.869
Tank plates, Pittsburgh	1.90	1.90
Tank plates, New York	2.169	2.169
Beams, etc., Pittsburgh	1.70	1.70
Beams, etc., New York	1.869	1.869
Skelp, grooved steel, P'gh	1.70	1.70
Skelp, sheared steel, P'gh	1.80	1.80
Steel hoops, Pittsburgh	1.90	1.90
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	2.50	2.50
Galv. sheets, No. 28, P'gh	4.75	4.75
Wire nails, Pittsburgh	2.00	2.00
Cut nails, Pittsburgh	1.90	1.85
Fence wire, base, P'gh	1.85	1.85
Barb wire, galv., P'gh	2.85	2.85

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.70 cts. to 1.90 cts.

Railways.—No big jobs for the railways made their appearance last week. Several small betterment undertakings, however, were reported near the letting stage. F. Rolandi, Montgomery St., San Francisco, Cal., was awarded the contract at $1,543,000 for the construction of the 67-mile Hetch Hetchy railway for the city of San Francisco. This work calls for over 1,000,000 cu. yds. of grading, of which 161,000 cu. yds. is in granite and 376,000 cu. yds. in solid rock. J. M. Cook, Jacksonville, Fla., secured the contract for grading 17½ miles of new line from Maytown, Fla., for the Florida East Coast Ry. Booth & Flinn, Ltd., New York City, at $6,639,023, was low bidder for Section 3 of Route 8 of the Rapid Transit system of New York City. This section comprises a tunnel under the East River. Other New York City rapid transit contracts let recently include the following: Bayly Hipkins, New York City, at $352,511 for additional track on Myrtle Ave. elevated railroad for New York Municipal Ry. Corp.; Lawrence C. Manuwell, New York City, at $2,063,877, for Section 2 of Routes 19 and 22.

Roads and Streets.—California is asking bids on 24.2 miles of concrete road; Connecticut also is advertising several jobs, one of them calling for 36,815 ft. of reinforced concrete road; Los Angeles County, California, opens bids Dec. 27 on 58,667 sq. yds. bituminous surfaced concrete road. Tampa, Fla., is calling for bids. on 115,500 sq. yds. of street pavement. County Supervisors at Kosciusko, Miss., awarded a $38,000 contract for sand-clay and gravel roads; Perth Amboy, N. J., let a $110,000 paving job; Osceola and Little River Road District of Mississippi County, Arkansas, awarded contract for 28½ miles of concrete road; California State Highway Commission let a $72,000 road contract.

Drainage and Irrigation.—The South San Joaquin Irrigation District of Manteca, Cal., has readvertised the work of constructing Dams Nos. 2, 3 and 4 of the Woodward Reservoir, a $163,300 job. J. B. Arpin Dredge Co., Houston, Tex., was awarded a $126,189 contract by the Commissioners of District No. 3 of Victoria County, Texas; Harrington-Peters Co., Seattle, Wash., at $129,000 was low bidder for clearing 1,200 acres of land at Lake Keechelus reservoir site for the U. S. Reclamation Service. Robstown Drainage District of Corpus Christi, Tex., will readvertise for its drainage work for which a $158,000 bond issue was authorized. J. C. Anderson, Marshalltown, Ia., was awarded a $30,954 county ditch job.

Bridges.—Marion County, Iowa, is asking bids on bridge and culvert construction estimated to cost about $85,000. The California Highway Commission opens proposals Dec. 27 on bridge over Petroleum Creek to consist of a steel bascule span 148 ft. long, two 80 ft. concrete and steel approach spans, and 1,122 ft. of creosoted pile trestle. Swain Highway Commission, Bryson City, N. C., is asking bids on four bridges, one to be a 300 ft. concrete structure. Janse Bros., Boomer, Hughes & Crain Construction Co., Detroit, Mich., secured contract at $42,498 for concrete bridge at Wabash, Ind.

Water Works and Sewerage.—No important developments in either of these fields appear to have been advertised during the past week. Kansas City, Mo., is asking bids for a 20,000,000 gal. turbo centrifugal pump; Galesburg, Ill., is calling for proposals on a 12-in. well, 2,500 ft. in depth; Kenova, W. Va., opens bids Dec. 23 on sewers to cost about $55,000.

Rivers and Harbors.—The State Superintendent of Public Works, Albany, N. Y., is asking bids on a 15-mile section of the Champlain Canal. The Port Directors of Boston rejected the bids for 1,500,000 cu. yds. of dredging and filling at East Boston. Bay State Dredging Co., Boston, Mass., at $82,230, was awarded contract for bulkhead and fill for the Port of Boston. Snare & Triest Co., New York City, at $548,000, was low bidder for the superstructure of pier No. 78 for Philadelphia, Pa.

Copying Specifications.

The writer of the first set of specifications was a genius. No literary gem has had a greater circulation or has been more widely copied. It has been said that construction conditions may change, but specifications never do. This of course is not true, but, nevertheless, even in these enlightened days, some men consider that what was good enough for their forefathers is good enough for them. One more less humorous example of the results of copying an old specification is given by a recent happening in Indiana. A township trustee had asked bids for painting several school houses. He wrote out the requirements in long hand, specifying the kinds of material to be used. Among these was pure "xixxeex" linseed oil. The contractors consulted all the local dealers, but none of them had heard of this brand. Finally one of the prospective bidders went to the trustee. The latter explained that the oil was used last year and that he copied the notation from the old specifications. He produced the document and the contractor saw at a glance what had happened. The person who wrote the original copy on the typewriter had mis-spelled "linseed" and had then crossed it out with the x's and other marks, and had written it correctly just after the obliterated word.

Helping the Railways.

The railways came in for a bit of good luck last week. In his message to Congress President Wilson recommended that a commission be provided to inquire into the railway situation with a view to ascertaining the serviceableness of present laws, before further legislation in this field is attempted. The purpose is evidently a friendly one. It has for its object the "bettering the conditions under which the railroads are operated." The second fortunate happening for the carriers was the action of the Interstate Commerce Commission in allowing the railroads in the western territory to increase their interstate passenger fares. About 50 lines are affected by the decision and, as a result, their revenues will be increased by more than $10,000,000 per year. But every rosebud must have its rose bug. On the same day the western carriers received their increase in rates their engineers and firemen voted to combine with fellow employes in the south and east in a demand for an 8-hour day and time and one-half for overtime. Thus are the railways relieved of all anxiety as to how they will spend their $10,000,000 and many millions more.

One Week's Business.

Records are being smashed these days—exports, crops, steel production, factory outputs, freight traffic, Christmas trade, all these items have established new records during the past few months. And now comes the announcement that business in the United States in the week ending Dec. 4, measured by the number and amount of checks drawn on bands, reached a greater height of activity than was ever before experienced. The total, $4,936,000,000, was a gain of 60 per cent over that for the corresponding week of last year. This record figure is a good indication of the great activity prevailing in practically all lines except construction. This, too, unless all signs fail, is about due to come in for its share of the general prosperity.

$6,311,000 FOR ROAD IMPROVEMENTS.

Large Amount of Work to Be Undertaken in Arkansas.

To Be Done By Special Road Districts and Counties.

Road contractors will find many construction opportunities in Arkansas during the coming season. An extensive road building campaign is about to be started in the state calling for an estimated expenditure next year of over $6,311,000. Under the new Alexander Road Law many special road districts have been organized. The following list shows the work outlined for 1916 by districts so far established:

	Est. cost.
Little River County, Districts Nos. 2, 3 and 4, 30 miles gravel	$ 125,000
Pope County, District No. 2, 10 miles macadam	53,000
Carroll County, 20 miles macadam	98,000
Pulaski County, District No. 7, 6 miles Warrenite	72,000
Miller County, 60 miles gravel and bridge	650,000
Miller County, District No. 2, 15 miles gravel	48,000
Jefferson County, Districts Nos. 9, 10, 11 and 12, 58 miles gravel	200,000
Sebastian County, 21 miles macadam	130,000
Craighead County, 10 miles asphaltic macadam	80,000
Scott County, 22 miles macadam and gravel	75,000
Chicot County, 50 miles macadam and gravel	260,000
Drew County, 6 miles	30,000
Clay County, 30 miles macadam	160,000
Union County, 60 miles macadam	330,000
Mississippi County, Districts Nos. 2, 3, 4, 5 and 6, concrete and macadam	1,500,000
Total	$3,811,000

Of the Mississippi County work about one-third provides for the construction of concrete paved roads. The first letting in this county was held early this month by the Little River-Osceola Road District, when a contract was awarded for 28 miles of concrete road. The Arkansas Construction Co., Southern Trust Bldg., Little Rock, Ark., secured the work at $184,495. The district will furnish the cement, stone, sand and gravel. In all 12 bids were received on the contract. This, by the way, is the first contract to be awarded in Mississippi County under the new road law, and probably is the first concrete road to be built in the St. Francis basin.

The commissioners of Road Improvement District No. 1 at Marshall have purchased road building equipment, including tractor, grader, roller and rock crusher, and may undertake the construction of a 14-mile road by day labor.

Road Improvement District No. 4 of Little River County has been organized recently and proposes the building of 10 miles of improved highway from Anderson's bridge on Walnut Bayou to a point near Rich's Ferry on Red River. The Arkansas-Jefferson Highway Association has been formed to promote the construction of a north and south highway through western Arkansas. Steps also are being taken to obtain the building of an improved highway from Piggott to Corning. This calls for about 28 miles of road extending virtually across the county. Surveys likewise are to be made for an improved road from Piggott to Brown's Ferry on the St. Francis River. Surveys have been completed for a gravel road from Texarkana to Garland City, via Genoa, a distance of 15 miles.

In addition to the large expenditures definitely decided upon by road improvement districts, it is probable that at least $1,000,000 worth of additional work will develop during the season. There also will be expended by the various counties from the regular three mill road tax an additional $1,500,000.

Union Depot at St. Paul, Minn.

It looks now as though there would be considerable delay in beginning active construction on the new union station development at St. Paul, Minn. The St. Paul Union Depot Co. has withdrawn the plans filed with the city officials and is preparing new ones. As first proposed the improvement called for changes in the channel of the Mississippi River involving a large amount of excavation and the construction of concrete retaining walls and a levee. Bids on this portion of the work were taken, but were rejected because of objections raised by the War Department to the proposed change of harbor lines. It is stated that the company is now preparing plans that will require no change in the harobr line.

A $105,000 Drainage Ditch Job.

A 1,750,000-cu. yd. ditch letting in Palo Alto County, Iowa, will come up for letting probably in March, 1916. The work is located in the Des Moines River valley, the nearest railroad stations being Emmetsburg, 2 miles from the ditch; Rodman, 3 miles, and West Bend, 4 miles.

The improvement is divided into four sections, as follows:

	Length, ft.	Bottom, ft.	Excavation, cu. yds.
Sec. 1	4,775	24	39,560
Sec. 2	54,500	30	780,350
Sec. 3	27,800	35	405,150
Sec. 4	29,400	42	528,000

The above yardages are figured for ½ to 1 slope. The material is black soil, clay, sand and gravel. The work is suitable for dredges. The old river channel is 8 to 10 ft. deep and 100 ft. wide and is well timbered. The new ditch intersects the old channel at irregular intervals. About two-thirds of it, however, is on open prairie and is without hazards from floods.

There is one railroad crossing on Section 2. This is on the Chicago, Milwaukee & St. Paul R. R. west of Emmetsburg. There are three bridges to be removed. The timber also will be cleared. Stumps of 8 ins. and over will be taken out for full width of the waste banks.

The total estimated cost of the excavation is $105,184. The maximum depth is 16 ft., but this is for one short cut only. The average depth is 12 ft. Maximum grade is 3.8 ft. per mile; minimum grade, 2.6 ft. per mile.

Guy R. Campbell, Emmetsburg, Iowa, is the engineer.

A 24.2-Mile Concrete Road Letting.

The State Highway Commission of California is asking bids for the construction of 24.2 miles of concrete road. Of this 14 miles are in Placer County and 10.2 miles in Tehama County. Contract Section III-Pla-17-A covers 7.5 miles of road extending from Roseville to Penryn. Section III-Pla-17-B covers 6.5 miles from Penryn to Auburn. Section II-Teh-7-A extends from Corning to Proberta and is 10.2 miles in length. Some details of the work involved are as follows:

	III—Pla-17-A.	III—Pla.-17-B.	II—Teh.-7-A and 3-B.
Excavation without classifications, cu. yds.	24,500	20,000	42,600
Corrugated metal pipe, 12-in., lin. ft.	696	240	530
Corrugated metal pipe, 18-in., lin. ft.	452	606	116
Corrugated metal pipe, 24-in., lin. ft.	256	120	......
Concrete, Class B, culverts and monuments, cu. yds.	160	110	650
Concrete, Class B, pavement, cu. yds.	7,400	6,400	10,130
Guard rail, lin. ft.	5,100	4,800	*5,634
Hauling and setting monuments, No.	111	291	68

*Also requires 3.75 miles moving and resetting property fences.

For the first two contracts the commission will furnish the pipe railing for culverts, reinforcing steel, corrugated metal pipe, Portland cement and sand and coarse aggregate for the culverts. For the third contract it will furnish all of this material except the sand and coarse aggregate. Bids for the 24.2 miles of highway will be received until 2 p. m., Dec. 27, at the office of the commission, Sacramento, Cal.

Steel Plant Extensions to Cost $6,000,000.

The extensions and improvements now being undertaken by steel companies indicate a confidence that the present demands for their products will continue for many months. The recently organized Midvale Steel & Ordnance Co. has announced that it will expend upwards of $4,000,000 for additions and betterments to the various plants of its subsidiary companies. An expenditure of nearly $2,000,000 was authorized a short time ago for additions and improvements to the plant of the Worth Bros. Co. at Coatesville, Pa. These include the following:

Six 50-ton open hearth furnaces of a capacity of 180,000 tons of ingots per year	$1,250,000
One blooming mill, 200,000 tons capacity per year	500,000
Two 750-K. W. turbo-generators	200,000

Further developments for the Coatesville plant include the following: One 500 ton blast furnace of a capacity of 175,000 tons of pig per year with gas engine equipment of sufficient capacity for an additional blast furnace, which probably will be authorized early next year; a machine shop forging department, consisting of one 2,500 ton and one 1,500 ton hydraulic press and two draw benches, and installation of 8 in., 12 in. and 15 in. bar mills, a steel tire department and a rolled wheel department.

Additions to the original Midvale steel plant at Nicetown call for an expenditure of over $450,000. Important additions to the equipment of the machine shop also has been authorized. These will give an increased capacity that will enable the plant to handle recent orders of the U. S. Government for heavy ordnance such as 14 in. and 16 in. guns, 70 ft. in length.

The Midvale Steel & Ordnance Co. has acquired all of the capital stock of the Buena Vista Iron Co., owner of extensive ore deposits in Cuba, said to contain 300,000,000 tons of merchantable iron ore.

River Terminals at Quincy, Ill., and St. Louis, Mo.

A considerable amount of construction in connection with river terminal developments is proposed by cities located along the Mississippi River. Plans for the first unit of the river and railway terminal system to be constructed by the city of Quincy, Ill., have been approved by a joint committee composed of business men and city officials. The plans provide for the construction of a sea wall 350 ft. long, elevated to a point well above the flood stage. The shore side of the wall will be filled in and a freight house 300 ft. in length will be erected. This will be used for package freight and will be equipped with electric trucks and electrically operated freight elevator. Bulk freight will be handled by a traveling crane of 25 tons capacity moving on tracks about 500 ft. in length. It also is proposed to install a locomotive crane with bucket of 1½ cu. yds. capacity for handling coal, sand, gravel and like commodities. The terminal will be connected with the tracks of the railways. A plan is under consideration for constructing a belt line to encircle the city and connect directly with the water terminal.

St. Louis, Mo., is about to commence construction on the first unit of its $285,000 dock project. This structure will have a total length of 1,200 ft. The first section, however, will be 300 ft. long. It will be constructed of reinforced concrete and will rest on reinforced concrete piles. Railway facilities will be furnished by a track running down the center of the dock and connecting with a municipal railway. The dock will have a steel frame warehouse and will be equipped with two traveling cranes for transferring shipments between boats and the warehouse, or cars and boats. Electric trucks will be used and possibly tiering machines. The estimated cost of the equipment is $30,000. Plans for the first section of this dock have been approved by the Board of Public Service and an ordinance authorizing carrying out the work is now before the Board of Aldermen.

BRIDGE AND CULVERT CONSTRUCTION.

Bids Asked on 22 Bridges and 65 Culverts.

Work to be Done for Marion County, Iowa.

A considerable amount of small bridge and culvert construction will be undertaken next year by various counties in Iowa. One of the first lettings of this kind of work for next season is now being advertised by Marion County. Bids will be received on bridges and culverts estimated to cost $85,000. Of this amount about $45,000 is for the culverts. These will be of the reinforced concrete box type, the greater number being 3 ft. x 3 ft. in size.

The work is divided into seven groups. Group A includes four pony truss bridges, three 50 ft. by 18 ft., and one 70 ft. by 18 ft. All of these are to be constructed on reinforced concrete abutments. The estimated cost of the four structures is $11,749. The total quantities are as follows: Concrete, 549.2 cu. yds.; reinforcing steel, 52,685 lbs.; structural steel, 97,700 lbs.

Group B covers nine I-beam bridges with reinforced concrete abutments. The spans range from 20 ft. to 32 ft., and all but one will be 16 ft. wide. The total estimated cost is $13,324. The approximate quantities are as follows: Concrete, 872.6 cu. yds.; reinforcing steel, 48,230 lbs.; structural steel, 59,210 lbs.

Group C also calls for nine I-beam bridges. Five of these are 32 ft. by 16 ft., and two are 20 by 16 ft. The total estimated cost is $14,982. About 896 cu. yds. of concrete, 49,630 lbs. reinforcing steel, and 84,760 lbs. of structural steel are required.

Groups D, E, F and G include the reinforced concrete box culverts. Details of these structures follow:

Shipping point.	Miles.	Size, feet.	Concrete, cu. yds.	Reinforcing steel, lbs.	Est. cost.
GROUP "D."					
Flagler	1½	4x4x42	33.8	1,940	$447
Durham	1½	3x3x65	38.6	2,215	500
Knoxville	1½	4x3x23	22.6	1,350	300
Knoxville	3	4x4x40	32.6	1,865	431
Bussey	2	4x4x40	32.6	1,865	423
Bussey	3	4x3x38	27.8	1,740	386
Everist	3½	8x4x24	39.6	1,955	514
Everist	2½	4x4x50	38.4	2,250	509
Everist	1	6x4x40	44.0	2,850	558
Palla	4	8x6x40	70.0	3,450	944
Tracy	2½	4x4x36	30.3	1,710	400
Pella	4½	6x6x40	56.5	3,400	780
Fifield	4	6x4x42	45.6	2,985	591
Harvey	2	3x3x32	22.8	1,210	310
Knoxville	2½	3x3x56	34.3	1,950	487
Everist	7	6x4x32	37.5	2,360	596
Bussey	2½	4x4x56	41.9	2,480	556
Knoxville	5½	4x4x60	44.2	2,660	643
Knoxville	3	6x4x70	68.3	4,765	911
Tracy	4	3x3x40	26.6	1,450	370
Pella	1	3x3x58	60.0	2,660	710
Olivet	4	6x4x66	65.2	4,510	901
Durham	5	3x3x34	23.7	1,270	352
GROUP "E."					
Purdy	4	3x3x38	25.6	1,390	355
Purdy	4	3x3x50	31.4	1,770	438
Purdy	3	4x3x46	32.1	2,040	430
Nepas	3½	3x3x34	23.7	1,275	335
Kimball	4	4x4x55	41.3	2,460	559
Melcher	7	4x4x24	23.3	1,240	369
Melcher	6	3x3x34	23.7	1,275	358
Melcher	5	3x3x58	35.2	2,010	518
Melcher	4	4x4x48	37.2	2,180	521
Melcher	3	3x3x34	23.7	1,275	323
Melcher	1½	12x8x36	118.6	5,570	1412
Melcher	1	6x6x24	40.5	2,240	503
Melcher	½	6x4x58	64.3	4,300	804
Melcher	9	3x3x48	30.4	1,700	545
Melcher	9	4x4x40	32.6	1,870	594
Purdy	4	3x3x50	31.4	1,760	430
Melcher	6	4x4x40	32.6	1,870	480
Melcher	5½	3x3x34	23.7	1,270	358
Melcher	5½	3x3x60	36.7	2,140	541
Purdy	5½	6x4x32	37.5	2,350	558
GROUP "F."					
Swan	¼	8x4x50	68.7	3,565	794
Swan	3	4x3x40	28.9	1,810	394
Percy	2	8x4x30	46.3	2,320	579
Percy	1½	3x3x40	26.6	1,455	350
Percy	1	6x4x36	40.8	2,600	527
Percy	3	4x4x44	34.9	2,020	471
Swan	2½	3x3x36	24.7	1,330	336
Cordova	3	3x3x28	20.8	1,080	277
Kimball	3	4x4x53	40.1	2,380	573
Kimball	1	4x4x28	25.6	1,400	330
Kimball	2	3x3x58	85.2	2,000	456
Pleasantville	2	4x4x68	48.8	2,975	638
Pleasantville	3½	3x3x54	33.3	1,890	448
Pleasantville	4	4x4x26	24.5	1,320	346
Pleasantville	4½	6x4x42	45.5	2,990	648
Pleasantville	3½	3x3x32	22.8	1,220	310
Pleasantville	3	4x4x60	44.2	2,650	577
Pleasantville	6	4x4x46	36.1	2,100	532
Knoxville	5	3x3x44	28.5	1,575	432
Cordova	4	4x4x32	28.0	1,550	375
Cordova	4½	4x4x60	34.0	2,550	485
GROUP "G."					
Otley	3	12x10x42	167.1	7,340	2058
Otley	4	3x3x52	32.4	1,825	460
Otley	3	6x4x32	37.5	2,350	502
Fifield	1	4x4x54	40.7	2,420	510
Dunreath	3	4x4x58	43.0	2,580	561
Otley	1	4x4x44	34.9	2,030	454
Otley	1½	4x4x26	24.5	1,320	321
Otley	1½	4x4x30	26.8	1,480	346
Otley	1½	4x4x28	25.7	1,390	337
Otley	2	8x4x28	44.1	2,200	551
Monroe	2½	4x3x46	32.1	2,040	430
Monroe	3	4x3x62	40.6	2,660	557
Cordova	2½	4x4x36	30.3	1,700	400
Dunreath	2½	6x6x44	60.5	3,690	776
Monroe	3	4x4x50	38.4	2,260	510
Dunreath	1½	3x3x52	32.4	1,820	419
Cordova	2	3x3x46	29.5	1,630	388
Cordova	3	3x3x30	21.8	1,150	291
Otley	3	3x3x36	24.7	1,430	339
Otley	2½	6x4x31	36.7	2,290	491
Otley	2	3x3x32	22.8	1,210	299
Otley	2	4x4x25	23.9	1,270	313
Otley	2	6x4x28	34.3	2,100	457
Otley	2½	8x6x32	59.7	2,860	787

Separate bids will be received on any or all the structures. Bids also will be considered on all the structures in any one group or combination of groups. Contractors will be expected to start work as early in the spring as weather conditions will permit and to complete the work by Nov. 1, 1916. No filling is included in these contracts, and contractor will be required to remove only such old structures as interfere with the new construction. The standard specifications of the Iowa Highway Commission will govern the work. Bids for the construction of the bridge and culvert will be received until 1:15 p. m., Jan. 18, by J. D. Schlotterback, county auditor, Knoxville, Ia. W. O. Price is county engineer.

Proposed Reconstruction of Newark Bay Bridge.

There is considerable agitation at present by citizens of Bayonne, Newark and Elizabeth, N. J., to secure the construction of the Newark Bay bridge of the Central R. R. of New Jersey. The citizens of Bayonne also are advocating the building of a bridge for highway traffic, either combined with the proposed new bridge of the railroad or as a separate structure. Efforts have been made to obtain the co-operation of the freeholders of Hudson and Union Counties and the officials of the first mentioned county have made an appropriation to study the question.

The State Board of Commerce and Navigation, of which B. F. Cresson, Jr., is chief engineer, has held several hearings on the project and has made a report to the federal government stating that in its opinion the present bridge of the railroad should be removed and replaced with a new structure. It appears likely that some action will be taken in the near future by the government looking to the reconstruction of the present railroad bridge.

The present bridge of the Central R. R. of New Jersey is about 7,368 ft. long from shore to shore. It is a timber structure supported on pile bents about 12½ ft. center to center, with the bottom of stringers 6 ft. 3 ins. above mean high water. It has two lift spans. The bridge carries two tracks from the Elizabeth side to and beyond the lift span, where it widens and carries three tracks to the Bayonne shore.

It has been suggested that this bridge should be replaced by a higher level long span structure. The railway officials are now understood to be working up plans and the necessary preliminaries for presentation to the proper authorities for approval. The general plan contemplated is one very similar to that adopted by the railroad for the reconstruction of its Hackensack and Passaic River bridges. These structures now give a clear head room at the draw span of 25 ft. at mean high water, with two draw openings of 100 ft. width at each bridge.

Granite Block Paving to Cost $1,200,000.

Street improvements contemplated for the downtown business section of Boston, Mass., and for Charleston and the South End call for an estimated expenditure of $1,956,000. The following is a list of the streets which the Highway Division of the Department of Public Works, wishes to improve the coming season, provided the necessary funds are made available:

Albany St., from Dover St. to Northampton St.	$ 155,000
Atlantic Ave.	200,000
Batterymarch St., from Franklin St. to Broad St.	9,000
Blackstone St., from North St. to Fulton St.	6,000
Boylston St., from Tremont St. to Washington St.	12,000
Beach St.	19,000
Billerica St.	3,000
Charles St., from Beacon St. across Cambridge St.	33,000
Cambridge St., from Chambers St. to River St.	30,000
Clinton St., from Merchants' Row to Commercial St.	11,000
Commercial St., from Fleet St. to Washington St., North	80,000
Cross St.	12,000
Devonshire St., from Water St. to Adams Sq.	9,000
Dorchester Ave., from Congress St. to Federal St. Bridge	80,000
Endicott St., from Hanover St., to Prince St.	24,000
Federal St., from Milk St. to Dewey Sq.	24,000
Franklin St., from Oliver St. to Broad St.	8,000
Fulton St., from Blackstone St. to Richmond St.	10,000
Friend St., from Washington St. to North St.	4,000
Haymarket Sq.	30,000
India Sq.	4,000
Lancaster St.	5,000
Leverett St., from Green St. to Causeway St.	4,000
Lincoln St.	23,000
Mercantile St.	8,000
Merchants' Row, from North Market St. to North St.	12,000
McKinley Sq.	22,000
Post Office Sq.	13,000
Purchase St.	27,000
Richmond St., from Hanover St. to Atlantic Ave.	15,000
Sudbury St., Court St., to Haymarket Sq.	12,000
South St.	25,000
Washington St., from Haymarket Sq. to Adams Sq.	15,000
Harrison Ave., from Harvard St. to Warren St.	115,000
Shawmut Ave., Pleasant St. to Roxbury St.	143,000
Tremont St., from Boylston St. to Northampton St.	179,000
Dorchester Ave., from Andrew Sq. to Ashmont St.	240,000
Main St., Charlestown	201,000
Chelsea St., Charlestown	49,000
Rutherford Ave., Charlestown	82,000
Total	$1,956,000

The costs are estimated for granite blocks on a concrete base with cement joints. James H. Sullivan, is Engineer Highway Division.

Water Front Development at Clearwater, Fla.

It is expected that construction will be started early next year on a good-sized private water front development near Clearwater, Fla. The improvement includes a bridge over Clearwater Harbor, the construction of a railroad over the bridge and through Clearwater to the eastern city limits. On the gulf side a recreation pier will be constructed and large and modern bath houses with pavillions erected. The bridge will accommodate railroad trains and automobiles. It will include a steel draw span, about 160 ft. span, and with the approaches will be about 2 miles in length. The approaches will be built of wooden piles and cypress or heart pine lumber. They will require about 3,000 piles and 1,500,000 ft. of lumber. The railroad will have a 60-lb. rail. All work will be done under the supervision of E. W. Parker, President and General Manager, Curry Bldg., Clearwater, Fla.

PERSONALS

Mr. George F. Maitland has been promoted to the position of division engineer of the Kansas division of the Union Pacific, with headquarters at Kansas City.

Mr. G. Sabin Brush has resigned from the employ of the Boston Elevated Railway Co. to become superintendent of the railway department of the Cumberland County Power & Light Co. of Portland, Me. He will have charge of 107 miles of railway.

Mr. George J. Adamson, formerly special construction engineer of the Union Pacific Railroad, with headquarters at Omaha, has been promoted to the position of division engineer of the Wyoming division of the same railroad, with headquarters at Cheyenne, Wyo.

Mr. F. C. Roberts, civil engineer, of Berkeley, Cal., has received the temporary appointment as general inspector for the architectural division of the State Engineering Department. This position is under civil service, but at present there is no eligible list. An examination will be called to create a list of eligibles.

Mr. P. E. Mercier has been appointed chief engineer for the city of Montreal, Quebec, to succeed the late Maj. Georges Janin, who lost his life when the steamship Anglia struck a mine in the English Channel. Mr. Mercier has been acting chief engineer since Maj. Janin obtained a leave of absence to join the French army. He was formerly a member of the firm of Baulne & Mercier.

Mr. R. A. Hart is now senior drainage engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture. He is stationed at Berkeley, Cal., and is supervising drainage investigations in the arid West and is making a study of methods of reclaiming alkali and over-irrigated lands. In the summers of 1906-08 he was employed by the water commissioner of Utah and made a study of the control of distribution of the Spanish Fork River for irrigation. In 1908 he was testing engineer with the General Electric Co. at Schenectady, N. Y.; 1909, assistant drainage engineer and, 1910-12, drainage engineer U. S. Department of Agriculture; 1913-14, supervising and, after July, 1915, senior drainage engineer, U. S. Department of Agriculture.

Mr. A. W. Creuzbaur of the engineering firm of Creuzbaur & Parmelee, Woolworth Bldg., New York City, has renewed his contract with the city of Elizabeth, N. J., as consulting engineer of railroad improvements. The plans for six-tracking and straightening the line of the Pennsylvania Railroad between Newark and Linden will soon be completed. The plan for the crossing over Broad street and the Central Railroad of New Jersey is practically decided upon. Mr. Creuzbaur is also in charge of the work proposed by the New Jersey Public Utilities Commission and the city of Elizabeth for grade separation along the Central Railroad of New Jersey where there are a large number of actual grade crossings and so-called paper streets crossing the main line of the Newark branch.

Mr. John Clayton Tracy was appointed professor of civil engineering in the Sheffield Scientific School of Yale University, New Haven, Conn., in November, 1915, to succeed the late Prof. A. J. Du Bois. He is head of the department of civil engineering, including the sub departments of sanitary engineering, railway engineering, structural engineering and surveying. He received the degree of Ph. B. from Yale in 1890 and the C. E. degree from the same institution in 1892. In 1890-91 and for several succeeding summers he served in the engineering department of the King Bridge Co. as draftsman and designer. He was an instructor in civil engineering in Sheffield Scientific School from 1894 to 1902, and from 1902 to 1915 was assistant professor of structural engineering. He is a member of various engineering societies and is the author of the following works: An Introductory Course in Mechanical Drawing (1897); Plane Surveying (1907); Exercises in Plane Surveying (1908); Descriptive Geometry (1913). He has been a frequent contributor to engineering journals and to the proceedings of engineering societies.

Mr. C. M. Pritchard, structural engineer, has recently formed the C. M. Pritchard Structural Co., with offices at 545-6 Robinson Bldg., Tulsa, Okla. The firm will engage in the design and construction of fire-resisting structures for industrial purposes, such as glass factories, oil refineries, cottonseed oil mills and refineries, power plants and bridges of all kinds. Mr. Pritchard graduated at the University of Michigan in 1896. Prior to 1900 he did structural detail and railroad drafting. For six years thereafter, until May, 1907, he was designing engineer for the Missouri Valley Bridge and Iron Co. From 1908 to 1912 he was designing and contracting engineer for the Kansas City Structural Steel Co. in Oklahoma and Texas. From 1913 to October, 1915, he was chief engineer of the Oklahoma Iron Works at Tulsa.

Mr. Joseph F. Hasskarl has been named assistant director of wharves, docks and ferries by Mayor-elect Thomas B. Smith of the city of Philadelphia. He was educated in the public schools of Philadelphia and in Elmhurst College. In 1883 he joined an expedition for the exploration of parts of British Columbia; entered the service of the United States Engineer Department in 1883, and was engaged in the surveys of Illinois, Kankakee, Des Plaines and the Mississippi Rivers; assisted in the surveys of the Rio Grande, and later made surveys of the Delaware River and Bay. In 1883 he was promoted to chief inspector and placed in charge of the Philadelphia Harbor improvement. This consisted of the removal of Smith and Windmill Islands and part of Petty Island from the Delaware River, being in charge of that work from commencement to completion. In 1897 he was placed in charge of the construction of the Breakwater of National Harbor Refuge, Delaware Bay. Completed that work in 1901. In the same year he was promoted to principal assistant engineer and placed in charge of all the works on the Delaware River and Bay from Trenton to the sea. During his connection with the United States Engineer Department he had charge of the dredging of more than 60,000,000 cu. yds. of material from various rivers; was in charge of the construction of more than 50,000 ft. of bulkheads, dykes and jetties; also had charge of the placing of more than 2,000,000 cu. yds. of stone. In 1907 at the request of the maritime and business interests of Philadelphia he was made assistant director of the Department of Wharves, Docks and Ferries. In 1909 he was promoted to acting director of that department, and in September, 1911, was promoted to be director of the Department of Wharves, Docks and Ferries. During his services as director of that department he had charge of the preparation of plans and the construction of Vine street pier, which was the first large fireproof steel and concrete pier built on the Atlantic seaboard, and has served as a model for similar piers since that time; also prepared the plans for the harbor improvement of Trenton, N. J. He is a member of the American Society of Civil Engineers.

Mr. George S. Webster, for years chief engineer of the Philadelphia Bureau of Surveys, has been appointed Director of Wharves, Docks and Ferries by Mayor-Elect Thomas B. Smith. Mr. Webster was born in Philadelphia in 1855. He was educated at Friends' Select School and at the University of Pennsylvania, from which he was graduated in 1875 as a civil engineer. He has since received the degrees of bachelor of science and doctor of science from the university. Immediately after graduation he entered upon the practice of civil engineering, and in January of 1877 was appointed to a position in the Bureau of Surveys, which he held until May 1, 1880, when he was elected surveyor and regulator, Tenth Survey District; on Feb. 1, 1892, he was appointed principal assistant engineer in the bureau, and this was followed by the position of acting chief engineer May 1, 1892, and chief engineer Feb. 1, 1893. Since his incumbency he has had supervision not only of the greatly increased volume of public improvements, but also of some of the most extensive works undertaken by the city, including the following works: Design and construction of miles of sewers. Sewage treatment plant at Torresdale. Report upon sewage disposal of entire city. Design and construction of many large bridges of tasteful design, the most notable of which are the great concrete arch bridge over the Wissahickon Creek at Walnut Lane, the Falls, Gray's Ferry and Passyunk avenue bridges over the Schuylkill River. Mr. Webster as the city's representative has supervised the abolishment of many grade crossings in the city, the most important being the New York division of the Pennsylvania Railroad, Philadelphia & Reading Railway on Ninth street, and in Pennsylvania avenue the Richmond branch of the Philadelphia & Reading Railway, Philadelphia & Trenton Railroad on Trenton avenue, and important work of this character now in progress in South Philadelphia. He also supervised the widening of Delaware avenue from Vine street to South street, and the erection of three large municipal piers and the dredging of the channel of the Delaware River from the city to Marcus Hook. He is a member of the following societies: American Society of Civil Engineers, American Society for Testing Materials, National Conference on City Planning, and Philadelphia Engineers' Club.

NEW CATALOGUES

MOTOR TRUCK TIRES.—Paper, folder. The B. F. Goodrich Company, Akron, O.

"Building Up the Nation's Defenses." Illustrates and describes some features connected with the fortifying of the Los Angeles harbor. Copy sent on request.

TUNNEL WATERPROOFING.—Paper, folder. Cement-Gun Company, Inc., 30 Church St., New York City.

"Bulletin No. 91." Reprint of an article describing the methods used in waterproofing a tunnel with cement and clay mortar, the work being done 50 ft. below sea level with the cement gun.

CORRUGATED METAL CULVERTS.—Paper, 8½x11 ins., 23 pp. Canton Culvert and Silo Company, Canton, O.

Contains a collection of letters and orders from users of "Acme" (Nestable) No-Co-Ro corrugated metal culverts. Also shows some advertisements run in various journals illustrating product of this company.

STEAM TURBINES.—Paper, 8½x11 ins., 10 pp. The Terry Steam Turbine Company, Hartford, Conn.

"The Terry Turbine." A new bulletin describing and illustrating the various kinds of high, low and mixed pressure turbines made by this company. Also gives a general description of the various turbine applications. Copy sent on request.

SHOVELING MACHINES.—Paper, 10x8¾ ins., 28 pp.; Myers-Whaley Co., Knoxville, Tenn.

Catalogue No. 5, presenting a brief description and a number of photographs and drawings of the Myers-Whaley shoveling machines for underground and surface work. The illustrations show the various types of machines working in coal and metal mines, on the Catskill aqueduct, in salt mines, loading from stock piles, etc. Summarizes the important features of the machines, the classes of work for which they are adapted and the economy of their use.

INDUSTRIAL NOTES

The general offices of Warren Bros. Co., Boston, Mass., will be removed from its present location, No. 59 Temple Place, to much larger quarters at No. 142 Berkeley St., same city, in a few days.

Yeoman Bros. Co., 231 Institute Place, Chicago, Ill., has entered into a special agreement with the Shone Co., of Chicago, Ill., by which it takes charge of the sale and installation of the Shone pneumatic sewage ejectors throughout the United States and Canada.

RAILWAYS

BIDS ASKED.

Massachusetts:

Boston, Mass.—Until noon, Dec. 16, by Boston Transit Commission, B. Leighton Beal, Secretary, for 1,760 sq. yds. of terrazzo finish on walls of "South Station Under," Dorchester Tunnel.

New York:

New York, N. Y.—Until Dec. 20, by New York Municipal Ry. Corp., 85 Clinton St., Brooklyn, for additional tracks in East New York and enlarging East New York yards.

PROSPECTIVE WORK.

California:

San Diego, Cal.—Santa Fe System, according to report, will start grading early next year for sidetracks and buildings for shops, round house and freight yards in Old Town.

Greenville, Cal.—Engel Copper Co. has completed location survey for seven miles of railroad and has also made preliminary surveys for two branches.

Needles, Cal.—Santa Fe system is reported to be considering making surveys for a line to Oatman.

Georgia:

Savannah, Ga.—Savannah & Atlanta Ry. Co., has applied for charter and proposes 60-mile line from St. Clair to Washington in Wilkes County. This is the proposed extension of the Savannah & Northwestern Ry., of which J. H. Hunter, Savannah, is president.

Idaho:

Pocatello, Ida.—Pocatello Traction & Interurban Co. has been incorporated with a capital stock of $100,000, and will, it is stated, begin work at once on 7 miles of track. Richard Douglas is President.

Illinois:

East St. Louis, Ill.—Vandalia R. R. has had work started for improvements to its freight yards northeast of the city. Work will cost about $80,000.

Indiana:

Bicknell, Ind.—Pennsylvania R. R. proposes expenditure of about $150,000 for coaling station here.

Massachusetts:

Attleboro, Mass.—New York, New Haven & Hartford R. R. is reported to be contemplating construction of a new freight terminal at East Junction to accommodate 1,000 cars.

New York:

New York, N. Y.—The Public Service Commission for the First District has approved the plans submitted by the Interborough Rapid Transit Co. for the construction of the Webster Ave. extension of the Third Ave. elevated railroad in The Bronx.

Ohio:

Canal Dover, O.—Dover, Millersburg & Western Ry. proposes electric line from Canal Dover to Millersburg, O. Work will require three bridges and about 1,000 ft. of trestles. Date of letting contracts has not been determined. D. F. A. Wheelock, Warren, Pa., is Chief Engineer.

Cincinnati, O.—Ordinance has been prepared providing for $100,000 bond issue for preliminary expenses of the City Rapid Transit Commission proposing construction $6,000,000 rapid transit developments.

Columbus, O.—Contemplated expenditures by the Baltimore & Ohio R. R. include the following: $600,000 for double-tracking between Midland City and Cincinnati; $640,000 for second track and track elevation through Defiance.

Canton, O.—Wheeling & Lake Erie R. R., according to reports, will let contracts at once for the construction of a 3-mile spur to cost between $200,000 and $250,000.

Youngstown, O.—Youngstown & Niles Ry. Co. has been organized for the purpose of securing right of way for an interurban line. Mahoning & Shenango Ry. & Light Co. is interested.

Oregon:

Medford, Ore.—The Southern Oregon Traction Co., according to reports, will start work Jan. 1 on extension of Medford-Jacksonville electric line to Ruch and Blue Ledge copper mine, 30 miles down the Applegate Valley.

Arlington, Ore.—Oregon-Washington Railroad & Navigation Co. will have work started in near future on double tracking and straightening its line between Blalock and Coyotte.

Pennsylvania:

Bloomsburg, Pa.—A plan is under consideration for construction of a railroad from Schenectady, N. Y., to Bloomsburg, following the Schoharie, Delaware and Tunkhannock Valley. R. B. Williams, Scranton, Pa., is reported to be interested.

Tennessee:

Clifton, Tenn.—Tennessee Valley Iron & R. R. Co., according to reports, will extend its line of railroad from Collinwood to Savannah, Tenn., if county will vote bonds to help construction work.

Texas:

Dallas, Tex.—It is reported here that construction will be started this month on the $1,500,000, terminal station and office building for the Rapid Transit Co., of this city. Work will include a station 8-stories 210x85-ft. with reinforced concrete frame, also concrete platforms and terminal yards containing seven tracks. Mark Lowd, 1017 Commonwealth Bldg., Dallas, is interested.

Weatherford, Tex.—Chicago, Weatherford & Gulf Ry. Co. has been incorporated with a capital stock of $250,000 and proposes railway from Gainesville to Waco. W. D. Stratton, Middletown, N. Y., is President and T. R. Erwin, Weatherford, Tex., is Secretary.

Utah:

Salt Lake City, Utah.—Harry S. Joseph has applied for franchise to County for electric road from West Jordan to Bingham.

Washington:

Wenatchee, Wash.—Preliminary surveys have been made and part of right-of-way has been secured for railway 25 miles in length from Leavenworth to Icicle. A. Van Eppes, Leavenworth, is interested.

West Virginia:

Huntington, W. Va.—The Baltimore & Ohio R. R. has surveys under way on Big Sandy River near Beaver Creek, Ky. It is reported the company has secured right of way on left fork of Beaver Creek for a line into the Beaver coal fields.

Wisconsin:

Blair, Wis.—Financial arrangements are reported to have been completed for construction of new railway from Blair to Ettrick to cost about $150,000. John C. Gaveney, Arcadia, Wis., is interested.

Green Bay, Wis.—Green Bay & Eastern Ry. Co., proposing an interurban line between Green Bay and Sheboygan by way of Manitowoc, has completed its organization. William Willinger, Manitowoc, is President.

BIDS OPENED; CONTRACTS LET

California:

San Francisco, Cal.—F. Rolandi, 55 Montgomery St., San Francisco, has been awarded contract by Board of Public Works, for construction of 67-mile railroad for Hetch-Hetchy Valley water project. Contract price is $1,523,000.

Florida:

Maytown, Fla.—J. M. Cook, Jacksonville, Fla., has been awarded grading contract for extension of Florida East Coast Ry., from Mayton to New Smyrna, 17½ miles.

New York:

New York, N. Y.—Booth & Flynn, Ltd., New York City, at $6,631,000, were low bidders for construction of tunnel under East River between 14th St. and N. 7th St., Brooklyn, for Public Service Commissioners of the First District.

New York, N. Y.—The Public Service Commission for the First District has approved the award by the New York Municipal Railway Corp. to Bayly Hipkins, New York City, of the contract for the erection of steel, constructing tracks, station buildings, platforms, etc., for the additional tracks on the Myrtle Ave. elevated railroad in Brooklyn between Willoughby Ave. and Palmetto St. and on Palmetto St. between Myrtle Ave. and Cypress Ave. Contract price is $352,511.

New York, N. Y.—The Public Service Commission for the First District awarded the following contracts on rapid transit lines in New York City: For the construction of Section No. 2 of Routes Nos. 19 and 22, the Westchester Ave. portion of the Southern Boulevard and Westchester Avenue extension of the Lexington Avenue subway, to Lawrence C. Manuell, for $2,063,877. This section is a three-track elevated railroad, and extends northerly from Whitlock Ave. to Pelham Bay Park. For the supply of Special Work, Order No. 6, consisting of frogs and switches which are to be used in the track-laying of the Lexington Ave. subway, to the Ramapo Iron Works, at $46,195. For the installation of tracks on the White Plains Road extension of the Lenox Avenue branch of the existing subway, to the Coast and Lake Contracting Corporation, the lowest bidders, at $53,930.

New York, N. Y.—Bids for the construction of Section No. 3 of Route No. 8, comprising the tunnel under the East River for the 14th Street-Eastern Rapid Transit Railroad, were opened by the Public Service Commission for the First District last week. The lowest bidder was Booth & Flinn, Ltd., New York City, at $6,639,023.50

Oklahoma:

Oklahoma City, Okla.—A. L. Cook, Ottawa, Kans., has been awarded 130 miles of bank widening for Missouri, Kansas & Texas R. R., between Oklahoma City and Atoka, Okla.

Pennsylvania:

Philadelphia, Pa.—Edwin H. Vare, Lincoln Bldg., Philadelphia, at $17,700, was low bidder for foundations for Frankford Elevated Ry., from Unity to Dyre St.

Connellsville, Pa.—Baltimore & Ohio R. R. has awarded the contract to B. F. Lincoln for construction of several piers over a small stream in connection with extension of east yards of railroad.

ROADS STREETS

BIDS ASKED.

Alabama:

Rockford, Ala.—Until Jan. 11, by County Commissioners, for 4½ miles of topsoil road.

Dothan, Ala.—Until Dec. 30, by County Board of Revenue, A. C. Crawford, Chairman, for 7 miles of road work.

California:

Los Angeles, Cal.—Until 2 p. m., Dec. 27, by H. J. Lelande, Clerk County Supervisors, for 5 miles of work on Mint Canyon Road. Improvement calls for about 58,667 sq. yds. of concrete pavement with bituminous wearing surface.

Los Angeles, Cal.—Until noon, Dec. 27, by W. F. McClure, State Engineer, Sacramento, Cal., for construction of paved roads, walks and drains, at State Normal School Grounds, Los Angeles.

Sacramento, Cal.—Until 2 p. m., Dec. 27, by State Highway Commission, Austin B. Fletcher, Highway Engineer, for three contracts for State Highway, as follows: 7.5 miles in Placer County from Roseville to Penryn, 6.5 miles in Placer County from Penryn to Auburn, and 10.2 miles from Corning to Proberta in Tehama County. Roads are to be paved with Portland cement concrete.

Connecticut:

Norwalk, Conn.—Until 2 p. m., Dec. 21, by Charles J. Bennett, State Highway Commissioner, Hartford, Conn., for widening of Armory Hill Road (brick pavement).

Hartford, Conn.—Until 2 p. m., Dec. 21, by Charles J. Bennett, State Highway Commissioner, for construction of about 4,500 ft. of

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS

H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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Concerning a National Organization of Engineers.

At present there is much discussion among engineers concerning the most effective means of increasing their influence and professional standing, and several organizations have been formed to direct work along these lines. In addition, a number of local engineering societies are giving increased attention to this kind of work. Undoubtedly much can be accomplished by those local societies which formerly have confined their activities largely to the technical side of engineering. There are, however, a very considerable number of engineers who feel that more rapid and certain progress can be obtained by the formation of a separate organization, which shall have as its principal object the education of the general public to an appreciation of the public need for engineering service. Unfortunately—but quite naturally—the leaders of the various associations formed recently have been unable to find common grounds for organization. An investigation of several new organizations, however, has convinced us that their main purpose is the same and that there is no valid reason why their interests should not be merged in a single organization. Of course this will mean some concessions by all parties, but the necessity for unity of action should outweigh individual differences of opinion as to ways and means. We are convinced there is a legitimate field for *one* new organization, with branches in different parts of the country.

Granting the need for such an organization, the question naturally arises as to how the much-desired results can most certainly be obtained. It is here that the greatest difference of opinion naturally exists. Few have given the question sufficient study to justify the assertion that they can offer a satisfactory solution of the difficulties to be met. There is, however, one fundamental truth which, it seems to us, must be recognized at the start if definite and continued progress is to be made. Engineers must keep constantly in mind the fact that their professional standing is measured directly by the degree to which the value of their services is generally recognized by the public—what the engineer himself asserts and believes matters little.

We believe this recognition can best be secured by starting at the bottom and beginning anew. In the first place, the engineer must prove himself to be a better neighbor than in the past to those men engaged in other lines of work. He must convince them that he is not a machine but is *human,* and that his interests are largely the same as theirs. Further, he must demonstrate to their satisfaction that his training has been broad—not narrow. We do not fear contradiction when we assert that, as a class, engineers have not made serious effort to understand the other fellow, and to be understood by him; they have been too much concerned with the details of their own engineering problems. We have noted the success attending the efforts of those few engineers who have tried to do this thing; yet some still wonder why such men have succeeded.

Having gained the confidence of those about him—his neighbors—one is indeed a poor engineer who can not show the application of his specialized knowledge to the little problems which vex the average citizen—such as poor streets, inadequate drainage, poor lighting and transportation facilities, etc. If such work were done intelligently and systematically, under proper direction, it would not be long until there would be created a wider market for the engineer's services—and we all know that a strong market tends to increase the returns to those having something to sell. The point which we wish to emphasize is that it is desirable that we start with the A. B. C.'s of this educational work, and that we present our ideas in such a way that they can be readily understood by others. It is not to be denied that newspaper publicity given to the unusual engineering project is beneficial, but such occasions for impressing the public are few, and they do not widen the field of service appreciably. Those who have studied the engineer's problems do not expect the millennium to come next year, nor the year after, but they are convinced that definite progress will attend well-directed and concerted effort at this time.

Accomplishing Engineering Results by Playing on Popular Emotions.

The old saying that "you can't change human nature," is, we believe, generally accepted as true by all. The sophisticated, however, take human nature as they find it and, by adroit use of their knowledge of the foibles of mankind, accomplish their own ends. Recent developments in the art of engineering publicity at Philadelphia serve well to illustrate how the engineer can accomplish results by utilizing his knowledge of human nature. To quote from the latest annual report of the Director of Public Works:

> Many matters which by themselves are not conspicuously available for newspaper use can be made so by a proper setting. Sewers and news about sewers do not fire the public imagination and hence the newspapers pay little attention to them. We were able to secure a large appropriation ($200,000) for a sewer that had been pressing for many years, largely through the human interest injected into a public hearing by the pathetic story of a poor baker-woman who had her small stock of flour ruined at every heavy rainfall and all for the want of the sewer. The story reached the first page of the newspapers and a public agitation and the appropriation followed.

To those who object to bringing extraneous and more or less incidental considerations into the discussion of an engineering enterprise we beg leave to suggest that the prime function of the engineer is to get engineering results. If these cannot be attained by the cold precision of technical discourse alone, surely the engineer may be pardoned for employing, as an aid, the warm vagaries of discourse to which the layman is so responsive.

Connecting Low Voltage Circuits to Water Pipes.

Now that such impartial experts as the electrical engineers of the United States Bureau of Standards not only advocate connecting low-voltage secondary circuits to water pipes but state that this course should be made compulsory, water works men will naturally look into this subject carefully and critically with a view to safeguarding the interests in their charge. It is stated that there is no good reason why the enactment of ordinances or other legislation requiring such connections should be longer delayed. The practice has been tried out in various localities and found unobjectionable. We feel very sure, however, that the subject is new to many water works engineers and operators and for that reason we shall give considerable space to an authoritative discussion of it in the next issue.

The average water works man knowing electrolysis to be the greatest, and in many localities the only, enemy of cast iron pipe, naturally rebels at the suggestion of making a new form of connection between electric conductors and water pipes. It should be noted at the outset of any consideration of the subject here under discussion, therefore, that electrolysis cuts a very small figure in the case. The article tells not only why but how these connections should be made. Careful distinction is drawn between the grounding of direct and alternating current circuits by connection or connections to water pipes. The precautions to be taken to safeguard property and life are fully set forth.

The subject is literally a vital one since deaths are sometimes caused by the conditions the course advocated was designed to correct.

Certainty in Underpinning Methods.

In connection with the construction of an extension of the subway system along William St., New York City, the contractors have made some interesting and instructive soil tests and have developed some effective methods of underpinning the adjacent buildings. In this issue we are publishing a comprehensive article on the results obtained thus far on this work, some features of which will herewith be treated briefly.

As it is essential to the success of any method of underpinning that the exact character of the subsoil be determined, physical analyses of the soil were first made. In this work two methods of analysis were used, the first consisting of a sieve analysis of the dry material, and the second of volumetric separation of the soil constituents by shaking with water. It was found that the second method alone gave satisfactory results, as the soil consisted of sand and clay, in constantly varying percentages of each. From the results of these tests a chart was made on which profiles of the various strata were shown. This made it possible to proceed with some degree of certainty with the underpinning operations.

The underpinning methods now in use are particularly worthy of note as they practically insure the buildings against future settlement. In brief, they consist of forming grillages under the present shallow foundations, and resting these grillages on 14-in. steel-encased concrete piles, each pile being tested with an applied load equal to from 1½ to 2 times its ultimate building load. The encasing steel shells, which are sectional, are driven by means of hydraulic jacks, and, after being cleaned out and concreted, are immediately tested. The building load is later transferred from the grillage to the piles. Tests of these piles have shown that, even when filled with sand, they are capable of sustaining loads greatly in excess of what such piles would ordinarily be expected to support without undue settlement. An attempt is being made to determine the actual load transferred from the grillage to the piles by measuring the deformation of auxiliary I-beams placed at the side of the piles while the load is being transferred. Satisfactory results are being obtained in this manner. The contractors on this work are to be commended for their successful attempt to place underpinning operations on the basis of certainty of results, as the element of uncertainty has heretofore been great in this class of work.

ROADS AND STREETS

Concrete Pavement at Park Ridge, Ill.

(Contributed.)

A reinforced concrete pavement has just been completed on Prospect Avenue, Park Ridge, Ill. This pavement is 21 ft. over all, or 20 ft. between curbs, and is about 660 ft. long.

The mixture was 1:2:3, reinforced with steel wire mesh. The pavement is 8 ins. thick at the center and 5½ ins. thick at the sides. On each side an integral curb 6 ins. x 6 ins. was laid directly following the striking of the road surface proper, and a good bond was thus secured. The road was finished from the usual bridge with wood floats. Contraction joints were provided every 35 ft., and a single joint bar with a ¼ in. x 7 in. strip of felt attached was used. This joint bar is an angle in section with dove-tailed lugs and is manufactured in Chicago by the Universal Concrete Bar Co., 167 W. Washington Street. At the end of the pavement a corner bar manufactured by the same concern was used.

One of the novel features was the undulating effect secured in the pavement. The grades were established at level elevation. The inlet basins for surface drainage were built about 300 ft. apart. Summits one-half way between were located 8 ins. higher than the inlets. Since the curb is of uniform height (6 ins.) above the pavement, the elevation of the curb, while it conforms to established grade at the intersection corners or where the crosswalks are built, it varies from 4 to 12 ins. below the level sidewalk elsewhere. This takes care of the lawn and road drainage and presents a most pleasing appearance. During the cold nights the concrete was protected by a 6-in. layer of straw. This work was done by private contract for Fred I. Gillick, the subdivider, by O. E. Brooks & Son, cement contractors, Edison Park, Ill.

Method of Marking Paving Brick for Identification in Making Rattler Tests.

(Staff Abstract.)

The great difficulty of checking the rattler results of one sample of brick against those of an apparently similar sample chosen from the same kiln has caused testing engineers to wonder how the individual brick of a given sample would check against one another. Lack of means of identification after the brick came from the rattler has prevented more or less the investigation of this subject. A scheme of marking and identification recently tried out in the laboratory in connection with student work promises to be of use along this line. Figure 1 shows the scheme of marking. These marks are made with a diamond core drill. It is found that a hole one-eighth inch deep is usually sufficient. It will be noticed that the marks are located at the points of least wear on the bricks, thus preventing their obliteration. This location also is such as to be more or less free from the criticism that the marking weakens the brick, causing it to lose more in the test. It cannot be argued that the marking does not increase the loss; but it is contended that with proper location of drill marks, the increase in rattler loss is very slight indeed. It is further pointed out that in general this method is to be used in a comparative way and cannot therefore be seriously objectionable.

Extracts from an article in the "Iowa Engineer," by C. A. Baughman, instructor in civil engineering, Iowa State College.

General Description of Concrete Road Construction Methods in Wayne County, Michigan.

When the County Road Commission was created in Wayne County in 1906, a definite, systematic plan involving the improvement of certain logical routes was outlined covering a period of years. We do not take over a road as a county road until we are ready to proceed with its actual construction. At the October session of the Board of Supervisors we made our recommendations as to the roads we desire to take over as County roads, together with the amount of tax we desire levied which cannot legally exceed 50 cts. on a thousand dollars of the equalized valuation of the County for the preceding year. The cities and villages of the County contribute their proportion according to their assessed valuation, although no money can be legally spent in any city; money can be spent in the villages, but only after the village authorities have relinquished their jurisdiction over the road to be improved, and turned it over to the Board. The Board of Supervisors accept, amend, reject or alter our recommendations both in the matter of roads to be improved and of the tax to be levied.

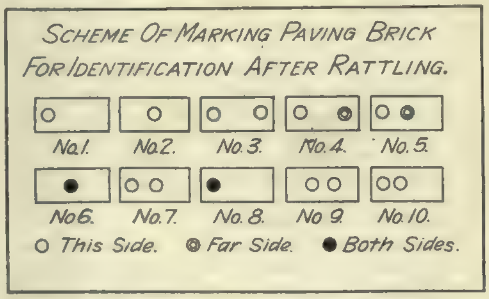


Fig. 1. Diagram Showing Paving Brick Markings.

After action by the Board of Supervisors determining upon the roads to be improved a record is put into our minutes by an aye and nay vote setting forth our determination to take over the road as a County road; the road is given a name, usually the one by which it is commonly known; that portion of our minutes showing our determination to adopt the road is published for three successive weeks in some newspaper circulating in Wayne County, and notice is served upon the officials of the township in which the road is located setting forth the above facts. When this action has been properly taken the jurisdiction over the road passes into the hands of the Board of County Road Commissioners which involves the authority to improve, regulate and maintain it.

A survey of the road is then made, plans and profile prepared, and these together with specifications and application for state reward are filed with the State Highway Department. Following the provisions of the County road law bids are asked for by advertising for the construction of the road (a purely perfunctory proceeding, as we have not contracted nor have any proposals been received for the construction of any road for several years past). When the bids are received, we have the option of accepting the lowest one and awarding the contract for the work to that bidder, or of rejecting all the bids, and doing the work ourselves under the day labor plan.

As soon as weather conditions will permit in the spring, and after the road has been staked out, we prepare and shape the subgrade, doing the major portion of such work with scarifiers and graders, and hauling power for which is furnished by steam tractors or rollers. Careful attention is given the grade to eliminate soft spongy places, and a ten-ton roller is used to roll it hard. To produce a good concrete road, thorough drainage is necessary in addition to a good subgrade. Both proper grade and drainage are difficult to cope with in Wayne County as the County for the most part is flat and situated in a valley not easily drained. The subsoil is largely of heavy, sticky clay with some loose, deep sand.

Our great problem has been in getting the materials on the subgrade, and various plans are followed on the different roads, due to varying conditions. On long hauls we use an industrial railway to transport all materials from the point of receipt to the point of construction. This outfit consists of a seven ton, 30 H. P. locomotive, sixty 1,000 double side V-shaped steel dump cars, each of 1½ yard capacity, and eight 16-ft. flat cars, all of 2 ft. gage. The track is furnished in built-up units, 15 ft. in length, consisting of steel rails fastened to steel ties. A turnout may be laid wherever needed by replacing a section of track by a switch or curve, as this is also furnished in 15 ft. lengths and of such radius that locomotive and cars will readily pass through. Two men can handle a section of track weighing 275 lbs. (We have two outfits of this character.)

Of course it is not necessary to turn the engine around as it pushes as well as pulls the load. The average train consists of thirty loaded cars, though as many as forty-two cars have been hauled.

Materials for the work begin to arrive before actual concreting is in progress. These are immediately unloaded by a clamshell bucket and thrown into stock piles. After concreting has been in progress, the materials are unloaded directly from the railroad cars to the steel dump cars and transported to place. The unloading crew consists of four laborers, an engineer, and team and teamster. The team hauls seven loaded cars to the siding where trains of thirty cars are made up. Whenever shipments are delayed the stock pile is resorted to for materials. Work is started at the end farthest away from the railroad switch. Five miles per hour is the average set speed including time for coaling and watering. The actual running speed en route is from eight to ten miles per hour.

There is no danger of dumped materials falling back upon the track, as the center of the pile is about 3 ft. from the edge of the nearest rail. Two men are able to tip a loaded car body. Materials are readily measured in the cars and distributed along the road at such intervals as to best meet the requirements of the mixer. The aggregates are loaded into the dump cars, the cement in any available cars, and expansion plates, asphalt filler and other necessities on the flat cars. Coal for the mixer is likewise brought to the site over the railway. As concreting progresses the haul becomes shorter and the track is taken up. These rail sections are transported to the loading point on the return trips of the train.

The tracks for our industrial railway can be laid on any surface over which transportation of any kind is at all possible. Rainy weather and muddy roads do not impair the efficiency of rail haulage, nor is the load too heavy for the ordinary highway bridge. A factor of much importance is that very little hauling space is required. When necessary the track can be laid on the berm of the road, so that it is possible to haul material either in the same direction as the concreting is proceeding or else in the opposite direction. The railway, too, is practically independent of labor conditions, as one engineer and two brakemen make up the entire crew. Although the unit rail sections provide an easy method of crossing highways and steam and electric lines, and the clearing of these when necessary by removing the rail sections, it is not always possible to obtain permission to make such crossings.

Where the use of an industrial railroad is not feasible we use a combination of team and engine hauling. Teams work economically on short distances, but weather conditions at times are a handicap, and at certain seasons of the year the demand is so great for them generally that they are difficult to secure. Our traction outfits are also handicapped by bad roads, rainy weather and the limited speed which they are capable of attaining. Road rollers furnish the motive power largely for hauling wagons, each of which holds seven tons of material. Over earth roads one wagon is usually all that can be drawn. When, however, a concrete road is available for hauling, six wagons containing a total of forty-two tons of material are made up into a train and hauled by one 10-ton roller. The crew of one of these trains consists of an engineer and a fireman. Our hauling operations involve the use of two industrial outfits, eight traction outfits and from one hundred to one hundred fifty teams.

One man on the grade has charge of the dumping of material and he is furnished with the following table in order that the material may be properly placed to minimize rehandling.

The foreman in charge of the yard is also furnished with a table of quantities, Table II showing amounts required on different widths of roads so as to avoid surplusage at a given point:

Shoulders of crushed stone or gravel, whichever is the more available, are built three to seven inches thick and three to four feet wide on each side of the concrete; on many roads additional width of earth shoulders is built. This work is not started until after the road is at least four weeks old.

TABLE I.—MATERIALS TO BE PLACED PER 100 FT. STATIONS.

Width of metal.	Bbls. cement.	Yds. gravel.	Yds. sand.	Wagon loads. Cement.	Gravel.	Sand.
12 ft.	45	26	13	4	20	10
15 ft.	56	33	16	5	25	12
16 ft.	60	36	17	6	27	13
18 ft.	68	39	20	6	29	15

Cement—45 sacks to 1 load (when team hauling is used).
Gravel—1⅓ yds. to 1 load (when team hauling is used).
Sand—1⅓ yds. to 1 load (when team hauling is used).

During the past year most of our work has been carried on well away from towns where suitable quarters could not be obtained for the men, so we provide sleeping and eating quarters in tents along the road. The men obtain food from the nearest town and cook their own meals, while the water supply for the roads usually serves as well for the men. The mixer crew's quarters are kept at sites a convenient walking distance from the work, and the men unloading and transporting materials live in tents pitched close to the railroad siding.

Three concreting crews were maintained in the field during the past summer and to each of these crews is attached a grading crew, a shouldering and ditching crew, an unloading outfit, and a culvert crew. An additional bridge and culvert crew was also kept busy building bridges and culverts over roads previously improved. All work is specialized and machinery is used wherever possible since man and horse labor are scarce and expensive in the country districts during the road-building season. Many little economies and labor-saving devices have been worked out which increase both the quantity and quality of our work, and our whole aim is to produce a durable, dustless road at cost for the people of Wayne County. The accompanying pictures give a general idea of our methods.

Extract from Ninth Annual Report of the Board of County Road Commissioners of Wayne County, Michigan.

TABLE II.

Board of Wayne County Road Commissioners—
Edward N. Hines. William F. Butler. John S. Haggerty.

1 cu. yd. pebbles	1.4 tons	1 carload pebbles	35 tons
1 cu. yd. sand	1.25 tons	1 carload sand	44 tons
1 bbl. cement	0.19 tons	1 carload cement	36 tons

Width of road.	Pebbles Cu. yds.	Tons.	Carloads.	Sand Cu. yds.	Tons.	Carloads.	Cement Bbls.	Tons.	Carloads.	Quantities.
12 ft.	1,369	1 916	55	684	855	20	2,396	455	13	....
15 ft.	1,711	2,395	69	855	1,069	24	2,995	569	16	....
16 ft.	1,825	2,555	73	912	1,140	26	3,194	607	17	....
18 ft.	2,053	2,874	82	1,026	1,383	31	3,594	682	20	....

The above amounts are for one mile of road.

WATER WORKS

Some Intangible Values in Water Systems, with Special Reference to the Water Right.

In no subject with which the writer is acquainted has there been such confusion and have there been so many attempts to obtain a result from theories more or less baseless than in the realm of intangibilities. All that the writer wishes to do is to refer briefly to some particular phases of the subject. To evaluate a property involves more than the mere stock-taking. An established business which has been produced by energy and enterprise is not an inert object, but, on the contrary, is a living commercial organism which cannot be subjected to the measuring yard and to the weighing balances in order to obtain its intrinsic value. To solve the problem: "What is the value of a property?" requires the most logical reasoning, involving law, commercial knowledge, mathematics and technical science; and, in addition to all, that very rare human endowment known as common sense.

I am more or less familiar with the valuation of water works. In my professional activity I have been brought face to face with the valuation of water works properties, and I have realized that the revenues accruing from an established business of this kind are usually modest. I mean by this, that an equal capital invested in any other enterprise of a commercial nature would have shown better results at the end of 20 or 30 or 40 years than the hazardous business of providing water for a growing community.

Take as instances these: Where water is procured from watersheds it requires large investments of capital not only for present utilization but for the provisions of future growth. In the case of wells it is extremely difficult to know beforehand where to find an abundance of potable water. I have known a well to be bored to a depth of nearly 1,600 ft. at great expense, and after a few years of utilization it was practically abandoned and other sources were developed. Investments of this kind cost money, and it goes without saying that men who will follow an enterprise of this character and attend to its business without flinching are, indeed, public-spirited men, because the money could have been invested to better advantage without the personal annoyance that usually goes with a public service plant. In almost any other enterprise an owner may stop after reaching a certain industrial output, if satisfied with its results in a monetary way, but in the water business, having once started it, the owner must go ahead at all hazards, whether inclined to do so or not.

If ever a tribunal was needed to pass on public utilities it is in the case of water supplies, because an intricate study is required to get at the bottom facts and to pass judgment on the evidences which are not clear at first sight. Boards of trustees or supervisors have neither the time nor the training to do so. The public utilities commissions have before them a noble work, and the evidences of their activities show that it is the desire of these commissions to get at all the facts and to decide upon their merits in a systematic and painstaking way.

It is usually not difficult to evaluate a physical plant—that is, to take stock of the real estate, machinery, pumps, tools, pipe system, reservoirs, and so on, and to sum up their values, making allowances for depreciation in accordance with the age of the article valued. We may differ as to methods of depreciation, but we shall finally arrive at a physical value which will be acceptable all around. If engineers differ on this, their differences are usually within such reasonable limits that an agreement will be reached without friction. The moment, however, that we get to the so-called intangible values we enter a realm that most of us are inclined to call speculative, and all theorizing on the subject leaves us just as far from a definite solution as ever, for a theory is sound only as long as the premises underlying it will bear any and every attack. It seems almost unreasonable to expect a theory to be applicable to every case of this kind.

There are two principal intangible values in water works utilities; one is called "Going Value" or "Development Expense," and the other "The Water Right." Let us refer briefly to the second.

THE WATER RIGHT.

Frequently we are asked the question: What is the value of a water right? I have been asked very often: "What do you mean by this; the franchise?" No, I am not going to take up the value of a franchise, because that does not play an important part in water works properties, but I shall define the water right as the *specific value* of watersheds, wells or other water sources because of their particular adaptability to obtain therefrom water for public use. It seems reasonable that if the exclusive right to take water for public purposes from certain localities rests with the owners of the water works, then the right has a distinct value and allowance should be made for it. A recent decision of the Supreme Court of the United States has fully justified the existence of a water right in the case of the San Joaquin and Kings River Canal Irrigation Co. vs. the County of Stanislaus, Cal., and it becomes necessary, therefore, to make an allowance for the value of the water right in the case of the water companies. What method have we of estimating this value?

One method which has been applied is this: A comparative estimate is made of what it will cost to supply water from the nearest other available source; the difference between this and what it does cost to supply this water from the source in actual use is capitalized, and the capital is applied to the value of the property if it be in its favor. Pure and unpolluted water in abundance and under an adequate head adds to the health, comfort, safety, wealth and pleasure of a community. If the source of it is in absolute possession of an owner, then he may in all justice be credited with a certain value which this particular supply has above that of some other supply not so attractive, advantageous or economic.

The difficulty that confronts us, however, is to know when this comparative method is applicable. Its results appear to be fair enough in cases where the other available source lies within a reasonable distance of the utilized source, or where the difference in cost between the two remains within economic limits. No one would make use of the results of this method, however, in any case where the cost difference reaches such large proportions as to look unreasonable at a glance, and the statement is indisputable that if the comparative method is not applicable except in cases where it happens to fit it ceases to have any value whatever. Again, there may be no other source that can be substituted for the one under consideration, and you will have to admit that in such an event there is no other alternative than to make an allowance for the water right according to our best judgment, based upon personal experience and precedent. And so it is with all theories; they are applicable to certain conditions but not to all conditions, and it is, after all, the man behind the theory who will know when and how to use it.

I am inclined to think that you will subscribe to this statement; but let me ask this question: Can we make an allowance if we do not make use of something to measure that allowance with, and is not that tangible something, after all, the quantity of water obtainable under the given conditions? As soon as we agree upon the value of water as a product, then the rest of the problem is comparatively simple.

Take the case of a desirable watershed which is to be evaluated for a water supply. It may be already in use for this purpose or not, as the case may be. Assuming that the land is particularly suitable and that there is a demand for its water, then a specific property value is reasonable because of this adaptability. The land in question may be valueless for anything else, but if its topographical and hydrographical conditions combined are such as to expose a comparatively large area to a copious precipitation, with a liberal and unpolluted run-off, which may be caught and stored in natural basins of voluminous content, then it goes without saying that such land has a "water value." And, based upon the human conception of value, it is not unreasonable to maintain that the more ideal the conditions of run-off and storage the greater the value of the land for this purpose.

While the water itself, as a corpus, may be as free as the air, it enhances the value of the land upon which it falls. This is all the more apparent if this water may be prevented from running away—that is, if the topography of the country admits readily of the construction of dams. It is difficult to separate what may be called the "water crop" from the storage facilities, because even an abundance of this element is more or less valueless if a portion of it cannot be gathered and held in reserve for the season when there is no influx, and when there will be a greater demand for it. On the other hand, neither has the storage facility as such any value if there be not sufficient water to fill a reservoir which may be absolutely ideal. These two features go together. The value attached to a property of this kind lies, therefore, in its practicability to store water, water of the rainy season's abundance, which value would not exist if the element to fill the storage reservoir were lacking. The ability to husband this water for a great public use is the pre-eminent factor of value, and in order to rate this value by some standard or measure it is convenient to assume a unit embodying both volume and time, like the miner's inch, or the second-foot, and to set a certain price upon this unit, which is then applicable to the number of million gallons per day which may become available for use, and for which there must be a demand. To argue that such a thing as a value does not exist until there is a complete development of a water system to enable one actually to withdraw the daily quantity for which a value is sought is begging the question. The facilities to store run-off are there before the dam is built, and the value of the property lies in the possibilities of this development. This does not become remunerative, to be sure, until the installation is made, but the value is there, nevertheless; it is an inherent one, and is embodied in the fact that the property is certain to be remunerative for water purposes at some future time. Water is not a wild animal, nor a domestic animal; it is an element which an act of God bestows upon us. If in nature's beneficence it falls upon a certain area in great abundance; and if it may be prevented by artificial means, aided by a favorable natural configuration of the drainage-way, from running to waste; and if by retaining this water it secures for itself an immediate demand as one of life's necessities by the human family, then the owner of the land should be recompensed for the possession of these favorable conditions. The value of the land must be based on the highest use to which it can be put, and if a crop of water is its highest use, then our valuation must assign that as its limit.

Again, I wish to reiterate that no attempt is made to value the water as such, but to place upon the land a value which it has by reason of its aquatic productiveness, which is measurable by the quantity which may be developed for human utilization for every day of the year, even through critical periods deficient in the usual or normal amount of rain. With the necessary physical data in our possession, this quantity is determinable within reasonable limits, and, having established it, it remains but to agree upon the value of some accepted standard of water measure, like the miner's inch, to determine the value of the land for water supply purposes, using the quantity capable of development as a scale or gage.

The resulting value is not one applicable to the area per acre, but it is a lump sum independent of the dimensions of the watershed. If a watershed of 5,000 acres produces the facilities to husband 5,000,000 gals. of water a day, its value will not be any greater than that of a watershed of 1,000 acres if the latter is capable of developing the same quantity by reason of a more copious rainfall and a more bountiful run-off. The value always lies in the capability of developing for consumption a given quantity of water in a given time, and not in the areal extent of the watershed. We may apply the lump sum value to a value per acre for convenience sake, but such acre-value will hold good only for the particular watershed under consideration and for no other.

What is the reasonable value of a water unit? The solution of the problem hinges upon this answer. Is it possible to agree upon what this measuring unit should be worth, but is it not a fact that the value of water, like everything else, is a matter of supply and demand? In certain sections of the country where water is rare, say, in the southern part of California, the value of this commodity must be greater than in the northern part of this state, where the rains are plentiful and the run-off is correspondingly large. Who is going to place a standard on the value of the water right as between one community and another? Now, there again is where the experience of the appraiser comes in, and the statement that the allowance should be made which seems fair in the judgment of the appraiser remains indisputable; this allowance, however, must be based upon something it cannot be arbitrarily assumed, and this base should be the value of the water unit for a certain locality. The expert should use his judgment here.

In Judge Farrington's decision a value of $60,000 for each 1,000,000 gals. per day was placed on the property in the suit of the Spring Valley Water Co. against the City of San Francisco in 1903. This is at the rate of $969 a miner's inch, of which 40 go to the cubic foot per second.

To show how much experts' opinions may differ as to this value, the case of a city in Los Angeles County may be referred to, which was tried before the Railway Commission. The opinions of engineers as to the value of a miner's inch of water differed, I think, between $1,500 and $3,800. Now, it is extremely difficult for a commissioner to pass upon a value where the opinions of experts are so conflicting, and the then president of the commission, Mr. Eshleman, allowed a value of $2,000 per miner's inch, with the following explanation, which appears to be absolutely to the point:

> Some of the problems of valuation are insoluble on any legitimate basis, and the only thing a public official can do is to attempt to arrive at that result which his conscience tells him is fair, always limited by what he thinks higher authority will permit, which higher authority in many instances, we are led to believe, does not give the conscientious thought to this subject which it should. Still I could find a value as low as $1,000 per inch and believe it would be justified from the evidence, as well as a value close to $4,000 per inch; and on the rule that where the evidence is conflicting the determination of the administrative body will not be upset, either of these valuations would stand, yet I believe from all the evidence in this case, a valuation of $2,000 per inch is all, if not more, than justice demands and is amply supported by the evidence.

One of our prominent engineers, one experienced in water matters, in a case in this part of our state, tried before the Railway Commission, admitted a value of $1,000 a miner's inch, or $77,400 per 1,000,000 gals., per day, based on the ratio of 50 ins. to the second-foot. He reasoned, however, that this value does not become effective until the water is actually developed and available for transmission to consumers. I do not agree with this reasoning, because it loses sight of the fact that the development would not be possible unless the facilities for developing the water as a commodity are actually in existence, and that without these existing facilities there is no value to the development. When is the time that this value sought actually takes effect? Just as soon as development is contemplated the water-value of the land begins its real existence, which is based upon the expected future utilization. If in 1919 4,000,000 gals. a day will be drawn from storage, then the value for 1919 may be fixed for this utilization. If in 1920 the quantity become 5,000,000 gals. a day, then the value has increased to that extent. If the ultimate limit of supply of, say, 10,000,000 gals. a day may be reached in 1930, then the value of 10,000,000 gals. may be counted upon in 15 years, beginning with the year 1915. We may discount this value by putting aside in 1915 a sum of money which, at a certain assumed interest, compounded annually, will grow at such a rate as to keep pace with the increased utilization and the corresponding increase of the water-value of the property. This line of thought is perfectly logical, for we may start with zero from the time of the first inception of water development and carry out the valuation to the greatest possible limit of the property by discounting the final and ultimate value for the period which it will take to develop and to bring the ultimate limit of supply into actual use. The rate of interest to be compounded may be fixed at 4 or 5 per cent, or more, as it may be agreed upon in the estimate. We have here an available method applicable in many cases, perhaps not in all. The principle pointed out is to establish the value on the basis of the water-producing capabilities of the property and its storage facilities, and to the extent of which this water may be in demand for the intended supply. There are other methods that have been proposed and that have been made use of, but when they are analyzed they all revert again, just like this one, to the skill, the judgment and the common sense of the appraiser.

Let us take the case of a bountiful well which supplies a town with all the water it needs. If it were the only well of its kind, one that could not be replaced by any other in the town which is absolutely dependent upon it, then the specific value of this well as a water supply source must be determined in some way, for it goes without saying that it is worth more than its mere boring and installation. We recognize here a very valuable water right. On the other hand, if this well could be replaced by boring another one in its neighborhood just as bountiful and satisfactory, then the specific value does not exist and the water right is worth nothing.

Another method, actually applied, is to compare the domestic utilization with that of irrigation. This, in some localities, may be reasonable and appropriate, but it is extremely difficult and complicated and it, more than ever, requires the judgment of the appraiser and great experience in the value of irrigation works and their output.

Now that I have come to the end of the subject on this occasion, you will probably tell me that I have not enlightened you very much and that we are not much wiser than we were before I started in. I shall not disagree with you there, and I told you in the beginning that I was not going to solve this problem, but that my object was to arouse your interest in it. I desire to bring out this point, however, that although it may be conceded that the water right should be determined by the skill of the appraiser, based upon his experience and judgment, the quantity of water which can be developed and which will be required for domestic and other usages is, after all, the measuring gage for the estimate. The appraiser's professional ability will be called into play to determine the value of the water unit for the particular locality with which he may happen to be concerned. To do this thoroughly and with justice to those interested, treating each individual case that may be brought before him upon its own merits, and making due allowances for all the local conditions and environments that may have a bearing or an influence on the intangible value to be sought, is indeed a very serious duty.

ACKNOWLEDGMENT.

From a paper before the League of California Municipalities by Otto von Geldern, Consulting Engineer, Pacific Bldg., San Francisco, Calif.

Design and Construction of World's Highest Reinforced Concrete Water Tower-Tank, Middleboro, Mass.

The present article describes the design features of and methods of constructing the highest reinforced concrete water tank yet built. This structure, which has a capacity of 500,000 gals., was recently built for the city of Middleboro, Mass. The tank has a hemispherical bottom and is supported on a cylindrical tower. The total height of the structure is 172 ft.

Local conditions required the storing of 500,000 gals. of water at an elevation sufficient to meet the combined demands of domestic and fire service. The most economical type of structure fulfilling the requirements was a tower-tank, an elevated tank supported on a tower, and the only practicable materials for building such a structure are steel and reinforced concrete. A steel tower-tank was estimated to cost about $2,000 less than one of concrete, but the cost and inconvenience of frequently painting it inside and outside, a safe life of not over 30 years, its unsightly appearance, and other considerations made it apparent that if a satisfactory watertight concrete tank could be constructed it was greatly to be preferred to a steel structure. The difficulties, however, of designing and building such a structure, especially of the proportions required, were many and vital. The success or failure of a reinforced concrete water tower-tank, perhaps more than in any other engineering structure, depends to a large degree upon each individual connected with the work from the time the concrete materials are selected until they are placed. With due regard for the difficulties involved it was decided to build the concrete structure here described. The essential details of the design are shown in Fig. 1.

Foundation.—The foundation extends 7 ft. below the finished grade and rests upon a fine, well compacted sand, the safe bearing power of which was determined experimentally by loading a timber set at the elevation of the bottom of the foundation. At a loading of from 1 to 3½ tons per square foot, the settlement was uniform and slight, being only 1/32 in. for each additional ⅛ ton; but 4 tons per square foot produced a relatively large settlement—5/32 in. for the last ½ ton. The footing area is such that with the total dead weight of 4,485 tons the soil is compressed to the extent of 2.38 tons per square foot. The wind load was computed from an assumed velocity of 70 miles per hour, the equivalent of 30 lbs. per square foot on a vertical projection of the structure, which with a full tank adds a maximum of 0.68 tons, thereby giving a total maximum pressure of 2.96 tons per square foot. Although the resultant of the wind pressure is slightly more than doubled with an empty tank, it is more than offset by the reduction in the dead-weight of the water, so that the maximum mentioned represents the worst condition.

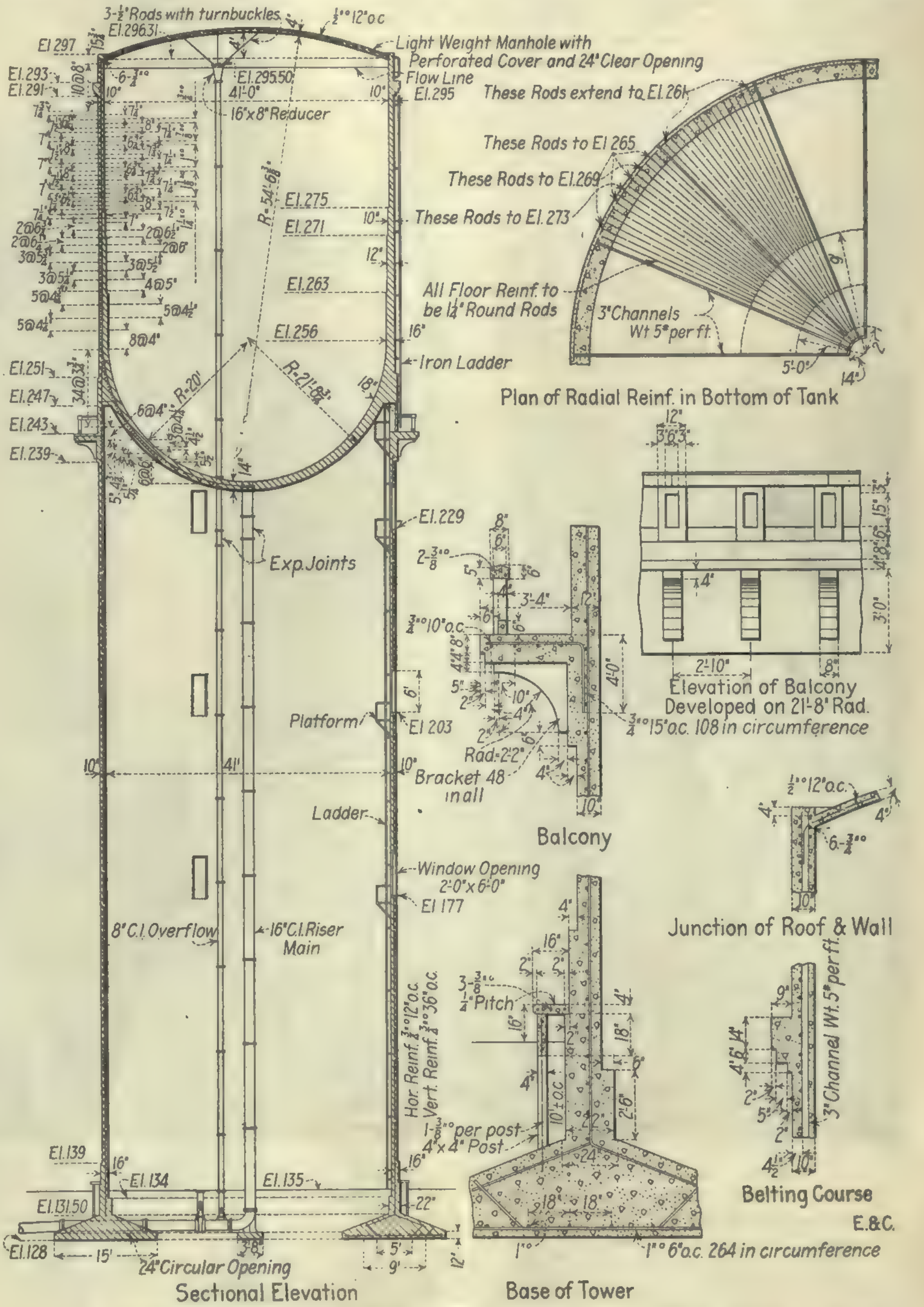
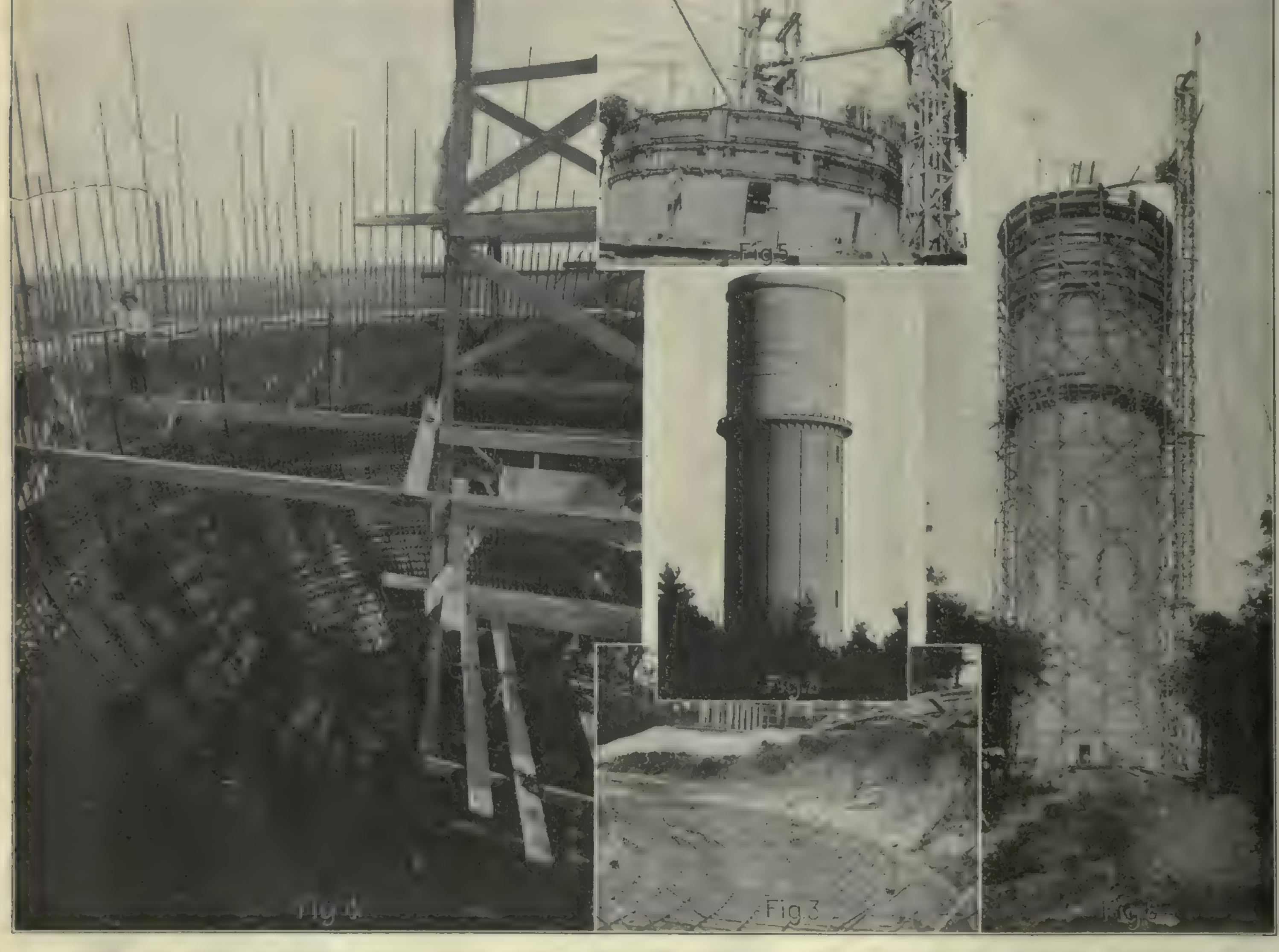


Fig. 1. Essential Details of Design of New Reinforced Concrete Water Tower-Tank at Middleboro, Mass.

Tower.—A cylindrical tower was adopted in preference to a number of columns, because structurally it seemed a safer type of support, would probably be more economical to construct and could be made to present a more pleasing appearance. Considerable study was given to the architectural side of the problem in order to produce at a moderate cost a structure that would be, to some extent at least, an addition to the landscape. The completed structure is shown in Fig. 2. The plain aspect of a simple cylinder is relieved by the addition of twelve 4 x 24 in. pilasters, which were assumed to take their proportion of the load. The appearance of solidity at the bottom is accomplished by a concrete seat extending around the base of the tower. A balcony of reinforced concrete with bracket supports, pannelled posts and railing, the floor of which is 108 ft. above the ground, furnishes a suitable point of vantage for inspecting the outside of the tank and provides a visual starting point for the tank proper. The thickness of the tower wall between pilasters is 10 ins. and the greatest compression due to the dead load is 483 lbs. per square inch, increased to 631 lbs. by a 70 mile gale. Entrance to the tower is through an iron door. Light and ventilation are provided for by means of twelve windows, three of which are arranged to open. An iron ladder within the tower leads from the ground to the balcony through an opening in the wall of the tower at the elevation of the balcony floor. Another iron ladder on the outside of the tank connects the balcony with the roof above. A 16-in. cast-iron flanged pipe with expansion joint, rises from the ground and enters the tank at its center. An 8-in. overflow and drain discharges at a safe distance from the tower.



Figs. 2-6. Views of Middleboro Water Tower. Fig. 2. Completed Structure. Fig. 3. Steel Reinforcement in Foundation of Tower. Fig. 4. Steel Reinforcement in Hemispherical Bottom of Tank. Fig. 5. Second Ring Concreted, First Ring Form Removed and Erected Ready for Concreting Third Ring. Fig. 6. Structure Nearing Completion Showing Outside Staging and Erecting Tower.

Tank.—The tank proper, 41 ft. in inside diameter and having a depth of water at its center of 59 ft., has a capacity of slightly over 500,000 gals. The bottom of the tank is a hemispherical bowl hung at its rim from the wall of the tower, and marks the first application of this type of bottom to an elevated concrete tank, although for many years it has been used with success in elevated steel tanks. The bowl itself has a capacity of 125,000 gals. The vertical wall of the tank varies in thickness from 10 ins. at the top to 16 ins. at the bottom and the hemispherical bowl from 18 ins. at its connection with the tank wall to 14 ins. at its center. The thickness of concrete is such that without any assistance from the steel reinforcement its stress in tension is about 250 lbs. per square inch. The tensile stress in the steel acting independently is approximately 14,000 lbs. per square inch; and with both materials acting in conjunction the computed stresses are 215 and 2,150 lbs. The tank is covered to guard against the growth of algae, not uncommon in a filtered water supply exposed to light, and to prevent freezing. The roof is a concrete dome 4 ins. thick, 41 ft. in diameter and with a rise of 4 ft. at the center. The thrust is carried by steel reinforcement embedded in the top of the tank wall.

Concrete.—Whitehall cement from the Whitehall Portland Cement Co.'s mill at Cementon, Pa., was used throughout the work. Sampling and testing was done by the New England Bureau of Tests of Boston, samples being taken as loaded on the cars which were then sealed. The tests of the 12 carloads required, aggregating 8,100 bags, were unusually uniform and satisfactory, especially for the essential qualities of strength, fineness of grinding and slow initial set. The sand and coarse aggregate were obtained from a gravel pit about 1¼ miles distant, screened by hand at the pit to give the sizes required. The sand was tested for tensile strength as compared with standard Ottawa sand and gave an average of 112½ per cent thereof. The gravel stones were washed to remove a slight coating of clay and cemented sand. The proportions of the concrete for the foundation are 1 of cement, 2½ of sand and 5 of gravel stone; for the tower 1:2:4; for the hemispherical bottom and wall of the tank to elevation 279, 1:1:2; from elevation 279 to 293, 1:1½:3; and above elevation 293, including the dome roof, 1:2:4. The relative amounts of sand and stone were somewhat varied to provide the densest practical mix; the percentage of cement to the sum of the aggregates, however, remaining as stated. The amount of concrete used in the work was 1,120 cu. yds.

Steel Reinforcement.—"Havemeyer," round, deformed, open hearth, hard grade reinforcing rods furnished by the Concrete Steel Company of New York, and bent at the rolling mills, were used in the structure. These were tested at the Carnegie mills by the New England Bureau of Tests, a large proportion of which were 1¼ in. and developed an ultimate tensile strength of 120,000 lbs. per rod. Laps were 40 diameters and in addition each joint in the tank was secured by two cable clips. The horizontal rods of the tank were firmly secured in their true position to 16 vertical 3-in. channels drilled to the exact spacing of the rods. A total of 160,000 lbs. of steel reinforcement were embedded in the concrete. The foundation reinforcement is shown in Fig. 3 and the reinforcement in the bottom of the tank in Fig. 4.

Forms.—Steel forms made by the Blaw Steel Construction Co. of New York were used for the outside surface of the tower and tank, as shown in Fig. 5. Two complete rings were provided, each 4 ft. in height, at a total cost of $600. Two 4-ft. rings of wooden forms were used on the inside at a first cost of $400. The use of steel forms was justified both on account of a considerable saving in time and expense in erection and because of the resulting smooth, dense surface, requiring very little finishing and less susceptible to the action of the elements. The hemispherical bottom was cast between forms consisting of wooden ribs covered with sheet iron.

Joint Between Old and New Concrete.—For the tower, in order to secure a bond between the successive rings of concrete, the forms were overfilled about ¼ in., which surplus containing the laitance was screeded off previous to the initial set of the concrete, following which as soon as the final set occurred the surface was wire-brushed to expose slightly the stones and immediately before placing fresh concrete, washed with a hose stream and coated with a neat cement grout. For the tank, in addition to the above precautions which were carried out with especial care, there was cast in the old concrete a continuous triangular groove, about 1½ ins. in depth, running around the wall near its center and subsequently filled with grout and concrete; to still further minimize the chances of leakage at each horizontal joint an uncoated steel plate or dam of No. 14 gage metal 10 ins. wide, turned over 1 in. at each edge to form a channel and bolted together to form a continuous watertight stop, was embedded 4 ins. into the old work, thus leaving 4 ins. extending up for a bond with the new concrete. The cost of 12 channel rings in place was about $400.

Progress of Work.—Ground for the foundation was broken on April 26, 1915. After the excavation was completed the earth was wetted and thoroughly compacted by rammers, following which a 2-in. layer of concrete was placed over the entire surface to serve as a working base for the erection of the steel reinforcement and as a suitable medium upon which to place concrete. All concrete was mixed in a 15 cu. ft. Smith mixer operated by steam and discharging into a bucket elevator which at the desired height was tripped and dumped into a receiving hopper, whence it was conveyed by gravity through a sheet steel chute to a central distributing hopper, and finally by means of eight movable wooden chutes was deposited between the forms around the circumference. A view of the concreting plant is shown in Fig. 6.

The concrete materials were brought to the mixer in dump cars running on an inclined industrial railway and pulled up the incline by a cable attached to a drum of the hoisting engine. The average rate of progress on the tower was a 4-ft. ring each alternate day, with a marked increase in efficiency as the work advanced. The actual time required for concreting was about 4 hours to each 4-ft. section. The bottom of the tank, including 4 ft. of the wall immediately above the tower was poured continuously. Concreting began at 5 a. m. on Sept. 9, and the last batch was deposited at 4 a. m. the following day, during which time about 130 cu. yds. of 1:1:2 concrete were placed. Five days elapsed before the following section was in place and two more days before the succeeding ring was concreted. Four days were then spent in preparing for future operations, so that when concreting began again on the fifth day, the following eight successive lifts were made in nine days and it was only due to a violent gale of about 70 miles per hour that operations had to be suspended for one day. The roof of the tank was poured on Oct. 13.

Watertightness.—As soon as the forms were removed from the inside of the tank and the staging from around the outside, the surfaces were cleaned and so far have received no further treatment, although after the tank has been fully tested and accepted as satisfactorily watertight, the question of waterproofing the inside and damp-proofing the outside surface will be considered. Coincident with the removal of the outside staging around the tower, the surface was cleaned and washed with a brush coat of neat cement grout, mixed in the proportion of 1 of cement to 1 of water. The cost of cleaning and coating the 14,000 sq. ft. of surface was $64, or about 0.46 ct. per square foot. In connection with the subject of watertightness, the following clause from the specifications may be of interest:

> The concrete in the bottom and wall of the tank shall be substantially water tight at all times. Any leakage amounting to jets or visible seepage shall be repaired by and at the expense of the contractor and by methods approved by the engineer. Small damp spots, if few in number, which do not increase nor disfigure the appearance of the concrete, will be considered to meet the requirements hereunder. It is intended that the work shall be sufficiently waterproof that severe freezing will not at any future time threaten the integrity of the concrete and that the general appearance of the structure will not suffer through efflorescence or other disfiguring stains.

The work, including grading and cleaning up, is now completed, and it is hoped that water may be turned into the mains on January 1. The static hydrant pressure with a full tank will be 84 lbs. in the higher residential area, 104 lbs. in the business center and 120 lbs. in the low district along the Nemasket River, reduced by about 20 lbs. by frictional losses during an ordinary fire. For the year 1914 the population supplied with water was 5,000 and the average daily consumption was 320,000 gals., so a storage equal to a 36-hour demand is provided by the new tank.

ACKNOWLEDGMENT.

The structure here described was designed by Mr. George A. Sampson, Civil Engineer, Boston, Mass. The contract was executed by the Hennebique Construction Co. of New York City. The contract price was $23,140. Mr. Thomas F. Dorsey, representing Mr. Sampson, was resident engineer in direct charge of the construction work. Mr. Alvin C. Howes is chairman of the Board of Water Commissioners and is Superintendent of Water Works at Middleboro. The information here given is from a paper by Mr. Geo. A. Sampson before the December meeting of the New England Water Works Association.

The Water Works Operator's Interest in Epidemiology.

Epidemiology is a study of the factors influencing the transmission of the communicable diseases. Its scope includes the microorganisms causing disease, their means of transmission from one individual to another and of the opportunities that facilitate or hinder transmission. This knowledge may be effectively applied in disease prevention and eradication. The water works man is chiefly interested in the part that public water supplies may play in the transfer of infection. Typhoid fever is the most important and, in this country, is from a practical standpoint the only disease encountered which may be transmitted through water.

As is well known typhoid fever is an infectious disease caused by the bacillus typhosus. This organism always has its origin from the discharges of some previous case of typhoid fever or a carrier of the organism. From such sources of infection the typhoid bacillus may be transferred to susceptible persons through the routes of infection of contact, water, milk, ice cream, uncooked and cold foods, flies and some other relatively insignificant routes of infection. An inquiry into the prevalence of typhoid fever, therefore, has to consider the opportunities which have existed for the infection of these substances, consumed by the patients at the probable time of infection.

Public water supplies may be either continuously or intermittently infected with the typhoid bacillus. The course of supply may become contaminated from the sewage of other towns, from the sewage of the same city, from the waste of individual houses, institutions or factories, from privies situated directly on or over the banks of the source of supply, or excrement which has been deposited on the ground being washed into a water course by rain or by seepage. Or the supply may become infected through the temporary admission into the mains of water from a contaminated source at the time of some accident or emergency. Where infection is continuous the source of supply is heavily polluted with sewage the year round. Its effect is manifest by a very high typhoid fever case rate and death rate extending throughout the year, in other words as an epidemic of long duration. Where the infection is intermittent or temporary the disease outbreak appears as an explosive epidemic from two to four weeks after the temporary contamination occurred. Moreover epidemics due to temporary infection present certain distinctive characteristics. In a temporary infection of a water supply the infection is generally rather dilute, unless a grossly polluted source of supply has been temporarily substituted. The typhoid bacillus does not find water a favorable medium for its continued growth and multiplication and gradually diminishes in numbers until finally extinct. This characteristic is well known and is used in the purification of water by storage. The decrease in the numbers of the typhoid bacillus takes place more rapidly in the summer months than in the winter. Most large water-borne epidemics have occurred in northern cities, both in this country and Europe and nearly always occur in the spring, fall or winter when the water is cold. The number of cases developing daily shows a rapid rise, soon reaches a maximum and rapidly declines; in other words the epidemic is explosive. The contamination of the water is usually nearby, and the transfer of virulent organisms is fairly rapid.

CHARACTERISTICS OF WATER-BORNE TYPHOID.

In the investigation of a typhoid epidemic where the evidence collected indicates infection from a contaminated water supply we generally find something like the following. All or nearly all cases will give a history of the use of the suspected water at about the approximate time of infection for drinking, or have eaten raw vegetables washed in it, or used it in washing the mouth. In public supplies the infection will be distributed uniformly through the population regardless of age and sex and largely coincide with the limits of the water supply. Cases living outside the limits of the supply will usually be found to have used the water at school or place of business or elsewhere. When private supplies are infected the distribution of cases is generally localized and confined among those of a particular nationality, age group, sex or occupation, etc. These are but a few of the characteristics of a water-borne outbreak of disease.

While water-borne typhoid is of very common occurrence, yet it is not the sole or chief cause of typhoid and is playing a rapidly diminishing rôle in the spread of the typhoid bacillus. The greatest water-borne epidemics have over-shadowed other means of infection. The larger part of the typhoid fever prevalent is not water-borne. In 1908 Whipple estimated that 35 per cent of the cases were contracted from water, and at present the percentage must be much less. Typhoid fever may be excessively prevalent, even epidemic in a city having a water supply of a good sanitary character.

THE WATER WORKS OPERATOR'S DUTY WITH RESPECT TO TYPHOID.

Every water works superintendent should keep constantly posted on the current prevalence of typhoid fever in the city or town he serves, and at the first manifestation of an undue increase in the disease should insist that the local board of health institute an epidemiological investigation of the disease.

Furthermore every public water supply, no matter what its sanitary quality, should be equipped with either a hypochlorite or liquid chlorine sterilization plant, for continuous or emergency use. Then at any time, should emergency compel the use of water from a doubtful source, the health of the community can be safeguarded by sterilization of the water.

ACKNOWLEDGMENT.

From a paper before the Iowa Section of the American Water Works Association, by Mark F. Boyd, Epidemiologist, Iowa State Board of Health, Iowa City, Iowa.

BUILDINGS

Cranes for Factories and Shops.

(Staff Abstract.)

The traveling crane in its various forms represents one of the chief factors in cheapening production. It is also true that an improper installation of cranes, or an improper selection of types, is a serious handicap to any business. In the following discussion attention will be confined to cranes and hoists for use inside of the factory walls. Cranes of this type may broadly be divided in the following four classes.

TYPES OF CRANES.

1. Traveling bridge cranes which span the entire bay of the factory and travel back and forth throughout its length. These cranes may have one or more hooks, the latter being carried by one or two trolleys which move across the bridge.
2. Traveling wall or job cranes which project from one side of the plant and cover a limited space along the side in a manner similar to the traveling crane.
3. Swinging jib cranes which are supported on pivots at top and bottom and cover the area within a given circle.
4. Monorail hoists or beam trolleys which travel in one direction only.

TRAVELING BRIDGE CRANES.

Each type has its distinct advantages and disadvantages. In a moderate sized building where the work can be done with one, or at most, two or three bridge-type traveling cranes, these will be found efficient, fairly rapid and very economical as to power consumed.

As the length of the building increases, or the amount of work upon its floor increases so as to necessitate the installation of an increased number of bridge traveling cranes, we immediately encounter the factor of interference. When there is only one crane in the building we frequently find the men losing much time waiting for crane service. The introduction of more cranes may not overcome this loss of time, on account of the fact that where it is desired to transport material along the length of the crane runway one crane may have to wait a considerable length of time for the others to get out of its way so that it can proceed down the building. For a crane to travel approximately the entire length of the building necessitates driving all of the other cranes before it. In this case most of the crane men are usually idle and a considerable amount of power is consumed in transferring all the cranes to one end of the plant to make way for the one doing work. At the same time the men further up the floor may be waiting for crane service, even though the cranes are standing idle further down the plant.

Another serious problem which confronts us in the multiplication of cranes on one runway arises from the repair problem. When one crane burns out a motor and it becomes necessary to repair it the ordinary way is to run it as near one end of the plant as possible and shut it down, and this frequently locks up other cranes. Sometimes a trolley has to be repaired while the man remains in the cage operating the bridge travel motor to keep his crane out of the way of those engaged on each side of him. A practice of this kind means: in the first place a non-productive man in the crane cage; in the second place the use of electric current without accomplishing work, and in the third place a delay on the part of the repair men.

To overcome these repair difficulties some shops have been constructed with a crane hospital. This latter is simply a cross monitor provided with some means for lifting up one of the traveling cranes bodily so that the others may run under it. Usually the lifting device in a case of this kind consists of four heavy screws operated together. By means of these screws the disabled crane is hoisted into the hospital and repaired without interfering with the other cranes beneath it. This hospital overcomes one serious objection to placing a number of cranes on one runway, but it does not overcome the delays resulting from crane interference.

The crane interference can be reduced to a minimum by a proper arrangement of work on the floor, but even then the transportation of material the full length of the shop cannot be accomplished without interference.

There are two overhead carrier systems which are frequently installed under the bridge traveling cranes for shifting work the length of the shop without interfering with the bridge cranes. These are the monorail and the traveling jib crane. Figure I shows in plan and elevation the arrangement of the three systems. The travel of the crane hooks of a traveling crane across the bridge is always limited by the construction of the trolley and the larger and more powerful the crane the greater these limits. In other words, the distance of hook travel, *B*, across the shop is always less than the span, *A*, as shown in Fig. 1.

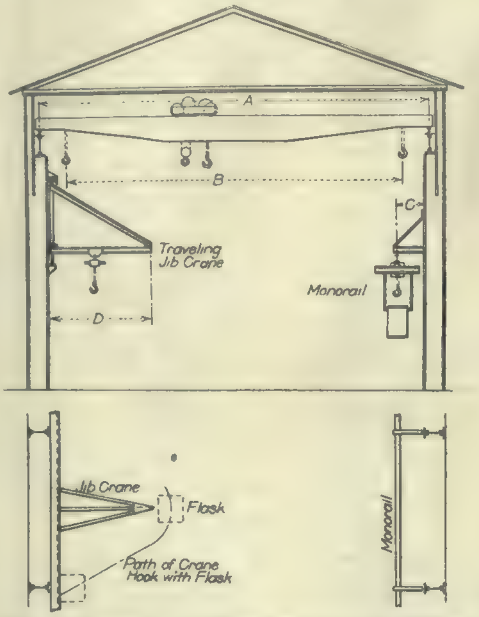


Fig. 1. Diagram Illustrating Use of Bridge and Jib Cranes and Monorail Systems.

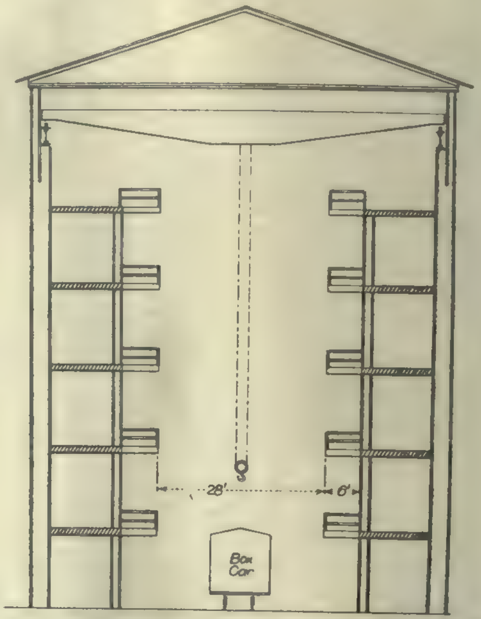


Fig. 2. Traveling Bridge Crane Designed to Serve Several Floors.

MONORAIL SYSTEMS.

A monorail may be supported along one side of the shop, the rail being placed at the distance *C* from the crane columns. It will readily be seen that under ordinary circumstances this distance *C* is largely lost space in ordinary crane service, so the monorail does not really cut off much of the active floor space available under the traveling crane. If the monorail be arranged without conductors outside of the monorail track, there is no danger of a short circuit from sling chains or crane hooks striking the monorail conductors. The monorail can be used for the distribution of material up and down the shop under the main traveling cranes. In this case each traveling crane becomes to a large extent localized and the interference of traveling bridge cranes is reduced to a minimum.

On account of the fact that the monorail has to be supported on brackets from the crane posts its carrying capacity is more limited than that of the bridge crane. Monorails, however, will carry loads up to five tons and this will be found sufficient for general distribution work in most foundries or machine shops.

TRAVELING JIB CRANE.

The other type of overhead distribution service which can be installed under a traveling bridge crane—the traveling jib crane—is also shown in Fig. 1. The traveling jib crane can be used to serve machines along the wall and on account of the fact that it has two motions, in many cases would be much more useful than the monorail. It has one serious disadvantage in that the projecting jib may interfere seriously with the bridge traveling crane. The dot and dash lines in the plan show the course that the crane hook of the bridge crane would have to take in moving a load around the end of the traveling jib crane. The traveling jib cranes are sometimes wrecked by striking loads being carried on the traveling bridge cranes, and this constant risk in operating the two types on one floor is the most important point that has to be taken into consideration. There are cases, however, where the traveling jib crane will pay in spite of the additional hazard which it incurs.

The traveling jib crane is open to one of the objections already stated for the monorail, and the fact that it extends as a cantilever or bracket supported at one end only and the length of the jib crane makes its capacity even more limited than that of the monorail.

SWINGING JIB CRANE.

Swinging jib cranes on posts along the side of the traveling bridge crane runway are open to the same objection as to carrying capacity and interference that apply to the traveling jib crane, except for the fact that the swinging jib crane will be forced out of the way if struck by a load carried by the traveling crane. The swinging jib crane, however, is so limited in its service area that it is only applicable for serving one or two machines in the machine shop or one or two molding pits in the foundry. Nevertheless, cranes of this kind are found exceedingly useful for setting cores in molds.

In the cases so far referred to it is presumed that the cranes or monorails are equipped with cages so that the man rides with his work. When we come to floor controlled hoists of any type we find them subject to a serious handicap in moving work. The floor control, however, is very efficient in the case of swinging jib cranes used for serving single machines or for setting cores in molds.

SPEED OF CRANES.

There are several very important matters in the original building plan which affect the speed of operation and the service which may be obtained from a crane of any type. In the case of the traveling bridge crane a high-speed hoist involves the installation of a very heavy motor and this soon overloads the trolley, so we have to strike a happy medium and slow down the hoisting speed. In most cases the hoisting speed is less than 25 per cent of the bridge traveling speed and generally about 25 per cent of the bridge carriage or trolley traveling speed. In the case of some heavy cranes the hoisting speed is not more than 10 per cent of the bridge travel speed. This means that where work is being hoisted among obstructions the two operations of lifting the load in the first place and lowering at the destination frequently occupy more time than the combined bridge and trolley travel. From this it is evident that a crane does not make an efficient elevator. If loads are to be handled to a considerable height a well-constructed elevator with a powerful motor will be found better than a crane.

BRIDGE CRANE SERVING SEVERAL FLOORS.

Figure 2 shows the cross section of a typical factory in which a crane serves several floors. When the length of the hanging ropes increases, the difficulties arising from the swinging of the ropes and the attending difficulty of damping this swinging increase very rapidly. When the load is hanging only a few feet below the crane the bridge travel can be started rapidly without serious swinging, but when the load hangs 25 or 30 ft. below the crane the starting of the carriage in rapid motion will set the load swinging in a serious manner. Crane men become very expert in checking and overcoming the swinging action, but nevertheless much work is damaged and many accidents result from having the crane runway too high.

Where multiple stories of a building are to be served with material which is within the capacity of a platform elevator, the latter will be found much more economical to maintain and operate. The principal reason for this lies in the fact that we cannot install a sufficiently large hoisting plant on the carriage of our traveling crane without unduly increasing the size of the carriage, the bridge, the weight of the runway, and the strength of the supporting columns.

In many erecting shops two crane runways are installed, one high above the other. This system has a distinct advantage where high work is to be erected and it also makes possible the passing of work by one crane which is in service on the upper track over the lower track. The advantages gained, however, except in the case of high erecting shops, are not sufficient to pay for the additional investment, and the same results can be obtained much more simply with a combination of traveling cranes and monorails, or with traveling cranes and surface transportation.

SURFACE TRANSPORTATION.

In foundries surface transportation of the industrial railway type should be avoided as much as possible in all parts of the plant where molding sand or core sand is in use. The upkeep, that is, the keeping of the tracks in clean, serviceable condition, becomes excessive in these departments, and the power necessary to move a given weight of material is also excessive.

Where a plant is equipped with a locomotive crane this may frequently be brought into the end or side of large buildings served by other cranes, and it will be found advantageous for the delivery of material under the regular cranes or for handling material from one building to another. In this case, however, we have all the difficulty of surface transportation to contend with.

Within recent years a number of types of power-driven motor trucks have come into use for service in plants. These will be found very handy for transporting loads within their capacity between departments, but the objection is that where the loads are beyond a weight readily handled by men it becomes necessary to load and unload them with some form of power hoist, which means a traveling crane, monorail or jib crane.

The monorail for general service between departments is a form of transportation that has been much abused and rarely developed to its greatest possibility. The old standard type of monorail is equipped with a single hook so that the man traveling can carry but one load with him. Realizing this fact, two systems of multiple control have been worked out. In one there is only one control handled in the operator's cage, and two or more carriages are attached ahead of the cage like a train of cars. The operator throws the power on all of the hoists at one time, so that all loads can move together. In the other system there are two or more hooks arranged ahead of the cage, each provided with a separate control handle so that the man can handle each hook, or he can work the two hooks together. In the latter case if each hook is capable of carrying 2½ tons he can pick up two loads, or with a porter bar or a double sling he can pick up 5 tons by means of the two trolleys. With this type of monorail the number of trips required is cut down in proportion to the number of hooks employed on each machine, and the effective service of the equipment is greatly increased.

The monorail transportation system between departments possesses the advantage of not interfering with floor transportation, but the monorail is open to the same objection that applies to the bridge traveling crane, that is, if more than one carriage is operating on a system there will be times when one carriage will have to get out of the way of the other. To a certain extent this may be overcome by the use of suitable loops and switches and by planning the work so as to localize the service of each monorail operator. For example, one man may be stationed in the foundry delivering sand and supplies back and forth under the traveling cranes; another man may have for his duty the delivery of cores or dry sand molds to the foundry; and the third may serve the cleaning department and the casting storage.

No crane system will ever reach its maximum efficiency without careful study as to a proper schedule of the work so as to have the smallest amount of lost time and to use a minimum amount of electric current. It is far better to have a crane or hoist standing idle a portion of the time, on account of the fact that it has accomplished all the work in the department and is waiting on the next operation, than it is to have two or more cranes tied up by one busy crane, particularly at a time when if they could jump over the busy crane they could get busy themselves. At times the control platform or stations can be so arranged that during a portion of the day a man runs one crane and during another portion another.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by H. M. Lane, in *The Iron Age*.

Tests of Soil and Methods of Underpinning Buildings Adjoining Subway Construction on William St., New York.

(Staff Abstract.)

This article treats of the methods used to shore and underpin the buildings along William St., New York, in connection with the construction of a subway there; it also describes and gives the results of a number of soil and pile tests made in connection with this work. Although many of the buildings are of considerable height their foundations were shallow and rested on soil which contained every possible mixture of sand with clay. As the excavation for the subway would be largely below tide and ground water the greatest care and skill were necessary to prevent damage to the adjacent buildings. The work described covers the first eight months of operations, during which over 60 buildings have been partially or completely underpinned and the excavation completed in front of some of them. Figure 1 gives data on the scope and character of the work.

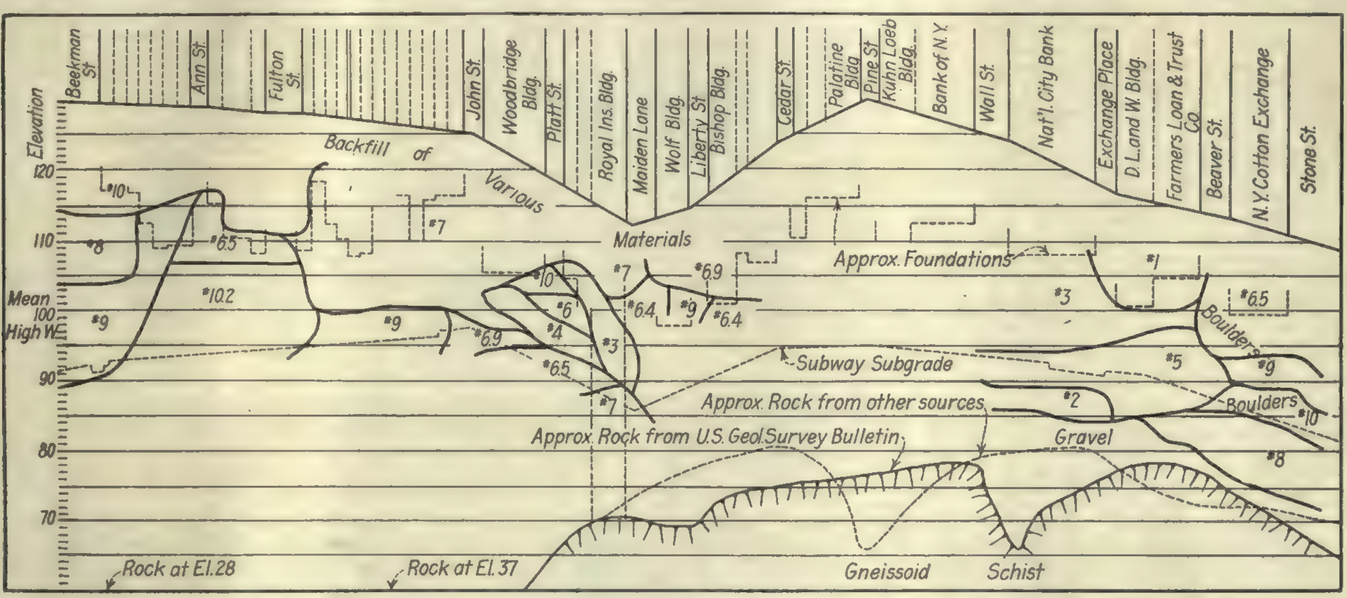


Fig. 1. Diagram Showing Area Covered by Underpinning Methods Described and Chart of Soil Strata Along William St., New York.

The success attending this work has been due more to carefulness and system than to elaborate or expensive methods. For example, shallow drainage trenches leading to a few large, screened pump-wells have dried the sand between tight sheeting and thus reduced the excavation to a minimum. The rigid observance of the following rules place the contractors' underpinning operations on the plane of known facts instead of on chance:

(1) To insure *permanent support* all building foundations shall be extended below the influence of the subway excavation.

(2) To insure *adequate support* every pile driven shall actually be tested with from 1½ to 2 times the load assigned to it (the area of spread foundations to be based on tests).

The observance of these rules makes it probable that there is no longer doubt that the buildings along this subway are being safely underpinned, even though founded on sand. The only uncertainty is whether the settlement incidental to all methods of underpinning can be eliminated or kept reduced to an inappreciable amount.

CLASSIFICATION OF SOIL.

The various tests made under the direction of the Public Service Commission are of value chiefly because the exact character of the soil was noted in every case, and a comparison with the soil conditions met elsewhere was made possible by grouping the various materials encountered according to their analyses.

Soil samples, varying from almost pure clay, through various graded mixtures of clay and sand, to almost pure sand were numbered from 1 to 10, and were analyzed as to constituents and fineness. The results are shown in Table I. (For locations of soil samples see Fig. 1.)

As all standard analyses are proportioned by weight an attempt was made to use dry separation by the No. 100 sieve as a dividing line between sand and clay. It will be noted by referring to Table I that many standard samples passing the No. 100 sieve have a percentage of clay, by weight, close to that otherwise indicated. This is because the sand is uniformly coarse and is entirely held on the screen. With fine-grained specimens, however, a large part of what passes the No. 100 sieve is sand. For example, the screen test of No. 5, if interpreted as above, would show only 1 per cent of sand (as 99 per cent passed the sieve), whereas water separation indicates 65 per cent sand (by volume and an even higher percentage by weight.) Therefore as volumetric separation by shaking with water, permitting the sand to precipitate first, has been determined upon as the closest to fact of any easily performed test.

TABLE I.—RESULT OF SOIL ANALYSES.

Standard soil sample No..	1	2	3	4	5	6	7	8	9	10
Percentage, by volume, obtained by shaking with water.										
Clay	90	84	75	45	35	30	9	6	5	2
Sand	10	4*	25	55	65	70	91	94	95	98
Percentage, by weight, passing sieve—										
No. 100	93	84	100	97	99	80	9	6	5	3
No. 50	100	88	100	100	100	100	15	8	25	10
No. 30	100	88	100	100	100	100	35	14	74	37
No. 16	100	88	100	100	100	100	66	37	98	78
No. 8	100	88	100	100	100	100	88	73	100	94
No. 4	100	88	100	100	100	100	96	91	100	98

*Plus 12 per cent of gravel.

Instead of great numbers of soil samples preserved as a record of the materials underlying buildings, the character of the ground exposed during underpinning is constantly compared (either by eye or the water test) with a set of the standard samples, and the numbers plotted on profiles of both sides of the street. Entirely new samples, as encountered, are analyzed and given interpolated numbers according to their constituents, as will be noted on the soil profile illustrated in Fig. 1.

BEARING VALUE OF SOIL.

The first test to determine the greatest imposed load which a particular sand would carry safely, that is, without undue or progressive settlement, was made on material in front of certain buildings which it was proposed to underpin by distributing their load (by means of grillage I-beams surrounded by concrete) upon concreted pits whose bottom area was in question.

A triangular platform of 12-in. I-beams, of 12-ft. length, resting at each corner on a 12x12-in. vertical timber whose end bearing on the soil had an area of 1 sq. ft. was used. To the known weight of the platform sufficient additional load was added by placing sand bags on it to give a total of 6 tons (2 tons per square foot of bearing). Levels were taken on spikes driven in the "legs" of the platform as low as possible. Levels were again taken immediately after the load was placed, and also after it had been applied 12 hours. Then 3 tons more (1 ton per square foot) of sand bags were added to the load, which was always kept in a central position; and levels were again taken immediately at the expiration of one day. At 4, 6½ and 8 tons per square foot the duration of loading was made one week. The levels, the values of which are plotted in Fig. 2, therefore not only indicate the settlement during loading, but also the settlement (often equally as great) under a steady load during the time interval.

The unequal settlement at the three corners is probably due to the fact the loading was done mostly at corner "A" (nearest the weighing machine) and particularly at "B" (corner "C" being inaccessible), involving impact as the bags were swung. By referring to Fig. 2 it will be noted that the horizontal increments of settlement, occurring after the load was applied, seem to indicate that a final bearing was very nearly reached in each case before more load was added, as the settlement during one week under 4 and 6½ tons is no greater in proportion than that under 5 tons during one day. The average total settlement under a load of 4 tons per square foot was ⅜ in., the soil being loose sand containing 3 per cent of clay.

Criticism of this test is not only directed at the method of loading, but also at the small area of each bearing surface. It seems reasonable to suppose that 1 sq. ft. of soil under the middle of a large foundation slab would, under the same unit load, permit less settlement than the same area by itself, because it could not spread laterally, the adjoining soil being similarly compressed.

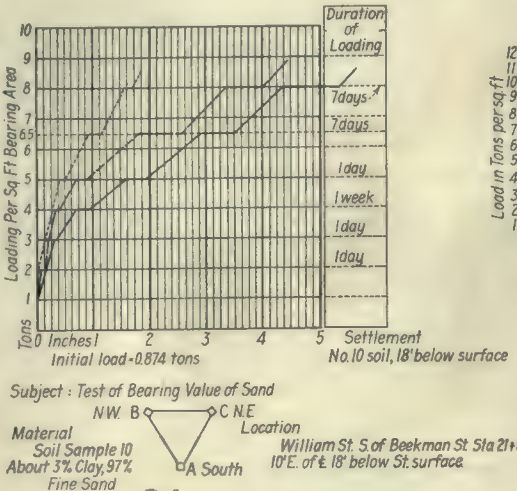


Fig.2

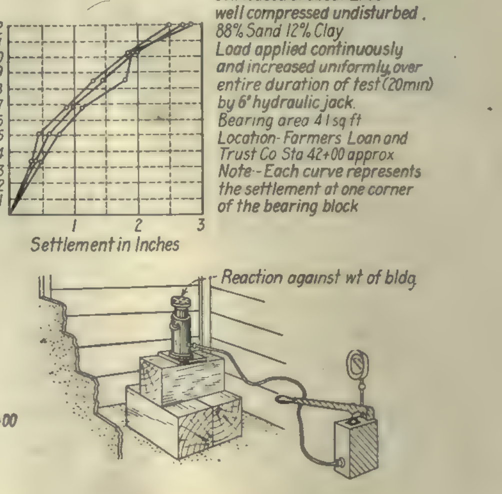


Fig.3

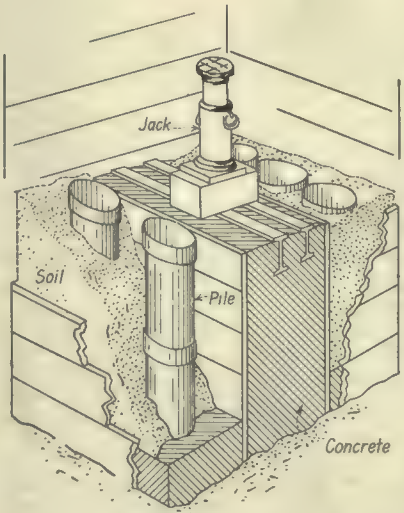


Fig.4

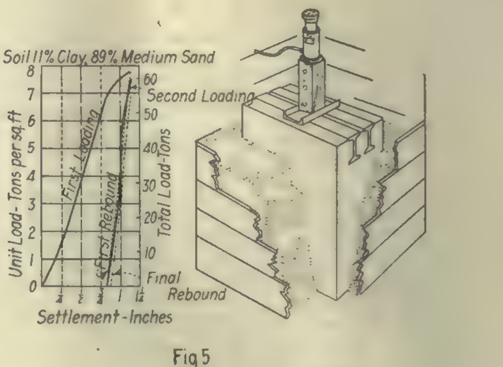


Fig 5

E.&C.

Fig. 2. Results of Load Test of No. 10 Soil on Three Separated Upright Timbers. Fig. 3. Results of Test of Soil (Sand, 88 Per Cent; Clay, 12 Per Cent) with Bearing Area of 4 Sq. Ft. Fig. 4. Diagram Illustrating Test of Soil Under Nos. 9-15 Park Place; Bearing Area 10 Sq. Ft. Fig. 5. Diagrams Illustrating Modification of Test Shown in Fig. 4 and Results of Test.

Accordingly 4 sq. ft. of bearing area were forced into a similar soil (containing 12 per cent clay, however) in an underpinning pit by successive, but rapidly applied, increments of load from a hydraulic jack, operated by a pump, with a pressure gage attached, which derived its reaction from the structure above. The simple apparatus used, and the resulting diagram, are shown in Fig. 3. Although the settlements were more uniform the results were corroborative of the previous test, the settlement being less than ½ in. under a load of 4 tons.

OTHER TESTS OF LARGER SCOPE.

To duplicate more nearly, and in an experimental manner, the actual conditions of bearing at the bottom of the underpinning pit, J. C. Meem, consulting engineer for both the

William and Beekman St. subways, conducted two tests on a larger scale.

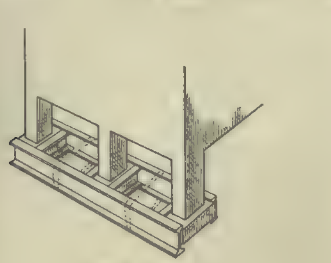


Fig.6a

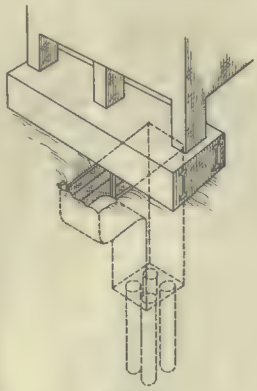


Fig.6b

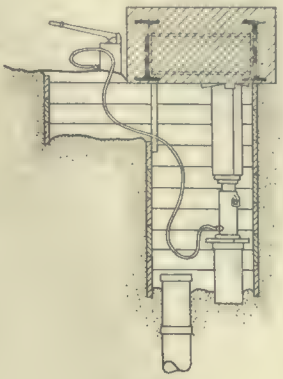


Fig.7

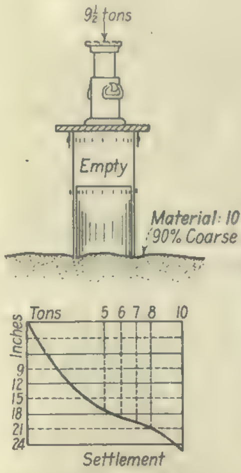


Fig.8a

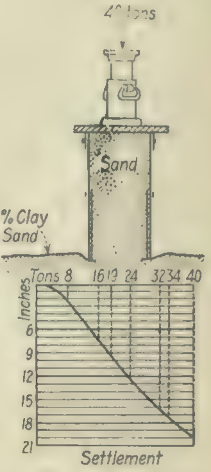


Fig.8b

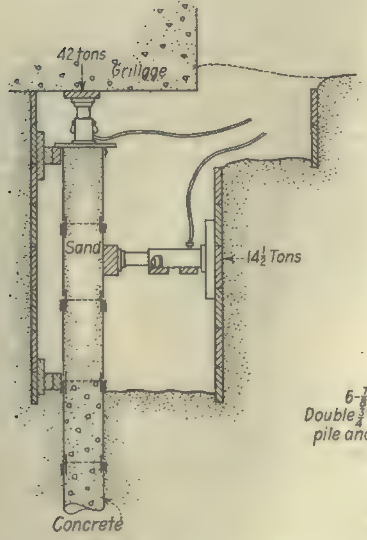


Fig.9

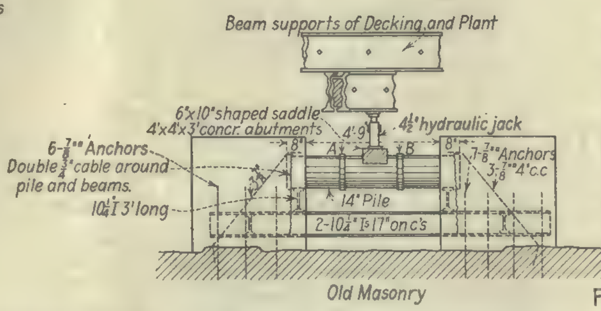


Fig.10

Test of Year Old 14" Pile

6'-1" long from support of Elevated R.R. at N.E. cor. Rector St. and Trinity Place.
Ends fixed 8" in concrete 13 days old. Load applied 3 times on account of necessary adjustments.
Test stopped at 40 tons because of inadequacy of reaction over jack.

1st Application			2nd Application			3rd Application		
Tons	Defl in Ft. at A	Defl in Ft. at B	Tons	Defl in Ft at A	Defl in Ft at B	Tons	Defl in Ft at A	Defl in Ft at B
0	0.000	0.000	0	0.000	0.000	0	0.000	0.000
6	.000	.001	19	.001	.001	20	.001	.000
8	.001	.001	23	.003	.001	30	.007	.002
10	.002	.002	26	.004	.002	36	.010	.007
13	.004	.004	29	.007	.002	40	.013	.011
16	.006	.006	18	.005	.002	18	.011	.010
18	.007	.007	11	.003	.001	8	.010	.005
0	.001	.003	0	.001	.001	0	.005	.001

E.&C.

Fig. 6. Sketches Illustrating Manner of Forming Combined Grillage of Separate Piers and of Underpinning Same. Fig. 7. Sketch Showing Manner of Driving and Testing Piles Under Column Grillage. Fig. 8. Data on Test of Steel Jacket of Pile, Empty and Filled with Sand. Fig. 9. Details of Transverse Test of Sectional Steel Shells Filled with Sand. Fig. 10. Details of Transverse Test of Concrete-Filled Pile.

Under Nos. 9-15 Park Place, Mr. Meem concreted a large block, with a bearing area of 10 sq. ft., between forms placed 2 ft. apart in a 5x5-ft. pit, the void on each side being backfilled over a 12-in. concrete seal at the bottom. This construction is shown in Fig. 4. (In order to use the pit later five piles were placed in the sides, before placing the backfill, with paper joints through the 12-in. concrete seal to facilitate driving later.) The load was applied in regular increments by a hydraulic jack acting against a computed building load of 90 tons. The test was stopped at 74 tons. Careful preparations were made to collect data for a curve of settlement—but there was no settlement. In fact, no penetration had been detected up to a load of over 7 tons per square foot in a material of medium sand containing 11 per cent clay.

The 12-in. seal was supposed to be separated, physically, from the bearing concrete by the wooden forms of the latter, which were left in place to represent the actual conditions in a sheeted pit. There was doubt, however, as to its function, inasmuch as there was already a backfill surcharge, and it was thought possible that it might partially have acted as an extension of the designed bearing area.

A second test was therefore arranged by Mr. Meem, the details of which are indicated in Fig. 5. A 2x4-ft. block of concrete, 7 ft. high, was jacked against the bottom of a 5x5-ft. pit, in the same soil as above, after the remainder of the space in the pit had been backfilled. The diagram in Fig. 5 shows how the load was released after being held at 62 tons for 3 minutes; then reapplied and held again; and finally released. This curve corresponds very closely to the former one.

Disregarding the settlement at corner "A" (Fig. 2) as not being representative (for the reason previously given) the various tests indicate a penetration of about ⅝ in. at 5 tons per square foot in every case. Since the 14-in. steel-concrete pile will settle that much in developing the usual assigned dead load of 30 tons (see diagrams 2, 3 and 5 of Fig. 12) it probably would be consistent to consider that these tests permit a 5-ton-per-square-foot loading on the soils considered. Of this 5-ton load less than 4 tons would be actual or dead load.

USE OF 36-CENTIMETER STEEL-JACKETED PILES.

The device which solved the soil problems at Williams St. was undoubtedly the 36-centimeter (14-in.) hollow, boiler plate shell, jacked to the desired depth, then cleaned out, and concreted. No one would attempt to sink a 4 x 4-ft. foundation pit below ground-water in sand, but by careful trenching and screened pumping from sumps the contractor in many cases lowered the ground-water level, and therefore his pits, many feet. However, all except the easiest cases were solved by the use of the 14-in. piles, some exceptional performances of which will be given after first describing the typical underpinning method in which they are used.

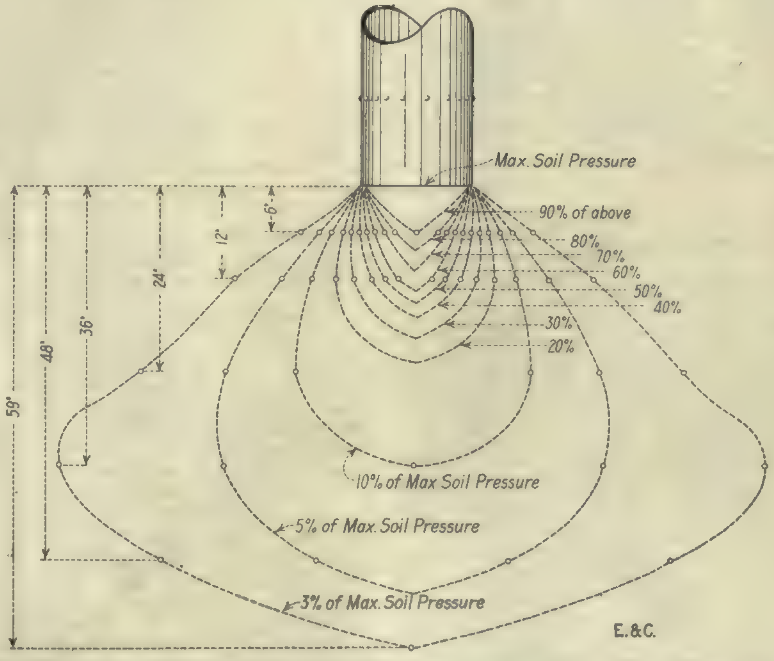


Fig. 11. Distribution of Soil Pressure Under 14-in. Pile Driven in Ordinary Dry, Brown Building Sand.

Figure 6 (a) shows a simple, three-pier foundation under the front of a building. As shown in this drawing two I-beams, or latticed girders, were clamped around the outer and inner sides of the foundation slabs and bound together by heavy cable between the piers. The transverse faces of the slabs were also fitted into channels, or I-beams, whose ends rested upon, or above, the longitudinal beams. The whole was then concreted solid to form a substantial grillage, as shown in Fig. 6 (b). A pit was then started *between the piers*, and carefully sheeted, horizontally, when large enough to admit a man. This pit was then deepened and kept closely sheeted until ground-water made further progress impossible. A 2-ft. cylinder, the first length of a 14-in. pile, was then stood on the pit bottom and jacked down with a hydraulic jack (equipped with a 4½ or 6-in. piston), the reaction being supplied by the weight of the building. When completely driven another length of pile was added, and the jack reapplied. The material in the pile was removed from each length, after it had been forced down, by a minature orange-peel bucket, a helical screw, or other simple device. When this pile had been carried to the required depth a second one was started in another corner of the pit (see Fig. 7). After all the piles required had been driven they were cleaned out, if necessary, and concrete immediately lowered into them in bottom-dump cylinders.

Each pile, while still newly poured, was actually tested with the hydraulic jack (a pressure gage being attached to the pump) to a load at least 50 per cent greater than that apportioned to it, the pile being jacked down, if necessary, until it would carry that load with no settlement for a period of observation ordered by the engineer. A very important operation was then carried out—important, not for safety, but for minimizing the later settlement of the building.

A column of steel shapes was erected upon each pile and powerfully wedged against the grillage with slender steel wedges. Thus a portion of the load was immediately transferred to the piles at a time when their settlement would not affect the building; subsidence due to shrinkage or to voids in the pit concrete, etc., was also provided against by this procedure. The pit was then concreted, and in every case grout was introduced (under about a 4-ft. head), through pipes left in the grillage, to take up the shrinkage of the concrete and especially to fill all the voids around the old foundation and the new pit.

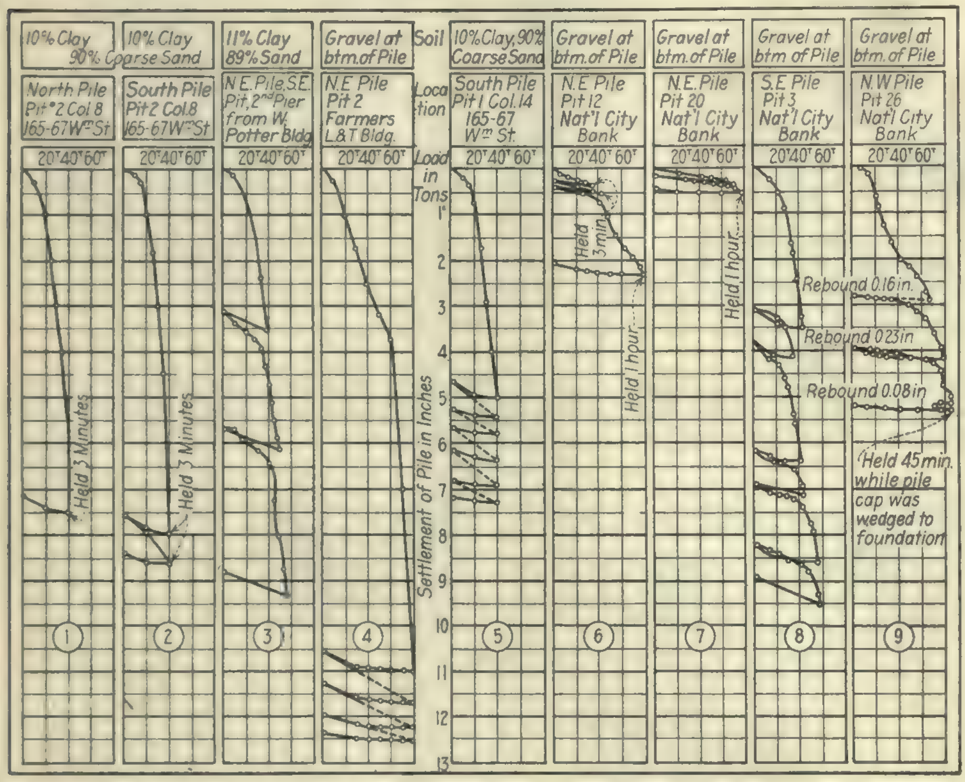


Fig. 12. Results of Nine Tests to Determine Penetration and Rebound of 14-in. Steel-Jacketed Piles.

The sectional pile shells, although made of ⅛-in. sheet steel, are very strong, the bearing and driven fit at the joints (2-in. inner lap, with outside band also) being especially close. The following illustrates the strength of these piles:

The steel shell of a 14-in. pile was jacked down upon a deep and empty pile which had already been driven to gravel under the Farmers Loan & Trust Co. building. Pressure was steadily increased to the limiting capacity of the jack—89 tons—with no appreciable effect other than a 4-in. additional penetration of the lower pile.

A single length of pile will carry remarkable loads. In the loosest and coarsest said available (under Nos. 165-167 William St.) a 2-ft. length, started empty, carried 9½ tons when jacked flush with the ground (see Fig. 8a). When filled with compacted sand and then jacked into the same soil it carried 40 tons, that maximum load being maintained without settlement for a previously-agreed-upon period of 5 minutes (see Fig. 8b). The diagrams shown give the settlements under various loads. This test was repeated under a nearby building with practically the same result.

To test the efficiency of the joints two tests were conducted. The first test (illustrated in Fig. 9) was arranged in a pit under the Farmers Loan & Trust Co. building. Three pile lengths were rammed full of sand (to prevent immediate collapse under lateral pressure), and stood upon a concreted pile. A load of 42 tons was then placed vertically upon them by means of a 6-in. jack acting against the building, and maintained during the entire test. Then lateral pressure upon a 10-in. shaped saddle, placed at the center of the middle one of three pile lengths, was gradually applied from a horizontal 4½-in. jack acting against the side of the pit (see Fig. 9). The clear span between the wedged blocks at the top and bottom of the three lengths was 5 ft. 7 ins. With a steadily increasing load up to 10 tons no appreciable effect was noted; at 14½ tons the test was stopped because the lateral jacking was causing the pit boards and earth backing to fail and because the sheet steel under the saddle was bending. Approximate measurements indicated a 1-in. deflection at the maximum load. And this pile had been *merely packed* with sand.

The second test was on a 6-ft. 1-in. length of a year-old, 14-in. concrete-filled pile, which was removed by Mr. Meem from Trinity Place, where it was used to support a portion of the elevated railroad. The Designing Department, which was interested in the test, agreed that the pile should be tested as a fixed-end beam (the contractor holding that some kind of end load, even indirect as in this case, was necessary to make the joints effective), mentioning, however, that it would be necessary to consider the fact that such a beam has only half the maximum moment at the center as a simple beam. The manner of fixing the 6-ft. 1-in. length of pile is shown in Fig. 10. It was intended to test the pile to failure, but three applications of a load at the center, the maximum of which was 40 tons, did not cause failure. The maximum deflection at the center of the span was less than ⅛ in. There was, however, a 1/32-in. separation of the under side of one joint, the interior lap being, as usual, 2 ins. Complete data on this test are given in Fig. 10.

DETERMINATION OF THE BULB OF SOIL PRESSURE.

The cross-sectional area of a 14-in. pile is only about 1 sq. ft., and tests show that the value of skin friction with these non-tapering piles is slight—say 5 per cent. In view of the fact that sand, especially quicksand, is not allowed more than a few tons load per square foot it is of interest to determine how a pile of this kind regularly supported a load of 80 tons without settlement during routing tests, and half that load in actual practice under building loads.

The results of experiments with brown building sand to determine the "distribution of vertical soil pressure" (conducted at Pennsylvania State College) have been plotted in an entirely new way in Fig. 11. Here we have visualized for us the cone, or more properly the bulb, of resistant soil which forms below the base of the pile, radiating the pressure, with diminishing intensities to the limits shown, in all directions to the points where no effect is produced by the load. (If the material had been confined water the highly compressed position under the pile would naturally have moved away freely, so that there would have been no limit to the penetration of the pile.) With the dry sand represented in the diagram the pile increases the interior friction of the sand in direct ratio as the load is increased; and the point is reached where lateral flow of the material stops, due to this friction. Beyond that point the soil compresses until it will just resist the pressure required by its relative distance from the pile; then the pile no longer sinks under that particular load. It seems obvious that the more nearly liquid the soil, and the greater the clay lubricant, the greater the necessary lubricant should be—other things being equal.

Nine actual records of the way piles act under final tests are shown diagrammatically in Fig. 12. The loads were read from the pressure gage of the hydraulic pump, and the settlements were measured directly from the pile head to a string, stretched horizontally, or by attaching the tape of a deflectometer to the pile head (in the case of curves Nos. 3, 8 and 9, Fig. 12).

It will be noted that all of the curves show the rebound which occurs whenever the load is released. This rebound, about ⅜-in., is about double the amount due to the elasticity of the pile; the remainder is evidently due to the expansion of the compressed soil below.

It is very probable that the soil does expand. The material in the smallest cone plotted on the bulb diagram of Fig. 11 is compressed, under an 80-ton load, to over 90 per cent of 95 per cent (subtracting skin friction) of $\frac{160000}{144}$, or 950 lbs. per square inch. Around the rim of the bottom of the pile the soil so compressed is within an inch or so of material comparatively unstressed (see Fig. 11. When the friction is reduced (with the load) translation probably takes place to a certain extent. This seems to be shown by the fact that, if a load is reimposed after it has been released, a settlement occurs which is greater than the rebound. Curves Nos. 4 and 6 (Fig. 12) show how the load was released and reapplied many times, each time involving a further settlement caused by the translation of material under the pile.

DETAILS OF PILE CAP USED.

In connection with the placing of the pile cap a great step forward has been taken by the contractor. Heretofore, after the official test of each pile, the load was released; later, when its assigned portion of the building load was carried (say 30 tons) the conditions just described made certain a further settlement of about ½ to ⅝ in. (see Fig. 12). To obviate this as far as possible, Lazarus White, engineer for the contractor, is introducing wide plates between the jack and the pile. After the official test to about double the actual dead load is completed the pressure is held until I-beams, one on each side of the jack, are cut, with a blow-pipe, and wedged, in an upright position, from the plate under the jack to the grillage of the building above the jack. The jack is then released and removed. Curve No. 9 (Fig. 12) shows a reduction of the rebound from 0.23 in. to 0.08 in. by this method, clearly indicating that at least half of the 80-ton test load was permanently maintained on the soil below. As this is more than the assigned load no future settlement is anticipated in this case.

The exact load permanently maintained on the pile by the wedged beams is, of course, not known, as the jacks and gage have been removed. It has been estimated, above, from the ratio of the slight rebound when the pile-cap is used to the greater rebound (representing the release of 80 tons) when the cap is not used.

EXPERIMENTS TO DETERMINE AMOUNT OF PERMANENT LOAD.

Some interesting experiments are now being made to measure the amount of this permanent load, by finding (using a "Berry" strain gage) the exact change in length of the vertical I-beams due to compression from the pile load. The stresses in both flanges of each flange are averaged, and the sum of the total stresses in the two beams equals the load on the pile. Satisfactory results are being obtained by this method.

The underside of the pile-cap has a circular 1-in. projection almost as large as the pile; the plate therefore rests on the fresh concrete and not on the steel casing.

AMOUNT OF SKIN FRICTION.

Only sufficient work has been done in the direction of determining the amount of skin friction of the 14-in. piles to determine the limiting values and the difficulty of securing accurate results. In the first place, pressure gages capable of recording loads of 100 tons on a pile are not very reliable for loads of about 5 tons or less. Again, the amount of muck left in the bottom of the pile is of great importance. If you remove the muck below the bottom of the casing apparently voids occur up the sides of the latter, as little or no pressure is then required to sink the shell. The low values obtained by mucking flush with the bottom of the shell suggested that, in semi-liquid soil, ground was also probably being lost outside the pile, and various amounts of muck were therefore left in the shell. Consistent results have not been obtained, however. Most of the values, when little or no muck was left, are very low. It appears that, of the 40 to 80 tons reaction obtained from a 15-ft. length of pile, only 4 to 6 tons are due to skin friction—about 5 to 15 per cent. The corresponding range of skin friction per square foot of the shell surface would be 150 to 250 lbs. As the shells corrodes somewhat this would undoubtedly be increased considerably.

ACKNOWLEDGMENT.

The foregoing article is a rather full abstract, generally re-stated, of a paper by John F. Greathead in the September, 1915, issue of the *Public Service Record,* the official publication of the New York Public Service Commision.

GENERAL

A Chart for Calculating for Different Materials and Belt Widths the Required Number of Plies of Conveyor Belt.

(Staff Abstract.)

Engineers who have occasion to ascertain the correct number of plies required for conveyor belt will find the accompanying diagram useful. The calculations are based on the average safe strength, factor of safety of 15, of the various standard rubber conveyor belts. The calculations assume maximum loading conditions; that is the belt is considered as carrying the greatest load that it will handle without spillage at ordinary belt speeds. This not only produces the most economical operating conditions but also the maximum tension in the belts. The chart is drawn for simple drive with base pulling and for other drives the number of plies should be multiplied by the factors: 0.83 for simple lugged drive; 0.67 for tandem base drive, and 0.55 for tandem lugged drive.

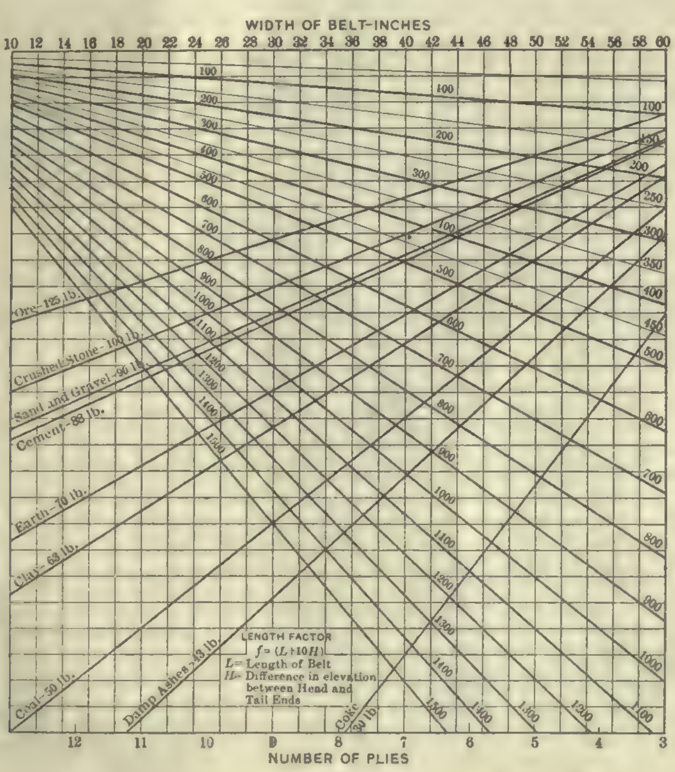


Fig. 1. Chart for Calculating Conveyor Belts.

The length factor, $f=(L+10H)$, represented on the chart by the lines 500, 600, 700, etc., is a developed factor equal to the sum of the length of the belt and ten times the difference in elevation between the head and tail pulleys.

To find the correct number of plies for a conveyor belt, knowing the width, the length, the difference in elevation between the head and tail ends, and the kind of material to be handled:

Start from the width given at the top of the chart and move down until this line intersects the line corresponding to the proper length factor; then move either right or left until the line corresponding to the given material is met; then move down again to the scale of plies, where the next largest figure will give the correct number of plies.

For example: To find the correct number of plies for a conveyor belt 36 in. wide and 300 ft. long, with 20 ft. difference in elevation; handling sand and gravel: Follow the line from the 36-in. width downward until it intersects the 500 length factor line; then follow to the right until the sand and gravel line is intersected; then down to the ply scale, where the ply will be found to be 7.

This chart is reproduced from a paper in Transactions, American Institute of Mining Engineers, September, 1915, by J. D. Mooney and D. L. Darnell with the B. F. Goodrich Co.

The Run-Off Problem in Draining Irrigated Lands.

Contributed by C. G. Elliott, Consulting Drainage Engineer, Washington, D. C.

The effort of engineers to express designs for all classes of work by definite formulas and standard plans is commendable and professional. Having at hand a few controlling facts and a knowledge of physical laws, it is both satisfying and expeditious to make a few computations with the aid of formulas and tables and evolve a result which is assumed to be scientifically precise and reliable.

There is one class of engineering problems, however, which depend for their correct solution upon facts secured by investigations of local conditions and the skill of engineers in utilizing them in a rational way. Among these are the problems relating to land drainage and to the drainage of irrigated land in particular. The writer begs to dissent from the view recently expressed in "Engineering and Contracting" that the status of engineering relating to the drainage of lands under irrigation is not creditable because no ready-to-use method has been developed which may be applied with ease and dispatch by the engineer who desires to drain irrigated land.

It should be remembered that no later than twelve years ago, draining land of this class was tabooed in prosperous sections, and the necessity for it which manifested itself in certain quarters was attributed by so-called irrigation experts to unwise irrigation and mismanagement.

While that might have been true in a measure, the fact remains that notwithstanding the economies that have been taught and practiced in irrigation, large areas of land may be found in every irrigation project which have been ruined by seepage and can only be restored to production by draining. The area of such land is increasing each year and its spread may be regarded as a constant menace to irrigated agriculture. It is one of the things that "is the matter with irrigation" and hence demands the best attention of engineers and managers of irrigated land.

A map showing the irrigation system and contours of the surface constitutes but a small part of the data required to design effective drains for seeped land. Plans based on data of that kind, while technically correct, have, when carried out, proven as marked failures as any "rule of thumb" methods that could be imagined.

Water that makes irrigated land too wet frequently comes from distant sources and finds its way to lower levels by percolation through under-surface channels which do not always parallel surface slopes. Water may accumulate in underground pools which when relieved by a drain will burst out in spring-like force and volume, or it may be fairly well distributed over a considerable area.

The source of the water is the amount applied to the land in irrigating it. It is conceded that a larger amount of water is required on new land to wet it properly than on older developed land, and that a considerable volume of both is wasted. The waste passes into the soil and off into the country drainage. When the dry soil beneath the irrigated becomes filled with water, and the natural under-drainage becomes overcharged and unable to remove the surplus, then will artificial drains be required. We then have a continuous supply of irrigation water, a continuous but insufficient under-drainage relief, the freeness of the latter depending entirely on the physical structure of the under strata of the land.

One peculiarity of drainage water in irrigated land is that it comes from below and exerts a constant upward pressure upon the soil due to the head which it derives from water in higher irrigated land.

The volume of water to be removed by drains is not proportioned to the area of wet land but to the area of irrigated land that contributes the surplus water.

The problem then consists of determining the amount of water which is applied in irrigation, the manner of its distribution, the amount which passes off in natural drainage and of then deducing from the observations, the amount that ought to be removed by artificial drains. It is necessary to locate the underflow and place the drain where the water enters the land which requires drainage, and not where surplus water leaves it, as is done in the drainage of rainfall. One drain may be so located as to remove the entire volume of water which causes the saturation of a considerable body of land.

The engineer must determine the location and volume of water that attacks the area he desires to reclaim by frequent and sometimes deep borings or pits. His surveys will be largely underground surveys. His plan will be developed from facts secured by local investigations. The general principles of treatment will be similar in a large number of instances but the runoff factor will vary greatly and must be estimated for each individual area to be reclaimed. The necessity of doing this, however, should not discredit the process or method by which he develops his plan, since it is based upon careful and scientific investigations and worked out with the skill which he has acquired in the study of all the related facts.

Successful Application of Sewage Farming at Nottingham, England.

Sewage farming was undertaken at Nottingham, England, several years ago. Two adjoining farms, having an aggregate area of 1,923 acres, are utilized for this purpose. One of the farms is four miles from Nottingham at Stoke Bardolph; the other is seven miles from the city at Bulcote. For the first few years of its operation the farm did not pay expenses, owing in part to want of experience and in part to poor management. However, for the past three years it has yielded a profit over all operating expenses.

The sewage farming, or broad irrigation, method of sewage disposal has been on the wane among recognized processes for some years, but it is profitable to consider isolated projects which have proved economically sound. These notes on the Nottingham experience are taken from the United States Consular Reports of a recent date.

CROPS UNDER CULTIVATION—DAIRYING AND STOCK RAISING.

During 1914 there were 708 acres under cultivation, divided as follows: Wheat, 100 acres; barley, 20 acres; oats, 200 acres; beans, 46 acres; potatoes, 37 acres; swedes, 35 acres; mangolds, 100 acres; ox cabbage, 25 acres; kohlrabi, 50 acres; Italian rye grass, 95 acres.

Stock raising, with the exception of pigs, has to a great extent been abandoned, although large numbers of cattle and sheep are purchased and fattened on the farm for market. Nine hundred and sixty-four acres on the farm are devoted to pasture. It has been found more profitable to keep on hand only a sufficient number of hogs to consume the surplus produce of the farm. Pigs are bred and disposed of when 8 to 10 weeks old.

A herd of from 50 to 60 dairy cattle is kept on the farm. The cows are secured at their highest milking capacity, and special efforts are made to secure profitable results by liberal feeding and support during lactation. At the end of this period the animal is fat and healthy and can be sold to the butcher at a good profit within a short time. During the past year more than $9,500 was realized from the sale of dairy products alone. The raising of young calves on the farm has been found to be undesirable and unprofitable, and they are therefore disposed of when a week or two old.

In addition to the dairy herd about 500 bullocks, from 3 to 3½ years old, are purchased each autumn, and these are grazed on the pastures during the spring and summer and sold to the markets as they become fat. During 1914 more than $55,000 was received from the sale of beef cattle that had been pastured and fattened on the farm. This paid a net profit of about $15,000. The bullocks are well matured at the age when purchased and the risk of disease usually associated with younger animals is overcome. This method is also considered advantageous in forcing a complete dispersion of the cattle annually, instead of keeping them on the land from birth to maturity.

The number of horses kept on the farm is regulated by the season and the amount of work to be done. About 80 to 90 are usually employed. A large proportion are mares of the Shire type, and the best of these, in addition to working, are utilized for breeding purposes. The foals are sold in the autumn of the year in which they are born and usually average about $125 each. This plan is considered more profitable than keeping them and accepting all risks until they are old enough to work.

FARM IMPLEMENTS AND MACHINERY.

The agricultural implements and machinery used on the farm consist of two 8-h.p engines, one special plow, one special cultivator, one special harrow and drag, one special roller, one special kniferer, one water cart, one steam traction engine with six trucks, one thrashing machine, two 40-h.p., one 20-h.p., and two 4½-h.p. gas engines, and one 2-h.p. petrol engine. At the Bulcote farm there is a suction gas plant. The whole of the grinding, cake, pulping, and pumping machinery there is driven by electric motor and the buildings are lighted by electricity, which is generated on the premises.

The other implements consist of self-binders, grass-mowing machines, Oliver and Hornsby digging plows, heavy, drags, joint and diagonal harrows, horse hoes, and the usual complement of smaller tools suitable for working a farm of this size.

METHODS OF HANDLING THE SEWAGE—ITS VALUE AS A FERTILIZER.

The sewage all gravitates to the farm from Nottingham through one large sewer. On arrival at the farm it flows from the main sewer in various directions by means of open "carriers" made of concrete. These are of sufficient capacity and strength to convey the quantity of sewage required for the area of land they are intended to control. A staff of men is always in attendance to deal with and apply the sewage where it is required. The method of "broad irrigation" is the one adopted on the farm. The sewage is only partially screened before use and, except for the removal of rags and large substances, it is in its crude state on reaching the land.

The method of manipulation is as follows: The concrete carriers mentioned go through and are intended to supply a certain acreage of land, which is divided into areas of various sizes, all of these having been previously surveyed and the levels ascertained. The crops are of various kinds, and the greater portion of them are suitable for irrigation. After the young crops are big and strong enough to withstand sewage, a "carrier," or grip, is drawn with a plow from a sluice in the main concrete carrier. From this grip smaller tracks are made by a ridging plow at intervals in the crop between the rows, where a suitable "fall" for the sewage may be obtained. The man in charge then commences operations by distributing the fluid over the land as evenly as possible. This goes on until the whole field is completed. In all cases the judgment of those in charge must be the determining factor as to whether the proper quantity of sewage has been applied to the crop. This method is the one generally used on all the pastures and crops capable of being irrigated and is the only one that will secure a satisfactory effluent and avoid the offensive odors that are always associated with sewage disposal. The crops that will take and thrive on repeated applications of sewage are Italian rye grass, ox cabbage, mangolds, and kohlrabi.

The work is not done in accordance with any recognized system of rotation in cropping, as special efforts must naturally be directed to the effective disposal of the sewage, through which the whole system is regulated and controlled. None of the grain crops is irrigated during the period of growth. Advantage is usually taken of this period to give the land a "rest."

Extremely good fertilizing results have been secured, after the land had been heavily sewaged, by making "lagoons," filling them, and allowing the sludge to settle. A very excellent manuring is thus obtained.

All the land is very heavily underdrained; stoneware pipes, varying in size from 4 to 24 ins., are systematically arranged to secure the effective filtration of the sewage. The effluent is thus carried off into the river Trent.

FINANCIAL RESULTS OF THE UNDERTAKING.

The financial statement for the year ending March 31, 1915, shows the farm to be in a prosperous and paying condition. The appraised value of the stock, farming implements, and other property on hand, exclusive of the value of the land, amounted to $116,815, while the receipts during the year from the sale of cattle, farm produce, dairy products, etc., amounted to $99,743. The principal sources of income were as follows: Sale of cattle, $56,900; of horses, $2,900; of pigs, $2,075; of poultry, $180; of produce, $24,700; of dairy products, $9,600; rents, $2,000.

During the past three years the city of Nottingham has not only been able to dispose of the sewage without expense to the taxpayers, but it has been receiving a profit on the undertaking. The net profits of the farm for 1914, after paying all operating expenses and writing off $1,000 for depreciation in farm machinery, amounted to $2,987.70.

Construction Features and Cost of Piledriver Built for General Use Around Water, Los Angeles, Cal.

Contributed by W. D. Jones, Assistant Engineer, Los Angeles Harbor Department.

About January, 1913, the piledriving work of the City of Los Angeles at its harbor became of sufficient magnitude to justify the construction of a piledriver for the purpose of constructing and maintaining wharves. The driver decided upon has given such thorough satisfaction both in its wear and its adaptability to general piledriving work that I consider some of the detail features may be of some use to anyone intending to build such a driver.

As most of the work contemplated was of a nature to keep the driver continually moving on and off wharves, which would necessitate raising and lowering the driver a matter of some seven or eight feet, and the piles to be driven would be creosoted and therefore have to be jetted as well as driven thus requiring only a light hammer, in order to meet these conditions, a comparatively light driver was decided upon. It was built with a total length of 59 ft. 6 ins., and a width of 16 ft. at moon beam and 14 ft. outside width at rear end of skid timbers. A height of 41 ft. 2 ins. from bottom of oak shoes to axle of cable sheaves allowed driving a 36-ft. pile with the driver resting on the ground. The leads were spaced 21 ins. and provided with 5-in. channel irons for hammer guides; 2x8-in. oak shoes were placed under skid timbers and 2x6-in. white oak (butter) boards were provided wherever driver was to work in order to reduce wear and friction in moving. In constructing, a level spot was selected as near the first work to be done as possible and the driver laid out so as when it was completed it could be moved directly to position for driving the first pile. The skid timbers were first laid out and engine base and flooring laid, the leads were then constructed laying face down and in position to be pulled up into place by block and tackle. This was done after engine was in place and provided a counter weight to pull against. The principal equipment purchased was about as follows: One No. 28 American Hoist and Derrick Co. 20-h.p. vertical boiler hoisting engine, double cylinders with 7-in. bore and 10-in. stroke, and double nigger heads; one Worthington duplex pump 9x5¼x10 ins. having a rated maximum capacity of 195 gals. per minute and a working pressure of 150 lbs. per square inch. (On tests conducted later the average discharge was found to be about 146 gals. per minute and the pump found to work best at this rate.) One 3,000-lb. drop hammer with yoke of 1½ ins. round soft steel cast in head, 350 ft. of ¾-in. plow steel cable, hemp center, having six strands of 19 wires each; one 175-gal. oil tank made of galvanized iron, this was placed 6 ft. above floor of driver in order to afford a gravity feed to oil burner; five sets of double and single blocks, four single snatch blocks; one coil of 1-in. manila rope, and

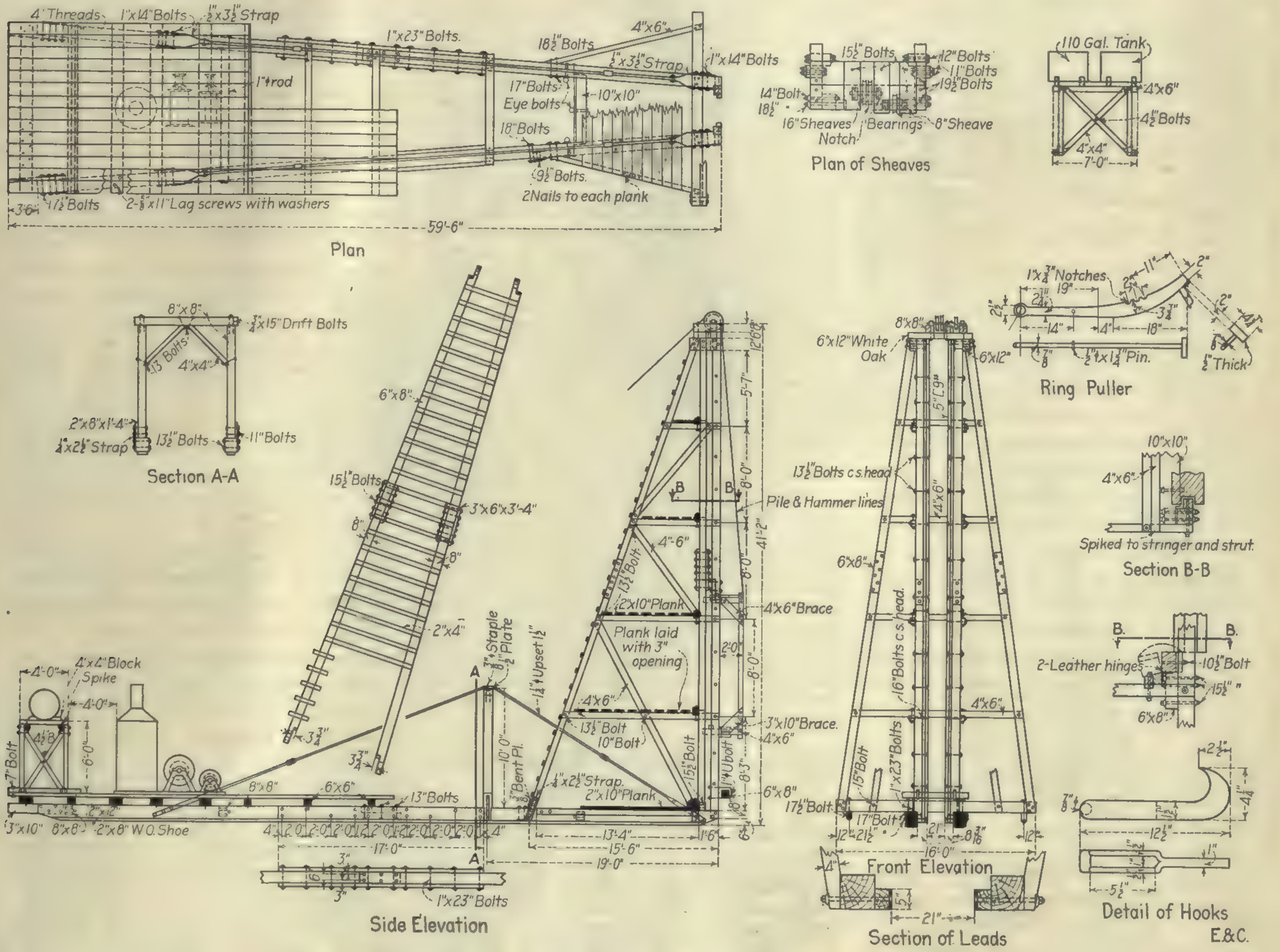


Fig. 1. Pile Driver for Water Front Service, Los Angeles Harbor.

TABLE I.—COST REPORT. PILE DRIVER CONSTRUCTED BY THE HARBOR DEPARTMENT

Classification, quantity and lineal feet—	Costs. Labor.	Material and supplies.	Wagon haul.	Total.	Unit cost.
Lumber, 1,068 ft. oak, 9,549 ft. pine, 10,617 ft.	....	$278.13	......	$278.13	$26.20 per M ft.
Iron rods, fittings, etc.	....	682.58	......	682.58	
Engine and hoist, American steam No. 28, double drum and winches, 7-in. bore cylinders, 10-in. stroke.	....	1,298.00	......	1,298.00	
Pump, Worthington No. 416226, 9x5½x10 duplex, brass-fitted	....	185.00	......	185.00	
Tanks, 1 1,200-gal. redwood, 1 175-gal., 16 gauge, galv. distillate	....	26.44	......	26.44	
Lines for driver, 350 ft. ¾-in. 6/19 plow steel rope	....	55.24	......	55.24	$0.1578 per ft.
Drop hammer, cast iron, 1½-in., yoke cast in head, 3,000 lbs.	....	79.40	......	79.40	$2.647 per cwt.
Handling equipment	....	....	$17.65	17.65	
Installation and building	$539.65	....	......	539.65	
Boom, 8-in. top, 45 ft.	14.84	17.00	......	31.84	Pole, $0.20 per ft.
Auxiliary leads	12.00	8.50	......	20.50	
Engineering, office work	158.84	....	......	158.84	4.58 per cent of cost.
Administration	91.54	....	......	91.54	2.64 per cent of cost.
Total	$816.87	$2,630.29	$17.65	$3,464.81	

TABLE II.—BILL OF MATERIAL.

No.	Size.	Length.	Remarks.
			—Fir.—
2	8"x 8"	20'-0"	No. 1, select S. 4 S., leads.
2	8"x 8"	22'-0"	No. 1, select S. 4 S., leads.
[illegible]	4"x 5"	14"	No. 1, select S. 4 S., leads.
4	6"x 8"	20'	No. 1, select S. 4 S., front inclined braces.
4	6"x 8"	22"	No. 1, select S. 4 S., back stays.
2	4"x 6"	12'	Merchantable S. 4 S. diagonals.
2	4"x 6"	10'	Merchantable S. 4 S. diagonals.
3	4"x 6"	18'	Merchantable S. 4 S. diagonals.
1	4"x 6"	10'	Merchantable S. 4 S. landing stringer.
1	4"x 6"	16'	Merchantable S. 4 S. landing stringer.
2	4"x 6"	12'	Merchantable S. 4 S. landing stringers.
2	4"x 6"	14'	Merchantable S. 4 S. landing stringers.
1	4"x 6"	18'	Merchantable S. 4 S. landing strut.
1	4"x 6"	12'	Merchantable S. 4 S. landing strut.
1	4"x 6"	14'	Merchantable S. 4 S. landing strut.
1	10"x10"	16'	Merchantable S. 4 S. cross beam.
2	4"x 6"	14'	Merchantable S. 4 S. floor stringers.
[illegible]	2"x10"	12'	Merchantable S. 1 S. landings.
5	2"x10"	14'	Merchantable S. 1 S. landings.
1	2"x10"	10'	Merchantable S. 1 S. floor.
5	2"x10"	12'	Merchantable S. 1 S. floors.
5	2"x10"	14'	Merchantable S. 1 S. floors.
13	2"x 4"	12"	Merchantable S. 4 S. ladders.
1	3"x 6"	14'	Merchantable S. 4 S. splice.
1	3"x 8"	14'	Merchantable S. 4 S. splices.
[illegible]	8"x 8"	10'	Merchantable S. 4 S. truss-rod frames.
1	4"x 4"	10'	Merchantable S. 4 S. truss-rod frame.
2	8"x 8"	12'	Merchantable rough sill struts.
1	10"x10"	12'	Merchantable rough sill strut and ham. rest.
4	6"x12"	14'	Merchantable rough sill engine platforms.
14	3"x12"	20'	Merchantable S. 1 S. engine platform.
1	6"x 6"	12"	Merchantable rough engine platform.
3	6"x 6"	14'	Merchantable rough engine platform.
7	3"x12"	12'	Merchantable S. 1 S. engine platform.
2	4"x 4"	16'	Merchantable S. 4 S. tank trestle brace.
2	4"x 4"	12'	Merchantable S. 4 S. tank trestle posts.
1	4"x 4"	12'	Merchantable S. 4 S. tank trestle base.
1	4"x 4"	16'	Merchantable S. 4 S. tank trestle X-beam.
1	4"x 6"	14'	Merchantable S. 4 S. tank trestle longl. beam.
1	3"x10"	10'	Merchantable rough sill extension.
4	4"x12"	18'	Merchantable rough sill splices.
1	6"x12"	12'	Merchantable S. 4 S. sheave support.
1	8"x 8"	12'	Merchantable S. 4 S. sheave support.
2	4"x 4"	12'	Merchantable S. 4 S. tank trestle braces.
4	12"x12"	30'	Merchantable rough sills.
1	6"x 8"	5'	Merchantable S. 4 S. toggle.
			—White Oak.—
6	2"x 8"	18'	Clear S. 1 S. 2 E. sill shoes.
1	6"x12"	10'	Clear S. 4 S. sheave supports.
			—Bolts.—
8	¾"	13½"	Back stay to landing stringers.
6	¾"	13½"	Back stay to diagonal braces.
4	¾"	10"	Landing stringers to diagonal braces.
2	¾"	9½"	Landing struts to diagonal braces.
2	¾"	15"	Cross beams to diagonal braces.
8	¾"	11½"	Landing struts to landing stringers.
8	¾"	11½"	Landing struts to front inclined braces.
8	¾"	16"	Landing stringers to leads, C. S. heads.
2	¾"	21½"	Sills to leads, C. S. heads.
22	¾"	13½"	Guides to leads, C. S. heads.
2	¾"	17"	Leads to sill.
6	¾"	17½"	Floor stringers to cross beam and diag.
2	¾"	18½"	Floor stringers to sills.
2	¾"	17"	Floor stringers to sills.
6	¾"	15½"	Front inclined braces to cross beam.
4	1"	23"	Sill to cross beam.
4	¾"	18"	Back stays to sill.
4	¾"	9½"	Back stays to sill.
12	1"	14"	Truss rods to sill.
4	1½"	4"	Truss rods to straps.
4	¾"	13½"	Truss rods to frame to sill.
4	¾"	11"	Truss rods to frame to sill.
4	¾"	13"	Truss rods to braces.
12	¾"	15½"	Splices in back stay.
12	¾"	13½"	Splices in front incline braces.
6	¾"	9½"	Splices in leads.
6	¾"	7"	Tank trestle to floor.
4	¾"	7½"	Back stay to sill.
4	¾"	12½"	Back stay to sill.
8	¾"	17½"	Sill extensions.
32	1"	23"	Sill splices.
12	¾"	13"	Sill splices.
2	¾"	18½"	Top of leads, C. S. heads.
4	¾"	14"	Top of leads.
2	¾"	11"	Top of front inc. braces.
2	¾"	12"	Top of front inc. braces.
6	¾"	12"	Top of back stay.
6	¾"	19½"	Cap to cap stringers.
8	¾"	15½"	Sheave blocks to caps.
24	⅝"	8½"	Tank trestles.
4	⅝"	4½"	Tank trestles.
6	¾"	15½"	Hammer rests.
2	¾"	10½"	Hammer rests.

Miscellaneous Metal.

No.,	material, description and remarks.
4	drift bolts, ¾"x15", truss rod frame.
32	lag screws, ⅝"x11", eng. platform.
370	O. G. wash., 3" diam., ⅝" thick, for ¾" bolts.
78	O. G. wash., 4" diam., ⅞" thick, for 1" bolts.
12	lbs. nails, 20d.
8	lbs. nails, 30d.
20	lbs. nails, 60d.
2	rods, 1¼"-43'-7" C. to C., upset, 1½" T. B., truss rods.
2	eye bolts, 1"x12" and 4"x⅝"x4" wash.
1	eye bolt, 1"x10" and 4"x⅝"x4" wash.
2	U-bolts, 1"x1'-11" and 4"x⅝"x6" wash.
2	staples, ⅝"x6".
2	plates, ½"x7½"x4".
2	bent pl.
4	bars, 2½"x¼"x2'-0".
4	bars, 3½"x1½"x3'-4".
4	bars, 3½"x½"x4'-6".
2	channels, 5"-9 39'-4".
7	lbs. cut wash. for ⅝" bolts.

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various small tools, etc., consisting of top mauls, boat hooks, peavies, ring puller, as shown on plan, bitts for boring drift bolt holes, etc. The Worthington pump discharged through a 3-in. pipe which was reduced to a 2½-in. about one-half the distance to nozzle. The nozzle was tapered from 2½ ins. to 1 in. in diameter in a distance of 12 ins. and when pump was working under considerable steam pressure and nozzle submerged in mud considerable back pressure was encountered. To overcome the resulting wear on the pump, a 4-in. pipe 4 ft. high was placed on force chamber to serve as an air chamber and has done considerable to take up the pounding in the pump. Considerable driving is done from a barge with this driver and it is sometimes used to drive sheet piles for bulkheads. In order to keep from supporting the driver at a height above wales of bulkhead auxiliary leads were provided as shown by Fig. 1. These permitted also of driving at an offset from face of leads of driver and allowed any dimension lumber to be handled. In placing these leads in the driver the hammer was lowered out of the main leads and auxiliary leads pulled in from bottom by a line to niggerhead. This line was then used to raise or lower the auxiliary leads as desired. The hammer was then pulled into the auxiliary leads, when driving could proceed. These leads provided for a drop of 8 ft. with hammer and were very successful for the purpose intended. The cost of these leads as well as the cost of a boom used for various purposes is shown as a separate item on the cost sheet. Table II shows the bill of material.

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First Annual Meeting American Association of Engineers.

The first annual meeting of the American Association of Engineers was held in Chicago Dec. 10 and 11, 1915.

In an address by J. H. Prior, chief engineer Illinois Public Utilities Commission, on "The Economic Aspects of Engineering Pay," he demonstrated by diagrams that the pay of the lowest "margins" man in an organization had a direct effect on that of the highest paid. He also pictured the law of supply and demand, showing that the same result was obtained in case free bargaining was indulged in and full knowledge of conditions was known by the engineer and his prospective employer.

F. H. Newell, Professor of Civil Engineering, University of Illinois, outlined the problems of the engineer from the welfare standpoint. He emphasized the idea that this organization was in nowise antagonizing any other good welfare movement, but would stimulate and help the existing organizations far more than it will draw from their membership. He spoke at length on the duty of the society to the engineer and suggested that younger men be chosen more often as officers. He likened the material development of the age to a Frankenstein organism which threatens to destroy its creator, the engineer, unless the same type of mind is utilized to control it. In other words, he sounded a call to the engineer to participate in the lager civic affairs of the nation. Engineers get what is really their due and will continue until they are willing to take their post in public affairs. There are no engineers in congress among the 400 representatives and 100 senators. There was one once, but he always apologized for being an engineer. Prof. Newell expressed his reason for taking an interest in the new association substantially as follows: It will not do to view imperfect public affairs from the outside. We must get together to help upbuild with high ideals rather than to call attention to the defects and deficiencies of other organizations or of existing conditions. He believes in the enthusiasm which has been manifested in getting up this association and in the broad sympathies of the men who have dition of the engineer, and especially of the engineer who has not found it desirable or practicable to get into the larger organizations. The organization now has about 330 members.

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The Lighter Side of Engineering and Contracting

Some Advise for Mr. Ned.

MIKE O'FARREL was doing a piece of levee work and was using Ethiopian skinners who shot an unusually hot line. They were chopping up the animals so bad the contractor commenced to fine every one 50 cents that drew blood on a mule. One day one of the skinners got clear out of patience with one of his mules. He pulled out of the run to let the wheeler by that was crowding him and walked around to the mule and said: "Look here, Mr. Ned, if you all don' git you mine on your business right now, I'll catch you when the boss ain't a-lookin' and I'll give you about a four-bit lick."—R. L., Nelson, Cal.

A fat job for every engineer, an own price contract for every contractor, a bushel of orders for every manufacturer and every supply man: Them's the wishes of Skinner Mulvey.

He Saved It, All Right.

IT WAS a big job for a green foreman to hanand the young and conscientious engineer was prolific with his grade stakes. After the final peg was set he took the old gent all over the work, and explained fully and at length the significance of every grade. "Now, Pat, this stake here, in the center of the curve, is the most important of them all. Without it you cannot get a true grade around your curve, and whatever you do, save this stake. I know some of them are bound to get knocked out, but you must save this one." Estimate day came around, and with it the engineers. As a whole the sewer did pretty well, but at the crucial point in the big sweeping curve the invert showed a big hump. "See here, Pat, what's the matter here, where is that stake I told you to save. You've got a high place here in your curve, you lost that grade and now you see what it has caused." "Sure and I have not lost the same, I have it here safe for you." And stepping over to the nearby tool box he leaned over and proudly brought to view the all important stake. "Sure and the teams was knockin' thim out so that I made sure of this wan, says I, 'I'll not disappoint the lad on me first job,' and here I have the blessed stake; sure and I saved it for youse."—M. T. C., Nashville, Tenn.

Paying Off the Gang.

BILL and Stephen were sewer contractors up in Michigan. They had a miscellaneous assortment of Poles, Turks, Wops, Czechs, Croatians, Salvonians, Serbs, Roumanians, Bulgarians and Bohunks in the ditch. Bill, who did not spell well in any language, was the timekeeper on the job. He wrote down something in English to represent, to him, the sound of each laborer's name. The first pay day he wrote out checks to cover the payroll to date. These checks were turned over to Stephen who mounted a lumber pile and called the gang. "Jappapa," read Stephen, impersonally, from the first check. The gang grinned but no one moved. "J. Jappapa," said Stephen, with rising inflection and black looks at the bunch. Still no one moved. Stephen tried it again. Carefully scrutinizing Bill's handwriting he read, with an air of finality, "Joe Jappapa." Again no one felt called. The men shifted from one foot to the other and grinned broadly. The suffocating resident engineer leaned against the lumber pile and gasped. Stephen's wrath waxed great. Glaring fiercely around him, with stinging emphasis on each word he asked, "Who in hell is Joe Jappapa?" More grins, more embarrassed shuffling of feet and more silence. Stephen hurled the checks to the ground. "Here, damn you," said he, "take 'em. They're all about the same size anyway."

Labeled.

AN investigation was going on recently in one of the departments of a large western city and several of the employes were dismissed for alleged "moral inefficiency." One of the employes, whom we will call "Slim" for short, bent over his work, and as he had removed his coat, the word "honest" appeared in view from the confines of his hip pocket. An old Irish contractor who was present, noticed the word and exclaimed, "So they have to label you fellows now, do they," just as "Slim" pulled out his package of "Honest Scrap" to take another chew.—H. J. F.

Hot Foot!

RECENTLY on an asphalt pavement under construction, a number of negroes were busy raking the hot asphalt. An old lady came out from a nearby house and going up to the foreman vented her wrath as to the poor progress of the job. "No wonder," she exclaimed, "the work is so slow with that bunch of cripples on the job. Why, half of them have the gout! Look, the way they have their feet all wrapped up!"—H. J. F.

Great Self Repression.

IT IS recorded that in Yorkshire in 1501, Henry Jenkins was born. He died in 1670, cut off at the age of 169. He remembered well the battle of Flodden Field. This occurred in 1513, when he was 12 years of age. The register of chancery and other courts show the administration of oaths to him 140 years prior to his death. He gave deposition as witnesses when he was 157. In his young manhood, when he was a little over 100, he was a remarkable swimmer. The remarkable thing about Henry Jenkins is the fact that he has left behind him no rules of living which would enable one to duplicate his feat.—"Health News," U. S. P. H. S.

CURRENT NEWS

The Doings of the Week.

Activities in trade and finance were well sustained during the past week. Bank clearings were well in excess of those of 1913. Money was in better demand and there was further stimulation in investment and new enterprise. Exports valued at $188,036,000 were shipped from the port of New York in November. This is the largest volume ever leaving an American port in one month. Final figures by the U. S. Government on the 1915 crops show that the total value of the leading farm products for this year was $5,280,000,000. This exceeds last year's record yield by $415,000,000 and is $615,000,000 greater than the average value of crops during the 5-year period 1909-1913. The Government report on acreage of winter wheat sown last fall, issued last week, shows a planted acreage of 37,256,000, or 11.3 per cent less than a year ago. This total acreage, however, is the largest on record with the single exception of last year. The indicated yield for next year is 617,000,000 bus. Danger of further freight car shortage is apparently over. The last monthly statistical statement of the American Railway Association shows a total shortage of approximately 5,000 cars less on Dec. 1 than on Nov. 1. This indicates that the peak of the crop and commercial movement has been reached. In the construction field there has been some improvement as regards the amount and size of new work reaching the call for bids stage. Several notably large road building and street paving contracts are being advertised. In the municipal water works and sewerage fields a fair amount of new work came up for advertising for proposals. In the iron and steel trades booking entered farther in 1916. Mills are now stated to have sufficient business ahead to guarantee capacity for the next 7 or 8 months. Some sales for heavier materials for the third quarter of 1916 are reported to have been made at 1.70 cts. to 1.80 cts. Fabricating shops are estimated to have taken business in November equal to 105 per cent of their capacity. This is the largest booking reported since the spring of 1909. Material for New York subways, 62,000 tons, comprised 33 per cent of the total orders for the month. The French government placed contracts for 65,000 tons of rails and has about 35,000 tons yet to let. The Southern Ry. placed a 10,000-ton order, the Great Northern let out 5,000 tons, the Philadelphia & Reading Ry., 4,000 tons, and the Buffalo, Rochester & Pittsburgh, 2,000 tons. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Dec. 15 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Dec. 15. Cts.	Dec. 8. Cts.
Bess. rails, heavy, at mill...	1.25	1.25
Iron bars, Philadelphia......	1.959	1.959
Iron bars, Pittsburgh........	1.80	1.80
Iron bars, Chicago...........	1.75	1.60
Steel bars, Pittsburgh.......	1.80	1.70
Steel bars, New York.......	1.969	1.869
Tank plates, Pittsburgh.....	1.90	1.90
Tank plates, New York......	2.169	2.169
Beams, etc., Pittsburgh.....	1.70	1.70
Beams, etc., New York......	1.869	1.869
Skelp, grooved steel, P'gh...	1.70	1.70
Skelp, sheared steel, P'gh...	1.80	1.80
Steel hoops, Pittsburgh......	1.90	1.90
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	2.50	2.50
Galv. sheets, No. 28, P'gh...	4.75	4.75
Wire nails, Pittsburgh......	2.00	2.00
Cut nails, Pittsburgh........	1.90	1.90
Fence wire, base, P'gh......	1.85	1.85
Barb wire, galv., P'gh........	2.85	2.85

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, zees 3 in. and over, 1.70 cts. to 1.90 cts.

Railways.—There are many rumors of minor improvements for the railways but the big jobs still remain in hiding. A considerable number of new projects have reached the incorporation stage in the last few weeks, and several small undertakings are understood to be near the construction point. The Casey Contracting Co., Pittsburgh, Pa., received the grading contract for the 5-mile spur line at Canton, O., for the Wheeling & Lake Erie, R. R. Guthrie, McDougal Co., Portland, Ore., were awarded a $450,000 contract for lining a tunnel with concrete for the Oregon, Washington Railway & Navigation Co. The Oneida & Western Ry. of Oneida, Tenn., let a contract for 2½ miles of additional line, and the Southern Ry. awarded a contract for about 2 miles of line to the site of the proposed dam of the Aluminum Co. of America. The American Bridge Co., at $249,000, was low bidder for structural steel for extension of the Frankford elevated line at Philadelphia, Pa. The Lutcher & Moore Lumber Co., Orange, Tex., wish to get in touch with contractors desiring to construct a 35-mile extension of its Gulf, Sabine & Red River R. R.

Roads and Streets.—One of the largest county road jobs of the year came up for advertising last week. The Commissioners of Grayson County, Texas, will open bids Jan. 12 for a highway system calling for an expenditure of about $900,000. Belleville, Ill., is taking bids on probably the largest single reinforced concrete pavement letting of the year. The work calls for 124,000 sq. yds. of paving and 55,000 lin. ft. of concrete curb. Greenfield, Ia., opens proposals Jan. 20 on 25,000 sq. yds. of paving. The Road Commissioners of Chippewa County, Michigan, are asking bids on several road jobs, and the County Commissioners at Dadeville, Ala., open proposals Jan. 12 for 38 miles of highway. Ontario, Cal., awarded a $44,000 street paving contract; County Commissioners at Pine City, Minn., let a $48,000 road job; Massachusetts awarded a $30,000 state highway contract.

Bridges.—The city of Rockford, Ill., is calling for bids for a reinforced concrete bridge estimated to cost $83,000. A considerable amount of bridge and culvert construction for western counties for 1916 also is ready for proposals. The Dunn-McCarthy Co., Chicago, Ill., at $53,660, was low bidder for bridge work at Indianapolis, Ind.; Cantrell Construction Co., Philadelphia, Pa., at $60,758, was low bidder for Diamond St. bridge at Philadelphia.

Drainage and Irrigation.—No particularly large undertakings in either the drainage or irrigation fields reached the call for bids stage during the past week. Several large judicial and county ditch projects in Minnesota are slated to come up for bids early next year. The Wyaconda River Drainage District No. 1 of Memphis, Mo., is asking for bids on 17.3 miles of ditch requiring 557,000 cu. yds. of excavation. Johnson & Baum, Superior, Wis., were awarded a $194,239 judicial ditch job for Beltrami and Koochiching Counties, Minnesota. J. B. Arpin Construction Co., Houston, Tex., received a $141,000 contract for drainage for the Robstown District, of Corpus Christi, Tex.

Water Works.—Sacramento, Cal., and St. Paul, Minn., are calling for bids for large pumping units. Wesson, Miss., opens proposals Jan. 4 for construction of water works and electric light system. Baker, Ore., is asking bids for furnishing 34,000 ft. of 12-in. to 15-in. concrete or vitrified water pipe. Danville, Pa., is calling for proposals for constructing a reinforced concrete rapid sand filter of 300,000 gals. capacity. The Town of Hobart, Tasmania, Australia, is asking bids for furnishing 42,000 ft. of cast iron, wrought iron or mild steel pipe. Lee's Summit, Mo., awarded a contract for water works to cost $44,500.

Sewerage.—St. Louis, Mo., is calling for bids on several fair sized sewer jobs. One of them calls for 1,672 ft. of 14-ft. by 11-ft. 2¾-in. sewer. Strawberry Point, Ia., opens proposals Jan. 7 for sewerage to include about 20,000 ft. of pipe and Imhoff tanks and filters. Hampton, Ia., is asking bids on 7,000 ft. of sewer. Loveland, Colo., opens proposals Jan. 4 on 3,700 ft. of sewer. Harbor Beach, Mich., let a $16,210 contract for a sewer system; Cantrell Construction Co., Philadelphia, Pa., at $72,876 was low bidder on an 8 by ~~12~~-ft. concrete sewer for Philadelphia; South St. Paul, Minn., let a $24,500 sewer job.

Engineering Bargain Hunting.

Bargain hunting is not confined entirely to the female of the species. Many public officials, when it comes to engineering work, are as eager to secure cut prices as any old woman. To accomplish this laudable object they sometimes hold prize competitions, seeking thereby to obtain 5 cts. worth of work for an expenditure of 1 ct. The Commissioners of a western county are now conducting one of these engineering bargain contests. They are offering a prize of $1,000 for the best design for a bridge that will call for an expenditure of possibly a quarter of a million of dollars. The contestants are allowed two weeks' time to prepare their studies and plans and to compute their construction quantities and costs. The winner will not be required to supervise the construction, so these commissioners only expect to get for their $1,000 a design that should cost them at least $6,000. Perhaps they will get their bargain. More likely they will get exactly what they pay for.

Immigration in 1915.

Immigration statistics for the last fiscal year furnish small comfort to those who look to this source for a supply of unskilled labor. Immigration to the United States was at its lowest point in more than 20 years. In the period ending June 30 last only 326,700 alien immigrants were admitted, as compared with 1,218,480 in the previous year. All admitted arrivals of aliens, immigrant and non-immigrant, were 434,244, nearly 1,000,000 less than the year before. The departures in 1915 amounted to 384,174. Of this number 204,074 were immigrant aliens and 180,100 non-immigrant aliens. The fiscal year of 1915 covers the period of sailing home for reservists from the beginning of the European war to June 30 The war not only caused a great falling off in alien arrivals but it also caused a decrease in departures. The number leaving in the fiscal year of 1914 was 633,895 as compared with 384,174 in 1915.

Delay in Awarding Contracts.

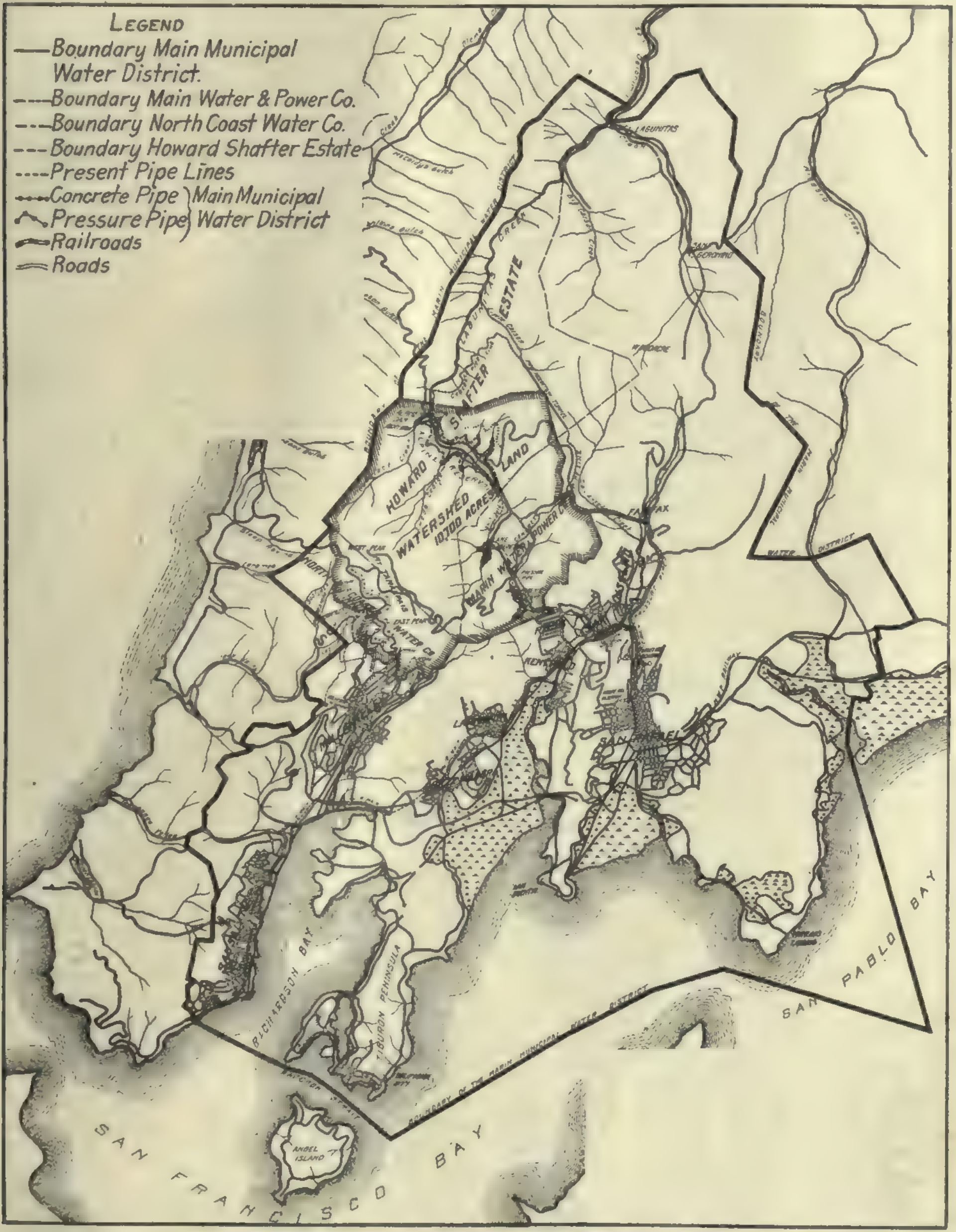
Delay in awarding a contract after the bids have been opened often causes serious hardship to the low bidder. Should his plant be limited he hesitates to figure on other work because he fears he will need his equipment on the first job. A New Jersey city has just awarded a paving contract, bids on which were received some months ago. One of the Aldermen is quoted in the daily press as stating that the city saved at least $24,000 by not readvertising, because of the increased cost of labor and material. Possibly the contractor may be able to secure his materials at the quotations on which his bid was based. If not, he is the loser by the city's delay.

A $1,373,000 WATER SUPPLY PROJECT.

Work Proposed for Marin Municipal Water District, California.

8,700 Ft. of 8-ft. Tunnel; Concrete Dam; Pipe Lines, Etc.

The Marin Municipal Water District of San Rafael, Cal., is about to begin construction on the first unit of its water supply development. This district is located in Marin County, California. Within its boundaries are the city of San Rafael, and the towns of San Anselmo, Fairfax, San Quentin, Ross, Kentfield and Sausalito. The district was organized in August, 1912, and on Aug. 28, 1915, a $3,000,000 bond issue was authorized by a vote of the people in a ratio of 3⅓ to 1.



Proposed Developments for the Marin Municipal Water Supply Districts.

The project, in brief, includes the purchase of the two largest present operating companies in the district—the Marin Water & Power Co., and the North Coast Water Co.—and the augmenting of the water supply by increasing the water sheds of the present companies through the purchase of 5,515 acres of adjacent land and the building thereon of additional physical structures. The cost of the water companies and water shed land already has been fixed by the Railroad Commission and the courts at $1,626,976. The remaining $1,373,024 of the $3,000,000 bond issue will be devoted to new construction.

The new construction will consist of the Alpine dam, a concrete arch structure, 100 ft. high, 450 ft. long on the crest, containing 20,000 cu. yds.; the Pine Mountain tunnel 8,700 ft. long, 8 ft. in diameter, horse-shoe shaped and lined with a minimum thickness of 6 in. of concrete throughout its length; 38,000 ft. of reinforced concrete pipe laid on a flow line grade, and transmission and distributing pressure pipe line. This construction will augment the present supply by 5,000,000 gals. daily and this ultimately will be increased to 15,000,000 gals. daily by raising the Alpine dam to 170 ft. and adding to the transmission and distribution systems. The Pine Mountain tunnel will be constructed full size in the initial development.

The estimated cost of the new structures is as follows:

Alpine Dam	$247,500
Concrete pipe lines	208,200
Pine Mountain tunnel	316,900
Transmission and distributing mains	200,000
Liability insurance	45,000
Contingencies	100,000
Interest during construction and contingencies	225,424

The water district opened bids Dec. 21 for the purchase of $600,000 of the $3,000,000 bond issue. This will provide for the purchase of the Howard-Shafter water-shed land and the starting of work on the Pine Mountain tunnel sometime during the coming spring. It is expected that practically the entire construction work during the first year will be confined to this unit of the project. The remaining work will be carried out during the second year. In this way all items of new construction will be brought to completion at about the same time, with a minimum interest charge during construction. The remainder of the bond issue will be marketed as needed for the construction and for the purchase of the operating companies. The condemnation suit of the latter is still in the courts on appeal but an early settlement is expected.

The engineering features of the project are commonplace except as regards the compactness of the job and the close proximity of the construction area to the material and labor market, which is not generally the case with similar developments in California.

The average annual rainfall over the Alpine water shed is 66 in. This, because of the peculiar geographical situation, is double that of the surrounding territory although the duration of the storms are about the same. This precipitation is at times very intense and the fact coupled with the steep, rocky hill sides which permit little percolation, results in a large runoff and phenomenal production of water in comparison to the catchment area. The profile of the damsite permits an extremely economical section of dam, and the exposed bedrock offers excellent foundations. No exploration work, however, has been done as yet.

A. R. Baker is engineer of the district and has been in complete charge of the planning and design of the project from its inception. M. M. O'Shaughnessy and Edwin Duryea, Jr., have acted in a consulting capacity.

LEVEE PROJECTS IN TEXAS.

Work Proposed in Ellis and Dallas Counties.

About 44 Miles of 10-ft. Embankment Proposed.

Important levee projects for the reclamation of overflow lands in Dallas and Ellis Counties, Texas, will be placed under construction next year. In Ellis County work is now under way on the building of a levee for the protection of about 5,000 acres of land comprising the Ellis County Improvement District No. 1.

Ellis County Improvement District No. 2 proposes the reclamation of 12,700 acres of overflow land. On Sept. 7 last the district unanimously voted a bond issue for the work. The levees will be about 18 miles in length and will begin at Stateroad Crossing and extend to a point about 3 miles south of the Ennis-Kaufman highway. The letting of this work has been delayed by reason of a contemplated change of plans. The original plans were made up on the assumption that a certain large slough could not be crossed by the levee or closed up. The army engineers are now considering the closing of the slough and as this would mean a saving of about $20,000 to the district, the engineer is waiting an opportunity of making the change in his plans.

The original plans for the levee in Ellis County Improvement District No. 2 provided for an embankment about 18 miles in length, approximately 10 ft. high and with a 6 ft. crown and 2 to 1 slopes. It will average about 950 cu. yds. per station. The soil is black silt and is reasonably easy to handle. The district is crossed by the Texas Midland R. R., which has an unloading switch at a point about 1 mile from the Trinity River. The city of Ennis is about 11 miles from the work. The town of Allsdorf is about 4 miles distant from the proposed levee while the town of Rosser is about 3 miles from it.

Ellis County Levee Improvement District No. 3 was formally organized on Dec. 3 by the Commissioners Court of the county. This district comprises 9,400 acres of overflowed land on Trinity River in the northeast corner of the county. The supervisors of the district expect to issue over $100,000 in bonds for levee purposes. Plans are now being made and the work should begin next summer or in the early fall. The preliminary plans contemplate the construction of about

14 miles of levee, 10 to 12 ft. in height, with 6 ft. crown and 2 to 1 slopes.

On Nov. 29 a petition to the Dallas County Commissioners Court for the leveeing of approximately 5,000 acres of land in the southeast corner of Dallas County was withdrawn in favor of another project covering about 8,000 acres of land and connecting up with the Ellis County Improvement District No. 2. This new district, to be known as the Dallas County Levee Improvement District No. 1, will issue bonds to the approximate amount of $90,000. The preliminary plans call for about 12 miles of levee, 10 ft. high, with 6 ft. crown and 2 to 1 slope.

This levee construction by the two last mentioned districts with that of Ellis No. 2, on which work will begin soon, will reclaim practically all overflow land on the west bank of the Trinity River for a distance of about 27 miles in Dallas and Ellis Counties. O. W. Finley, Ennis, Tex., is Engineer.

Status of New York State Canal Work.

Of the $27,000,000 bond issue authorized last November by the citizens of New York State for the completion of the Barge Canal about $9,846,000 will be applied to the work of construction and for attendent expenditures. Plans of the uncompleted work are now in such shape that contracts can be advertised just as soon as the proper steps can be taken for issuing bonds. It is expected therefore, that one of the first acts at the next session of the state legislature will be the making of provisions for the immediate issuing of the $27,000,000 of bonds.

The eastern half of the Erie Canal and the Champlain Canal each have a single unfinished contract which has been the chief obstacle to the entire completion of the respective sections. By letting these contracts, No. 29-A and 73-A, together with one or two bridge contracts, and pushing work on them and on the few other contracts which are under award but not quite completed, it is expected that one season's time will be all that is needed to finish the Champlain Canal and also a channel from the Hudson to Lake Ontario by way of the Erie and Oswego branches. Bids are now being asked on contract 73-A. This calls for the completion of the canal from Northumberland to Stillwater, a distance of about 15 miles.

On the Erie Canal west of the Oswego junction there are several uncompleted portions. Legal complications are largely responsible for the unfinished condition. There are numerous railroad crossings and these have proved to be very troublesome from the standpoint of the state both because of delays in coming to agreements with the railroad companies and on account of the slowness in performing the work in such manner as not to interrupt traffic. Because of the amount of work still to be done and the number of crossings still to be made, it is anticipated that two seasons will be required to complete the western half of the Erie Canal.

The status of canal plans in November was as follows:

No.	Description.	Status.
	Erie Canal.	
21A	Completing work on Contract No. 21	75 per cent completed.
23A	Completing work on Contract No. 23	Under way.
29A	Completing work from Sterling Creek to Oneida County line	Completed.
46B	Completing lock and dam at May's Point	Under revision.
47A	Completing work on Contract No. 47	90 per cent completed.
55B	Changes in gates, etc., at Delta Dam.	Before Canal Board.
59	Rochester Harbor	Under way.
63A	Completing work on Contract No. 63	Under way.
83	Constructing canal from Contract No. 19 to Niagara River.	Under way.
84	Viaduct over canal and railway at Clyde	Under way.
122	Bridge at Little Falls	Under revision.
130	Dredging Albany Canal entrance	Before Canal Board.

Ditch Construction in Koochiching County, Minnesota.

Ditch work, estimated to cost over $224,000 and requiring 1,372,000 cu. yds. of excavation, will be placed under contract probably in February by Koochiching County, Minnesota. The improvement involves the construction of three open ditches. Alongside each of these a road will be built with the excavated material. Judicial ditch No. 21 is located 3 miles to 9 miles from a railroad. The work is suitable for walking dredges. Ditch No. 22 is from 1 mile to 14 miles from a railroad. Part of the work can be done with floating dredges and part with walking dredges. Ditch No. 25 is from 5 miles to 8 miles from a railroad. The work is suitable for walking dredges. Some details of these three ditches are given in the following table:

	No. 21.	No. 22.	No. 25.
Length, miles	17.74	60.16	19.47
Average base, ft	4.5	5	4
Average cut, ft	6.6	6.4	6.7
Yardage, cu. yds	249,257	854,988	268,461
Clearing, acres	136.65	484.24	155
Grubbing, acres	53	185	90
Number bridges	11	33	11
Number culverts	46	101	28
Total estimated cost.	$43,517	$134,530	$46,214

E. W. Kibbey, International Falls, Minn., is County Engineer.

Meeting of Associated Technical Men.

The monthly dinner-meeting of Associated Technical Men was held at the Morrison Hotel, Chicago, Wednesday, Dec. 15th. At the invitation of this association the following men addressed the meeting: H. S. Baker, assistant city engineer of Chicago; W. W. De Berard, western editor, Engineering Record; and C. W. Malcolm, associate editor, Engineering & Contracting. The association publishes a monthly bulletin, "The Technician," which is devoted to the professional interests of technical men. The offices of the association are at 1215 Monadnock Building, Chicago.

NEWS LETTERS

St. Louis Items

A. L. Cook, Ottawa, Kansas, was awarded 130 miles of bank widening on the M., K. & T. R. R., between Oklahoma City and Atoka, Okla. Quite a lot of this is fine station work, also a lot of good team work which Cook will sublet in quantities to suit outfits.

Work on the first five of the buildings at the Alton State Hospital has been finished, and the buildings have been accepted. They are the administration building, the two receiving buildings and the nurses' home and the department for the untidy. The construction work on these buildings has been in progress for a year.

John Kenney has taken some bank widening work on the M., K. & T. R. R. in Oklahome from A. L. Cook. Jerry Wolf is with him.

Costello Bros. and McInerney has rented 23 teams to John Kenney at Eufala and Poto, Okla.

Belleville, Ill., will go ahead with the concrete paving of the rock road, despite the appeal of William Mitchell to the Supreme Court. This was decided by the City Council, when a communication from Special Attorney A. H. Baer was read saying the city should go ahead without fear of court orders interfering. The Mayor was authorized by the City Council to file a written notice of the city's decision in the County Court. Following the filing of the notice in the County Court the Board of Local Improvements will ask for bids on the work and as soon as possible contracts will be awarded. It is planned to do none of the actual work until spring.

J. J. McInerney has finished his levee work at Apex, Mo., and is going to Oklahoma on to some of the M., K. & T. R. R. bank widening.

Mayor Eckhardt of East Alton will ask the Alton, Granite & St. Louis Traction Co. to move the Interurban waiting station at East Alton 200 feet south. Several months ago the village laid a concrete walk, expecting that the Interurban station would be moved to the end of the walk.

M. L. Windham has moved a part of his team outfit to McClure, Ill., on a drainage ditch.

The proposed $150,000 bond issue being urged by persons at Valley Park will be used in building bridges and culverts in all parts of St. Louis County, according to Dr W. A. Koons, who is the originator of the idea. He said it would cost only $30,000 to bridge the Meramec River at Valley Park. Edward M. Flesh, president of the Automobile Club of St. Louis, sent letters to the members, urging them to give their support to the proposed county $3,000,000 road bond issue, on which a vote probably will be taken in February.

The Davis Commissary & Supply Co. opened up two more camps on the Big Little River Drainage District job southwest of Cape Girardeau, Mo., last week. This job is expected to last between eighteen months and two years.

The Floesch Construction Co., general contractors of the Little River Drainage District have doubled their outfit southwest of Cape Girardeau during the past two weeks.

The East St. Louis and Suburban Railway, which includes the Alton, Granite and St. Louis Traction Co., has announced the naming of a new official. He is to have the title of general manager. D. E. Parsons of Pittsburgh, Pa., will assume the new position Jan. 1.

J. H. Hayes was in the other day looking up work for his ten-team outfit. 7019 Hancock avenue, St. Louis, Mo., will catch him.

L. C. Haynes, president of the Alton, Granite & St. Louis Traction Co., has answered Mayor Beall's communication in which Mayor Beall asks the traction president to make his word good by building an electric line from Alton to the State Asylum. President Haynes says the line will be built if Alton and Wood River townships guarantee to adjust all possible claims for damages arising from the building of the street car line and make arrangements for such adjustments before the line is built.

A. Burke has finished his State Road work near Fulton, Mo.

The Vandalia Railroad Company, which maintains a yard valued at $1,000,000 at Rose Lake, northeast of East St. Louis, Wednesday, began the construction of an addition to the yards, to cost $80,000. The work will give employment to about 100 men. It is expected the work will be completed within 30 days.

Wm. O'Connor, who has been resting up here for a couple of years, says he is tired of laying around and going back into the contracting game. Glad to hear it, Bill.

Contractors, when in want of labor or work for their outfits, write Koenig's Labor Agency, 612 Walnut St., St. Louis, or 503 W. 5th St., Kansas City, Mo.

The List & Gifford Const. Co. have finished their steam shovel job at Cahokia Bridge, near Edwardsville, Ill., and moved this shovel on to their new work on the White River branch of the Iron Mountain R. R. in Arkansas.

T. P. Newland expects to have eight teams idle at East Alton, Ill., in a few days.

E. A. McClavey, of McClavey Bros., passed through St. Louis en route to Hollybush, Ark., from Des Moines, Ia., where McClavey buried his wife the first week in December. McClavey Bros. expect to finish their work on the levee at Holleybush about Jan. 15th.

Columbus S. Jones has quite a few stationmen under A. L. Cook on the M., K. & T. R. R., near Blue Jacket, Okla.

Keating Bros. will finish their work on the Wabash R. R. at Mt. Olive, Ill., in a week or ten days. They are in the market for some more team work in this neighborhood.

PERSONALS

Mr. Leland B. Raab has been appointed city engineer of Tracy, Calif., succeeding J. Henry Smith. Mr. Raab will take office Jan. 1, 1916. Mr. Smith will take up engineering work in San Francisco.

Mr. G. Edgar Norris, who recently resigned as superintendent of the Maryland and Pennsylvania Railroad, has been appointed chief engineer of the Virginia railroad with headquarters in Norfolk, Va.

Mr. L. A. Brodie has been appointed county road engineer for Somerset Co., Maryland, with headquarters at Princess Anne. He is a graduate of Cornell University and is a former employe of the Maryland State Roads Commission.

Maj. J. P. Jervey of the corps of engineers of the United States army, was recently nominated by the president for promotion to the rank of lieutenant colonel. Maj. Jervey was formerly in charge of the Wheeling, W. Va., office and had charge of important river improvements.

Mr. Robert B. Marshall, Chief Geographer of the United States Geological Survey, has been promoted to the position of General Superintendent of the National Parks. He was in charge of the Geological Survey in the Sacramento district from 1904-07. Since then he has been stationed at Washington, D. C.

Mr. Edwin Jennings has resumed practice as consulting engineer at 835 Broadway, New York City. He has had wide experience, including ten years as chief engineer of bridge works in Springfield, Mass., and twelve years in the department of bridges of the city of New York. He will specialize in the design and construction of dams and bridges.

Mr. Thomas H. Mather, commissioner of public works and a member of the intercepting sewer board and the flood commission, of Syracuse, N. Y., will relinquish these positions on Dec. 31. He is chief engineer of a new corporation which has been organized to carry on a transportation business on the old and new canals between Albany and Buffalo.

Mr. K. B. Duncan has been appointed valuation engineer of the eastern lines of the Santa Fe. From 1911-13 Mr. Duncan was office engineer of the Santa Fe, under C. F. W. Felt at the Topeka, Kans., engineering offices. He left Topeka in 1913 to be engineer of the Gulf Lines with headquarters at Galveston, Texas. He was promoted when Mr. Felt was made chief engineer of the Santa Fe system.

Mr. William Goldsmith was recently appointed construction engineer in charge of the $800,000 improvements at the New York City reformatory for boys at New Hampton Farms, New Hampton, N. Y. These improvements comprise buildings, water supply, sewerage, railroad spur, power house, roads, etc. They will be built by the inmates of the institution, it being the plan to teach the boys trades. From 1905 to 1907 Mr. Goldsmith was an assistant engineer with the New York Board of Water Supply on the Ashokan Reservoir work; from 1907 to 1910 district engineer in the Philippine Islands on extensive road, bridge and building work; 1910-15, first assistant engineer and then superintendent of the municipal asphalt plant of the Borough of Manhattan, New York City. He is an associate member American Society of Civil Engineers and a member of the Municipal Engineers' Society of the City of New York.

Mr. R. M. Morton was recently appointed chief engineer of the Sacramento County Highway Commission with headquarters at Sacramento, Calif. He will have charge of the preparation of estimates for the proposed bond issue of about $1,750,000 for road improvements. Also, he will select the routes, make the location surveys and decide upon the character of pavements to be constructed. He will have charge of the construction of this road system. From 1907-8 Mr. Morton was assistant highway engineer of the Office of Public Roads; from 1908-13 he was engineer of the San Joaquin Co. Highway Commission and expended $2,000,000 on roads; 1913-14, chief engineer Sonoma Co. Highway Commission and did the engineering work preparatory to the $1,600,000 road bond election which failed to carry; 1912, consulting engineer for San Mateo Co. road bond issue of $1,250,000; 1913-15, in private general engineering practice at Stockton, Calif.

Mr. W. L. Stevenson, who has been closely identified with all the sewage disposal investigations, experiments and reports, made during recent years in Philadelphia, was recently certified by the Civil Service Commission as having passed the examination for assistant engineer of design of sewage treatment works. He will receive a substantial advance in salary. Mr. Stevenson's average of 99.1 was the highest ever attained by a candidate in any technical examination held by the Philadelphia Civil Service Commission. His work on sewage disposal in Philadelphia is highly appreciated by his contemporaries throughout the country.

The Baltimore Sewerage Commission, which will go out of existence on Feb. 1, 1916, will drop about 50 employes on Jan. 15. Many of these are engineers. Among those who will be retired are Division Engineer Oliver W. Connet, who has worked over 20 years for the city, G. J. Requardt, acting division engineer, and Assistant Division Engineers H. F. Schaeffer, J. E. Sheppard, S. O. Graham, Ralph Hutchins, George W. Townsend, Paul Wroth, C. L. Offenstein and C. G. Walker. It is understood that Engineers Thomas D. Pitts and Alfred H. Hartman are to remain with the sewerage department after it is reorganized and will be sent to the new quarters at the pumping station in East Falls Ave. They will have a force of assistants until existing contracts are completed and all details of the work finished up.

Capt. William Strother Smith, engineer officer, who has been acting as commandant at the Philadelphia navy yards, has been promoted to a most important post, created for him, because of his unusual experience. Captain Smith was ordered to Washington to pass upon inventions which may come before the board of invention and development, of which Thomas A. Edison is chairman. In speaking about the new position, Secretary Daniels said he had named Captain Smith because of his wide experience in engineering. Captain Smith belonged to the old engineers' corps and was transferred to the line with other officers of that corps in March, 1899. He was appointed as a cadet engineer to the Naval academy in 1875, graduating in 1879, after having pursued the engineer course in that institution. Captain Smith was promoted to captain in March, 1911. His entire service has been in engineering work, both at sea and on shore.

Mr. George E. Datesman, for several years past principal assistant engineer of the Bureau of Surveys, has been named Director of Public Works in the cabinet of Mayor-elect Thomas B. Smith of the city of Philadelphia. Mr. Datesman is a graduate in civil engineering of Lafayette College. He has been principal assistant engineer of the Philadelphia Bureau of Surveys since 1893. He was assigned to duty as assistant chief engineer in 1912. He has been acting chief engineer five times for periods of from one to three months. He has been actively connected with the design and supervision of construction of various public works, comprising among others the following: 600 miles of main and branch sewers costing $19,000,000; concrete river bulkhead and Aramingo Canal improvement costing $2,160,000; three river piers (two double-deck recreation piers) costing $390,000; dredging operations and rock removal in the Delaware and Schuylkill Rivers costing $2,167,000; avoidance of grade crossings at North Penn Junction, at Walnut Lane and Chew street, Pennsylvania avenue subway (sewer system), costing $1,116,000. He shared in the managing control of the South Philadelphia abolition of grade crossings, improvement and construction of bridges, approximating $30,000,000 in cost; joined in investigation and report upon a comprehensive plan for sewage disposal for the entire city of Philadelphia, estimated to cost $35,000,000. He has been consulted upon subway construction, comprehensive plans of the city, including boulevard extensions, dock development and various public works coming under control of the department. Special mission: Commissioned by the mayor of Philadelphia in 1913 to represent the city at the International Buildings Trades and Scientific Accessories' Exposition at Leipsic, in Saxony, Germany, and to make an investigation of public works and especially modern methods of sewage disposal in European cities. On a visit to forty-five cities, including all the principal capitals, there were investigated harbor improvements, bridges, boulevard and parkway development, urban transportation systems, especially subways; modern street extension and paving methods, means of financing improvements and especially modern sanitary methods of sewage treatment. Mr. Datesman was called into consultation by the Metropolitan Sewerage Commission of the city of New York in connection with working out a comprehensive scheme of sewage collection and disposal for that city. He is a member of the American Society of Civil Engineers, Engineers' Club of Philadelphia, and the American Public Health Association.

OBITUARIES

Samuel M. Blevens, commissioner of public utilities in Arkansas City, Kans., died at his home in that city on Dec. 14.

Francis F. Roberts, once widely known as an inventor and railroad builder, recently died in Denver at the advanced age of 91 years. He constructed the famous mule-power railway at Nashville, Tenn., soon after the Civil War and before the advent of cable and electric railways. Later he built the street railway system of Milwaukee, Wis. During recent years he devoted much of his time to the promotion of one of his inventions, a metal railway tie.

Maj. Georges Janin, for years chief engineer for the city of Montreal, Quebec, was reported among the missing from the steamship "Anglia,' which struck a mine while crossing the English channel. Major Janin, who had raised a corps of engineers for army service, was being sent from France to England where he hoped to recuperate from sciatica. He was on a long leave of absence from Montreal on one-third his normal salary. He was a native of Poitiers, France, and was a veteran of the Franco-Prussian war of 1870 He went to Canada in 1892 and, after engaging in general engineering work, entered the employ of Montreal in 1898 as acting superintendent of the aqueduct system. He finally assumed charge of the water department. In 1910 he was made chief engineer for the city and subsequently formulated the plans for the enlargement of the aqueduct and for the hydro-electric system for the generation of 10,000 hp.

NEW CATALOGUES

Motor Trucks.—Paper, folder, Packard Motor Car Co., Detroit, Mich.

"Bulletin No. 11." Points out efficiency of Packard motor cars for all kinds of service and under all weather conditions. Catalog on request.

Asphalt.—Paper, 4½x8½ ins.; 12 pp., The Atlantic Refining Co., Philadelphia, Pa.

"In Modern Road Building." Describes and illustrates the use of Atlantic paving asphalt (for hot mixing method). Atlantic penetration asphalt (for penetration method), Atlantic N. C. B. asphalt (applied cold), and Atlantic asphalt road oil.

Motor Trucks.—Paper, 9x12 ins.; 24 pp., The Gramm-Bernstein Co., Lima, Ohio.

Booklet describing in detail and illustrating the various types and details of motor trucks made by this company. These trucks are made in six sizes: 1, 1½, 2, 2½, 3½ and 5-6 ton capacity. The illustrations used in this booklet are especially clear cut and comprehensive.

RAILWAYS

BIDS ASKED.

Kentucky:

Winchester, Ky.—J. L. Oldham, Colonial Bldg., Winchester, Ky., wishes to get in touch with railroad contractors to complete six-mile line, 80 per cent of which is now built.

Texas:

Orange, Tex —The Lutcher & Moore Lumber Co., Orange, wishes to correspond with contractors for constructing 35 miles of road. This will be an extension of the Gulf, Sabine & Red River R. R.

New Brunswick:

Fredericton, N. B.—Until noon, Dec. 30, by Irving R. Todd, President St. John & Quebec Ry. Co., for construction and equipment, without rolling stock, of uncompleted section of line of railway.

PROSPECTIVE WORK.

Arkansas:

Yellville, Ark.—Yellville-Rush & Mineral Belt Ry. Co. has been incorporated with a capital stock of $140,000, and proposes a 19-mile road through Yell County. It is reported that work will be started by Jan. 1. Line will tap rich mineral section. J. C. Shepard, Rush, is president.

Mountain Home, Ark.—Surveys are under way for a narrow-gage railroad to be built from Cotter to Rush. The line will be about 14 miles long and will traverse the Buffalo River and Rush Creek mining districts. R. P. Sharp is engineer.

Pine Bluff, Ark.—Pine Bluff & Northern R. R. Co. is reported to have completed plans for an extension from Cullor to Pine Bluff, a distance of 53 miles. It is stated that construction will be started next year.

Georgia:

Atlanta, Ga.—Louisville & Nashville R. R. is reported to be planning to secure entrance to Atlanta by means of an extension from Cartersville to Marietta.

Indiana:

Indianapolis, Ind.—Pennsylvania R. R. will start work early in spring on elevation of tracks in Indianapolis south of Ray St.

Kansas:

Topeka, Kan.—Kansas Southern Traction Co. has been rechartered with a capital stock of $100,000. This is the company proposing an interurban line from Parsons to Oswego and Columbus. Phillip Strack, Parsons, Kan., is the promoter.

Maryland:

Baltimore, Md.—It is reported here that the Pennsylvania R. R. has under consideration plans for entering the Curtis Bay district. It is believed that the road will either tunnel the Patapsco River from its yards at Canton or else make an agreement with the Western Maryland to use its car slip at Curtis Bay.

Michigan:

Detroit, Mich.—Grand Trunk Ry. contemplates an expenditure of $330,000 here in improving its team tracks and freight house conditions.

Mississippi:

Pascagoula, Miss.—Panama Line, Pensacola and Missouri Valley R. R. Co., has been chartered with a contemplated capital stock of $22,000,000, and proposes line from point near Pensacola, Fla., to Kansas City, Mo., and Omaha, with branches to coalfields in Alabama and Arkansas. Walter D. Seaver, Pascagoula, and C. W. Lacy, Anniston, Ala., are incorporators.

New Jersey:

East Orange, N. J.—City has retained George F. Swain, Boston, Mass., Consulting Engineer, to report on plans for eliminating crossings in city along line of the Lackawanna R. R.

Bernardsville, N. J.—New Jersey and Pennsylvania R. R., operating line from Whitehouse to Watnong, has been reorganized under the name of the Pennsylvania and New Jersey R. R., and a bond issue of $250,000 will be made. It is proposed to at once improve the line. Frank B. Allen is interested.

New York:

Syracuse, N. Y.—Syracuse Grade Crossing Commission has plans well advanced for eliminating grade crossings in this city.

North Carolina:

Bryson City, N. C.—Atarka Valley R. R. Co. has been chartered with a capital stock of $150,000, of which $12,000 has been subscribed, and proposes construction of 12 miles of railroad from Bryson City to falls of Atarka Creek. Arthur Brooks, Buckhannon, W. Va., is interested.

Ohio:

Cleveland, O.—The necessary land is stated to have been secured for city level freight terminal at West Ninth St., and the undertaking is reported to have been completely financed by Home Financing Co., A. A. Fudge, Secretary. It is stated work will be started before spring. The project includes a concrete and steel building, to cost about $2,000,000.

Oklahoma:

Oklahoma City, Okla.—Incorporation papers have been filed for proposed extension of interurban line from Edmond to Guthrie; capital stock is $500,000. Incorporations include Geo. Sharpel and Anton H. Classen. It is reported that survey will be started at once.

Pennsylvania:

Uniontown, Pa.—Pennsylvania R. R. will expend about $240,000 next year for new yards, freight house and warehouse here.

Tennessee:

Memphis, Tenn.—The Illinois Central R. R., according to report, will expend about $1,000,000 in improvements at the Nonconnah yards during 1916. Work will include additions to roundhouse facilities and other shops.

Memphis, Tenn.—Memphis Street Ry. Co. is considering extending its Florida St. car line to Nonconnah.

Johnson City, Tenn.—Holstein Valley R. R. is securing right-of-way for extension from Bull's Gap to Leadville, 22 miles.

Texas:

Waco, Tex.—Missouri, Kansas & Texas R. R. is reported to be planning an expenditure of $200,000 here next year for freight station and remodeling passenger station.

Freeport, Tex.—Surveys are under way for a railroad from this place to extend in a northerly direction on the west side of Brazos River. W. A. Randle, Freeport, is Engineer.

Austin, Tex.—Southern Traction Co., Waco, is reported to be planning to take up construction next year of an extension to its electric interurban line from Waco to Austin and thence to San Antonio.

West Virginia:

Huntington, W. Va.—Chesapeake & Ohio R. R. will expend about $100,000 for improvements in this city. Work includes trackage rearrangements in the yards.

Wisconsin:

Milwaukee, Wis.—Milwaukee Realty & Securities Co. has voted to increase the capital stock from $25,000 to $300,000. This company is helping to finance the building of an interurban line for the Milwaukee Western Electric Ry. Gustav Meisner, Oconomowoc, Wis., is president of the financing company.

BIDS OPENED; CONTRACTS LET

Kansas:

Leavenworth, Kan.—Chicago, Burlington & Quincy R. R. has awarded a $75,000 contract to Warren Houser of Weston, Kan., for furnishing willows to be used in riprapping the river bank.

Kentucky:

Barbourville, Ky.—A. B. Furnish, Mt. Vernon, Ky., has taken sub-contract for grading section of Cumberland & Lancaster R. R. Read Construction Co., general contractors.

Ohio:

Canton, O.—Casey Contracting Co., Pittsburgh, Pa., has been awarded grading contract for five mile spur line at Canton for Wheeling and Lake Erie R. R.

Oklahoma:

Henryetta, Okla.—Ally Bros. are reported to have been awarded a contract for grading ten miles of line for Henryetta, Oklahoma & Western Ry. W. P. Croslen, Oklahoma City, is president.

Oregon:

Portland, Ore.—The Guthrie McDougal Co., Portland, has been awarded contract by Oregon & Washington Ry. & Navigation Co. for lining about one mile of tunnel with concrete. Tunnel extends from Mock's Bottoms under Columbia Park to the Columbia Slough. Work will cost about $450,000.

Pennsylvania:

Philadelphia, Pa.—The American Bridge Co. at $249,000 was low bidder Dec. 14 for structural steel to be used in extension of Frankford "L" on Frankford Ave. between United and Dyre Sts.

Tennessee:

Oneida, Tenn.—Oneida & Western Ry. has let contract for 2½ miles of additional line. This company has 15 miles of line already graded and has laid 10 miles of track to Big South Fork river, where it is erecting a 240-ft span, 2-track bridge. The Cook Construction Co. is contractor.

Oneida, Tenn.—Rhodes, McDowell & Baker have contract for 11-mile extension of Tennessee Ry. Line will run up new river to Big Boushy Mountain, where a connection will be made with Harriman & Northeastern Ry.

Chilhowee, Tenn.—Oliver & Hill, Knoxville, Tenn., have been awarded contract for 2 1/5 miles of railroad on Bushnell extension of Southern Ry., to point in North Carolina where proposed dam of Aluminum Co. of America is to be constructed.

ROADS STREETS

BIDS ASKED.

Alabama:

Dadeville, Ala.—Until Jan. 12 by County Commissioners for constructing 38 miles of highway.

Arizona:

Tucson, Ariz.—Until 10 a. m., Jan. 3, by B. L. Hitch, Court County Clerk, for 11-ton steam or gasoline road roller and one 25-cu yds. capacity portable telescoping gravel bunker; also 15 h. p. portable oil engine.

California:

Santa Barbara, Cal.—Until 10 a. m., Jan. 3, by C. A. Hunt, Clerk County Supervisors, for fencing along state highway.

Florida:

Kissimee, Fla.—Until Jan. 3 by J. L. Overstreet, Clerk County Commissioners, for constructing 1 mile of sand-asphalt road.

Idaho:

Wallace, Ida.—Until Jan. 15, by Robt. Merriam, City Engineer, for paving streets in District No. 4.

Illinois:

Belleville, Ill.—Until 2 p. m., Dec. 23, by Board of Local Improvements for 124,000 sq yds. of reinforced concrete paving and 55,500 ft. of concrete curbing. W. C. Wolf, City Engineer.

Evanston, Ill.—Until 8 p. m., Jan. 17, by H. P. Pearsons, President Board Local Improvements, for 29,900 sq. yds. of brick pavement on portions of Simpson and other streets and 41,400 sq. yds. of brick pavement on Bridge and other streets. Advertisement in this issue.

Indiana:

Monticello, Ind.—Until 10 a. m., Jan. 4, by County Auditor, for crushed stone road in Walnut Township.

Shelbyville, Ind.—Until 10 a. m., Jan. 5, by F. W. Fagel, County Auditor, for gravel road ½ mile in length in Liberty Township.

Vincennes, Ind.—Until 2 p. m., Jan. 4, by J. I. Muentzer, County Auditor, for about

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thoma

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Success in the Future.

Conditions such as we are now facing in this country may well serve to emphasize the need for designing our structures, planning our industries, and training our young men in such a way as will enable advantage to be taken of changes which we must expect but which cannot be foreseen with certainty. Specialization will be desirable—in fact, specialization is necessary if we are to approach the limit of possibility in any science or in any art. It is doubtful, however, if we can train specialists in large numbers—as there has been a decided tendency to do—by starting their specialized training very early, and not pay a heavy price in the end for such efforts. The most successful specialists are—and will continue to be—those who follow their inclinations and complete their highly specialized training after they have secured a broad education in the fundamentals of success. Many of our schools and colleges have been more concerned with their attempts to make specialists of the young than in endeavoring to give each an education sufficiently broad and thorough as will enable the graduate to safeguard himself in any environment in which he later must work. As this country takes its proper place among nations it will be necessary for its citizens to be prepared, to an ever increasing extent, to change the nature of their work as the demands made upon this country change. Those whose education and training are broad and thorough will find greater opportunity than ever before, as adaptability and resourcefulness will count more and more as time goes on.

Good Reading for Officers of Engineering Societies.

Many organizations suggest the predicament of the young person who was all dressed up and had no place to go. Some engineering societies are so situated, apparently. The best illustration of an organization of this general type which comes readily to mind is a certain alumni club to which the editor belongs, and, it should be added, to which he pays dues. The membership is large, and permanent headquarters are maintained within easy reach of a majority of the members. The club is well organized, but the organization never seems to get any place—in fact it does not seem to be headed any place in particular. It has officers, committees, etc., but, to save us, we could not name two useful things it has accomplished in as many years. It either lacks purpose or its purpose is not wisely conceived, or is not well understood. When it was formed there was considerable talk about Siwash College men doing as much as the men from other colleges—some others had established permanent headquarters; therefore we must do the same. This reason appeared to be satisfying. We never heard any other seriously advanced. We wonder if there are not many other organizations with the same lack of purpose.

We publish a very interesting article in this issue on what the engineering society owes to its members. The author says: "It is not enough for men to get together to discuss technical matters of mutual interest, or to promote good fellowship by social gathering. There is such a thing as building up a machine in which all of the energies are devoted to the perfection of the machine and in keeping it in motion. People quickly get tired of 'watching the wheels go round,' and begin to ask what is the output and how efficient is the machine in comparison with the power applied to it."

The season of state engineering society meetings impends. Officers of such and similar societies will find the article to which we have made reference well worthy of a careful reading.

Economics a Quantitative Science.

Economics, whether industrial or political, is a science whose ultimate object is the attainment of maximum profits. Of course different aspects of the problems of economics present themselves, depending upon whether the point of view is that of the individual, or a group of co-operative individuals. But in any case, every economic problem must be finally expressed in money if there is to be a definite solution. Stated differently, economics is fundamentally a *quantitative* science.

With this thought held in mind, turn to the vast library of books and periodicals relating to so-called "economics," that is, political economy. We find there, it is true, a considerable array of cost figures, but, on the whole, they are buried amid verbiage—gold dust in tons of sand. To the engineer trained to reduce all his problems to expressions of cost and profit, it is a constant source of wonder that political economists dare call themselves economists at all, much less appropriate the term "economics" as their very own and to be used only in connection with public affairs.

When two intelligent and well informed men differ on a question of economics, it is a safe conjecture that neither of them has any trustworthy cost data with which to support his contentions. Curiously enough most men seem to think that they can solve a problem in economics without the use of cost data. In fact, of course, no solution of any economic problem is possible unless cost data are available. It may be true that the cost data are roughly approximate or determinable only between rather wide limits, but cost data of some sort are indispensible in every real solution of an economic problem, be it a question of "free trade" or of "the best way" to darn a stocking. Were this principle of logic generally recognized, probably 99 per cent of all literature on "economics" would remain forever unread, save by the historian or by the student of logic searching for examples of sophistry.

Every engineer should read several of the standard works of political economy, if only to know how little political economists really know. But in the reading of such works a reflective engineer will see opportunity to take from the arena of debate many a subject and place it securely in the temple of ascertained fact. To do so will involve research and scientific study of costs—the antithesis of the methods commonly used by political economists.

Failure to seek to reduce economic problems to quantitative expression is not confined to political economists. Engineers and other scientists are often chargeable with similar failure. Indeed many of the debates found in the proceedings of engineering societies savor of the futile attempt to solve a quantitative problem without the use of quantities. Thus, it may be claimed by one engineer that a certain design or a certain construction method is preferable to other designs or methods. And "proof" of this contention is often given by listing verbally the "advantages" of the given design or method. Yet such a process is no proof at all. At best it is merely preliminary to a possible proof. The real proof must be expressed in money or its equivalent—must be quantitative.

Ten years ago this journal began the consistent and persistent advocacy of the principles above outlined. From many quarters it met ridicule at first, but the ridicule gradually gave way to mild opposition which itself has at last almost vanished. Cost data are now generally admitted to have value to others than those who gathered them.

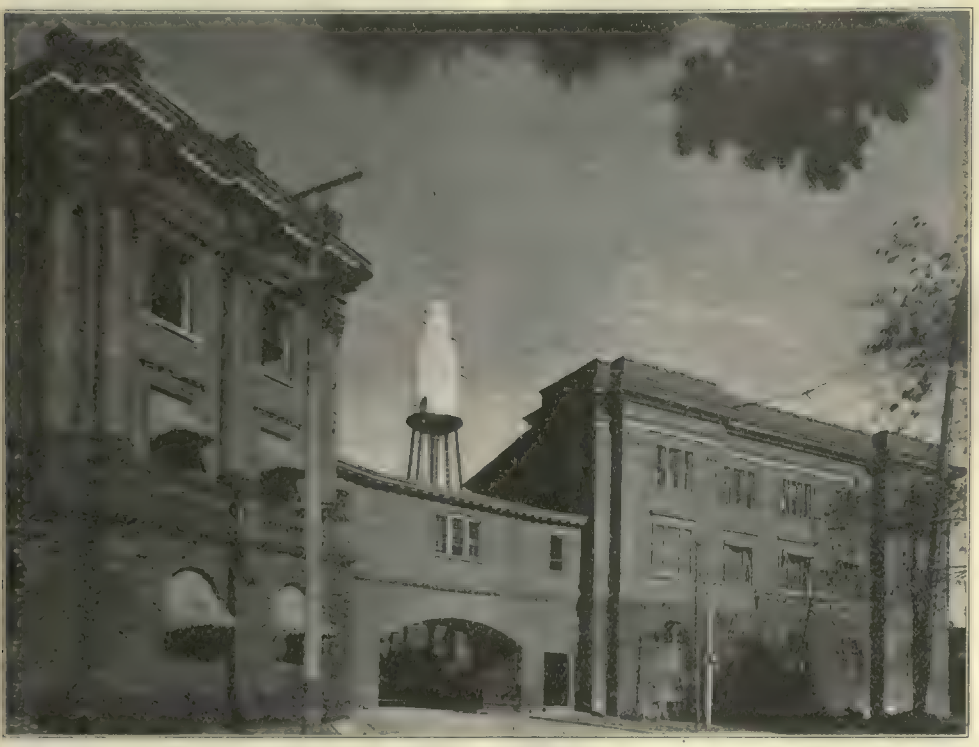
Highway Construction and Maintenance in 1914.—Statistics collected by the U. S. Office of Public Roads and Rural Engineering indicate that nearly $250,000,000 were spent in highway construction and maintenance in the United States during the year 1914. One-fifth of the work was done under the state aid system, the various state highway departments paying $24,220,000 and the counties and townships $25,193,000. State aid laws are in effect in 44 states, New Jersey having instituted the system in 1891 and Tennessee and Georgia being among the last to adopt it in 1915. Thirteen states spent $25,605,000 during the year in the construction and maintenance of state roads solely at their own expense, making a total of almost $50,000,000 paid directly out of state funds. One-third as much, $12,500,000, was spent for repairs and maintenance as was spent for new construction, $25,500,000. This shows the enormous loss resulting from the building of types of roads whose surfaces are not durable under present traffic conditions. Six eastern states paid two-thirds as much out of the state treasury for maintenance as for new construction. Rhode Island, New Jersey, Pennsylvania, New York, Massachusetts and Connecticut spent in the aggregate $14,338,800 for maintenance and $21,110,400 for new construction. There are now 247,490 miles of hard-surfaced roads in the United States out of a total of 2,273,000 miles of public roads, or 10.9 per cent. Last year 6,805 miles of state roads and state-aid roads were built, making the total of new roads built with such funds to January 1 last 35,477 miles.

Panama Canal Excavation Records in November.—The total excavation by the dredges in Gaillard Cut during the month of November, exclusive of rehandling, amounted to 1,228,730 cu. yds. This sets a new high record for a month's dredging work in the cut, the previous highest quantities having been 1,052,586 cu. yds. in September and 1,079,693 cu. yds. in October, 1915. In October, 872,982 cu. yds. were taken from the bases of the Culebra slides, and in November the spoil removed from these slides amounted to 1,004,480 cu. yds. The spoil rehandled by pipeline suction dredge No. 86, and not credited as excavation, amounted to 37,994 cu. yds. The new 15-yd. dipper dredge Cascades set a new high record for a month's work by one dredge in excavating 296,280 cu. yds. in November. This was the first month of operation for the Cascades, as the dredge was placed at work about midday of Oct. 31.

WATER WORKS

Shaping Water Tanks to Symbolize the Industry They Protect.

To the Editors:—In your magazine of Dec. 15, 1915, I have read with interest your article on "Shaping Water Tanks to Symbolize the Industry They Protect." I have much respect for your judgment on engineering subjects, but, in this case, I beg to differ with your conclusions. I have no business interest whatever in the City Dairy Co. of Toronto, who have recently erected a bottle-shaped water tower for fire protection, but I believe that the innovation in water tower design, as conceived by the manager of the firm in this particular case, is creditable, and adds to, rather than detracts from, the dignity and appearance of the surroundings. Herewith is a photograph of the plant, showing the new water tower, to which view I do not think you will take any serious objection.



View of Bottle-Shaped Elevated Water Tank, of the City Dairy Co. of Toronto, Ont., and Its Surroundings.

From the aesthetic point of view, this picture, to my mind, is more pleasing than the appearance of the well known form of the ordinary water tower, which is usually dingy and unattractive, though occupying often a prominent position.

This industrial symbolism for both advertisement and novelty in water tower design should not be carried too far, but in cases where the new design is not too far removed from the ordinary serviceable type, as for instance a barrel-shaped tank for a milling company, it would be, I think, an acceptable change to the public.

The unchangeableness of the Egyptians was largely responsible for their downfall. Originality, creative power and initiative were rigorously suppressed. They virtually became mummified. The caste system classified a man before he was born. Engineering, I think, should be far removed from even an approach to this unprogressive spirit. Where originality, combined with utility and good business, is displayed, as I conceive in the design and erection of this bottle-shaped tank, it is to be encouraged.

Very truly yours,

W. Blaine Redfern, B. A., Sc.,
Civil Engineer.

14 Wells Hill Crest, Toronto, Ont., Dec. 18, 1915.

(The editors are very glad to give space to Mr. Redfern's letter. We stated one view of the advisability of shaping water tanks to advertise an industry in the editorial to which he makes reference; he has made a forceful statement of the opposite view. The subject is new and this is the time to discuss its merits and demerits. We shall be pleased to extend this discussion at the pleasure of our readers.—Editors.)

Desirability and Method of Connecting Low-Voltage Secondary Electrical Circuits to Water Pipes—Effect on the Pipe System.

The protection of persons and property against electrical dangers has in recent years become an important problem. In the beginning of the art of distributing electrical energy to consumers voltages were low, direct current was used, and in the case of each system the points of consumption were confined to a comparatively restricted territory. Then the dangers to persons from electrical circuits were practically negligible, but the dangers to property were not, because insulation and methods of construction were undeveloped. At the present time, however, far different conditions exist. Electrical systems have been enormously extended, and the demand for economical operation of the extended systems has brought about the use of voltages greatly exceeding those used in the beginning. The development of alternating current machinery and methods of transmitting electrical energy over long distances has been chiefly instrumental in bringing about the new conditions. With the increase in the voltages at which electrical systems are operated, dangers to persons and property have multiplied. It is true that improvements in methods of construction and quality of insulation have kept pace with the growth of electrical systems, or vice versa, whichever way one chooses to look at it, but at the same time many dangers arise from electrical circuits which require special means and devices to render them harmless. One of the most important sources of danger is that due to the close proximity between high-voltage and low-voltage circuits in transformer windings, on pole lines, in manholes, and other places where, for lack of space or for other reasons, it is necessary to place such circuits near each other. The actual danger in this case arises from the entrance of voltage and current from the high-voltage circuit upon the low-voltage circuit through faults in insulation, contacts between wires and in other ways. The great importance of this source of danger is due to the fact that large numbers of people are continually coming in contact with apparatus and appliances connected to these low-voltage circuits. It is, therefore, the duty of persons installing such circuits to make them as safe as it is practicable to make them; and it is, moreover, to the best interests of everybody concerned with them that they should be made safe. Much can be accomplished in this respect by connecting these low-voltage circuits to earth in the proper manner. It is the purpose of this article to discuss briefly the principal causes of the dangers just mentioned, the desirability of connecting low-voltage secondary circuits to water pipes to avert these dangers, and also the effect on the pipe systems of such earthing.

DANGERS FROM ELECTRICAL SYSTEMS.

One of the most common forms of low-voltage circuits are those fed from high-voltage alternating current circuits through step-down transformers. In this case the danger arises from the entrance of current and voltage from the high-voltage circuit either through leaks in transformer insulation or contacts between wires. Leaks in transformer insulation or contacts are caused in most cases by lightning striking the line and puncturing the insulation between windings. Much effort has been expended in developing lightning arresters to take care of these lightning strokes without injury to the transformers, and much has been accomplished, but complete protection is not now obtainable. Contacts between line wires result from storms, electrical accidents to cables, and other causes.

As an example, take a transformer connected to a 2,200-volt distributing system which transforms energy for lighting a group of dwelling houses by means of a 3-wire 110-220-volt circuit. If during a storm a high voltage line wire breaks and falls on a low-voltage wire, or any one of the possible accidents occurs which may have a similar result, a condition may arise such as that illustrated in Fig. 1. That is, one side of the low-voltage circuit is, in effect, connected by a wire to one side of the high-voltage circuit. If both circuits are insulated from ground at all points, an electrostatic voltmeter, or some other voltmeter which takes but slight current to operate it, will show at V a difference of potential approaching 1,100 volts between low-voltage circuit and ground, the actual voltage indicated varying with a number of factors. It is not likely, however, that either circuit will be thoroughly insulated at all points. There may be faults in the insulation, and if there are the voltmeter may read as high as 2,200 volts. This would be the case if the opposite wire of the high-voltage line were down and touching ground somewhere, or were even in contact with a tree.

In either case if the low-voltage circuit were in any way accidentally grounded, the flow of current to ground might be considerable. In the first case the current flow that might occur would be due to the electrostatic capacity between the high-voltage line and ground, the line acting as one plate of a condenser and the earth as the other. The alternating voltage of the line itself would tend to charge and discharge this condenser through the fault *A* in Fig. 1 in series with whatever accidental ground happened to be on the low-voltage circuit. This might be the body of a person in contact with lighting fixtures. The value of this condenser current is about 10 milliamperes per mile of line. The magnitude depends directly upon the length of the line, so it would reach a dangerous value with a length of line of 10 miles. In the second case the current would depend upon the sum of the resistances between low-voltage circuit and ground and between the opposite wire of the high-voltage circuit and ground. Similar conditions may arise with any low-voltage circuit if it comes in contact with a high voltage circuit.

PROTECTION AGAINST THE MAXIMUM DEGREE OF DANGER.

It is obvious that when there do exist such high voltages between low-voltage circuits and ground, there is great danger to persons handling lamp sockets and other appliances; moreover, there is an extreme likelihood of fire following a failure of insulation of the low-voltage circuit because of current flowing from the high-voltage circuit to ground and heating inflammable substances. The frequency with which fires and accidents are reported from this cause is sufficient evidence of its seriousness. The condition described above, however, represents the maximum degree of danger which can arise, and the one which is likely to be met with the most infrequently. There may be a lesser degree of danger; such, for instance, as that which would be brought about by a failure of transformer insulation at some place beyond the end turn of the high-voltage winding. In that case the voltage to ground might be only a small fraction of 2,200 volts and the danger proportionately less. But it is necessary to protect against the full voltage because this will frequently be encountered.

It is evident, therefore, that in the case of low-voltage circuits fed through transformers from high-voltage circuits, or where a low-voltage circuit of any kind is liable to contact with high-voltage circuits, great precautions are necessary to prevent accidents; furthermore, the best available means and devices must be used. From the dangers just described a great deal of protection can be obtained by connecting the low-voltage circuit to earth as in Fig. 2. For the best degree of protection it is necessary that the resistance to flow of current from the low-voltage circuit through the earth wire *B* and earth connection *E* be very low. That is, a current must easily pass from the low-voltage circuit into the earth in case of contact with a high-voltage line. If this is the case, and the resistance to flow of current is low enough, a dangerous voltage can not exist between low-voltage circuit and ground. For example, instead of the voltmeter at *V* in Fig. 2 reading between 1,100 and 2,200 volts, as it did under the condition shown in Fig. 1, it will now read a value which may be found by multiplying the current flow in amperes in wire *B* by the resistance in ohms to flow of current into the earth at *E*. If the resistance at *E* is low, the voltage measured at *V* will be low even though a large current is flowing. The lower this voltage is the better, and for a high degree of safety it should in no case exceed 150 volts. The current which will flow in wire *B* depends upon the current carrying capacity of the protective devices on the line from which the current comes. This may be small or large, and the maximum allowable resistance in the earth connection at *E* will depend upon the maximum value of this current. The maximum current which a line will carry permanently is limited by the rated current of the fuses or automatic circuit breakers which protect it from overload. Hence, the maximumimum allowable resistance in the earth connection can be expressed by the following formula: $R = \frac{150}{I_a}$, where *R* is the resistance in the earth connection, 150 is the allowable voltage between low-voltage circuit and ground, and I_a is the current required to operate the fuses or circuit breakers which open the circuit. If this current is 100 amperes, *R* will be 1.5 ohm; 200 amperes, 0.75 ohm; and so on. One hundred-fifty volts, however, is the maximum allowable voltage rise between low-voltage circuit and ground. There is a slight possibility of danger from this voltage even, but only under special conditions; so for practical purposes 150 volts may be considered as a safe limit. Serious accidents to persons from potential differences between low-voltage circuits and ground of 150 volts or less have been reported only as having happened in very damp locations, or in other places where extraordinarily good contact was made with both low-voltage circuit and ground.

EARTH CONNECTIONS.

The next question is that of obtaining a low value of resistance for the earth connection *E*. There are several methods by means of which electric circuits can be earthed; namely, by utilizing water pipe systems, driven pipes or buried plates. Buried strips of metal of any desired length may also be used under special conditions, and there are on the market many patented devices for making earth connections. In this list, however, water pipe systems easily come first in point of desirability. In the first place, on account of their great extent they offer but little resistance to flow of current away from them into the earth, the resistance of water pipe earth connections being found to be but a fraction of an ohm in most cases. A resistance of two ohms would be extraordinarily high. As pointed out later, however, where these low resistances are found the pipe joints for a considerable distance from the earth connection must give as good metallic contact as will ordinarily be found with lead or screw joints. In the second place, water pipes are easily accessible at service pipes or at other places; and, in the third place, it can be shown that with certain precautions all possibility of damage to the pipes, or injury to employes of the water company can be easily avoided. In fact many dangers considered of importance in the past do not exist where the grounding is properly done.

TABLE I.—RESISTANCE OF EARTH CONNECTIONS.

Kind of earth—Clay, rather stony. Earth connections in place 4 months and soil fairly moist when measurements were taken.

Type of earth connection.	Resistance. Ohms.
Strips of galvanized iron 1½ ins. wide, 20 ft. long, in clay 12 ins. deep (av. of 8)...	30
Strip 160 ft. long in clay 12 ins. deep......	5
Strip 60 ft. long in trench 12 ins. deep with 4 ins. of coke in trench, covered with clay	8
Strip 60 ft. long in clay 12 ins. deep with 1 lb. of salt per foot of strip............	6
Paragon ground cones 2 ft. long, 5 ft. deep in coke (av. of 2)..........	57
Paragon ground cones 1 ft. long, 5 ft. deep in coke (av. of 2)..........	72
Maxum ground boxes 5 ft. deep in clay (av. of 2)..........	52
Brach hydroground, large size, 5 ft. deep in clay	61
Brach hydrogrounds, medium size, 5 ft. deep in clay (av. of 3)..........	64
Lord disc type hydrogrounds, 5 ft. deep in clay (av. of 2)..........	83
Federal Sign System, 22-in. cartridge ground plate, 5 ft. deep (av. of 2)......	30
Federal Sign System, 10-in. cartridge ground plates, 5 ft. deep (av of 2)......	59
Plates, 2x4 ft., on edge in clay 5 ft. deep (av. of 3)..........	33
Plates, 2x4 ft., flat in clay 5 ft. deep (av. of 2)	43
Plate, 2x8 ft., flat in clay 4 ft. deep......	32
Plate, 2x8 ft., in coke 4 ft. deep..........	17
Plate, 2x8 ft., in salted earth 4 ft. deep..	8
Pipe earths, ¾-in. pipe, 5 ft. deep (av. of 8)	73
Pipe earths, ¾-in. pipe, 10 ft. deep (av. of 8)	52

With regard to driven pipes, buried plates, or strips of metal, and patented earthing devices, Table 1 gives the results of measurements on a number of these forms of earth connections made in rather stony clay at the U. S. Bureau of Standards. These measurements represent a part of the results of a thorough study of the subject of earth connections for electrical systems which is now being made by the Bureau. The table is practically self-explanatory, and shows in general that a low resistance, or a resistance low enough effectively to avert danger of the kind just described, is not easy to obtain by means of any of these devices. In considering the results given in Table 1 it should be borne in mind that the resistivity of the soil in which these earth connections were made is considerably higher than the average of that found in practice, although the soil in some places will be of even higher resistivity and hence worse for the purpose of making earth connections than that described. It may also be stated as a well known fact that if pipes are driven in the earth at a distance from each other and connected together by a wire the combined resistance to flow of current away from the several pipes into the earth will be much less than that of a single pipe. In fact, for pipes driven at 10 ft. or more from each other the resistance to flow of current away from them into the earth is roughly inversely as the number. That is, with two pipes driven from 6 to 10 ft. from each other the resistance is a little more than half that for a single pipe, with three pipes the resistance is a little more than one-third that for one pipe, with ten pipes one-tenth, and so on. As just stated, this is only roughly approximate and as the number of driven pipes increases, the distance between them must also increase in order to maintain even the approximate relationship between number and resistance.

If the resistance of a single driven pipe earth connection in a certain locality were as low as 15 ohms, to obtain a resistance comparable with that of a water pipe system in the same place would therefore require 50 or 60 pipes driven in the earth at 10 to 20 ft. distant from each other and electrically connected together. This is plainly impracticable. It must be granted, of course, that by the use of driven pipes or buried plates a certain degree of protection can be obtained; in the case of small transformers and lines of limited capacity even an ample degree of protection can thus be obtained. But as the kilowatt capacity of the lines and transformers increases, the resistance required of the earth connection must decrease. The practicable limit of decrease of resistance with driven pipes or buried plates is soon reached, and for the circuits of larger capacity it is imperative that some other means be found. In fact, for all low-voltage circuits it is highly desirable to have low resistances in the earth connections. The most obvious solution of the problem is to use water pipe systems which, in most cities, cover approximately the same areas covered by the electrical systems. To connect to the water pipe systems is highly advantageous to both the electric company and the consumer.

There are, of course, localities not reached by water systems, and in such places it is necessary to resort to driven pipes and other means of making connection to earth. As stated above, where the installations are of small power rating an ample degree of protection can be obtained with driven pipes, and considerable protection even in the case of fairly large installations. In no case should earthing be omitted. If there is sufficient ground space available a number of pipes can be driven to a depth of 8 or 10 ft. at a distance of 5 to 10 ft. from each other and connected together. If space is lacking, 3 or 4 pipes driven to a depth of 10 ft. around a pole will give a resistance which in many cases may be considered sufficiently low. Three pipes driven around a pole and close to it will be found to have a resistance of approximately 50 per cent of that of one of the pipes.

EFFECT ON WATER PIPES OF USING THEM AS EARTH CONNECTIONS.

It has been shown above that it is very desirable to connect low-voltage secondaries to water pipes. It must also be shown, however, that the use of the water pipes for making earth connections is not in any appreciable degree a disadvantage to the pipe owning company. In the past it has been stated that trouble for the company would arise from three sources: (1) Electrolysis by stray currents from the earthed circuits; (2) danger to employes of the water utility while working on service or other pipes to which low-voltage circuits were earthed; and (3) complications from allowing a second public service utility the use of the pipes.

ELECTROLYSIS.

The subject of electrolysis in this case may be considered under two heads: (a) electrolysis by alternating current, and (b) electrolysis by direct current.

(*a*) *Electrolysis by Alternating Current.*—Referring to Fig. 3, *A* represents an extensive low-voltage alternating current circuit which is earthed at a number of points to service pipes, these service pipes being all connected to the same water system. It is readily apparent that under normal conditions of operation, or with insulation everywhere in good condition, the opportunity for current flow in pipes is very slight. With unbalanced load on the system current would flow in the middle wire, setting up differences of potential between the points *e*, *f*, and *g*. This would cause current to flow in the pipes, but the voltages between *e*, *f* and *g* being necessarily small, the currents would be small, since there is more or less resistance in the pipes. In no case would the current flow exceed a fraction of the flow in the middle wire.

On the other hand, there can be no interchange of current between circuits *A* and *B*. In order for this to occur, the flow would have to take place from *A* through earth wires *a*, *b* and *c* in parallel, over the water pipe to wire *d* and circuit *B* and back to *A* on the high-voltage line. As two layers of transformer insulation prevent this, such an interchange of currents is impossible, unless there are faults in the insulation of both transformers. If this should occur fuses 1, 2, 3, or 4 would be likely to go out and isolate the low-voltage circuit. Or, if the fuses did not go out, the current would be limited to their rated capacity. With a low-voltage circuit connected to the pipes at a single point or as in *B*, Fig. 3, there is obviously no opportunity for any but the very slightest flow of current into the pipes over wire *d*, because there is no place for it to go. The slight current that would flow would be due to electrostatic capacity effects and would hardly be measurable by any ordinary means.

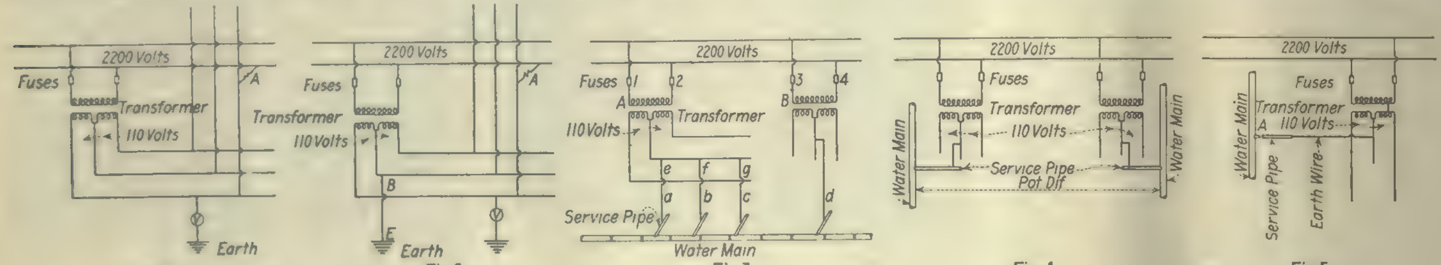


Fig.1 Fig.2 Fig.3 Fig.4 Fig.5

Sketches Illustrating the Discussion on Connecting Low-Voltage Secondary Electrical Circuits to Water Pipes.

With a condition existing such as that shown in Fig. 1, however, considerable current might flow for a greater or less time. If the leak should occur to circuit *A*, Fig. 3, for example, the current would pass from one side of the high-voltage line through the fault to circuit *A* and to the pipes over earth wires *a*, *b*, and *c*, whence it would flow through the earth back to the opposite side of the high-voltage line.

Nevertheless, granting that under normal conditions of operation slight alternating currents may flow, and that in the event of failure of insulation large currents may flow, it has been shown by experiments recently conducted at the Bureau of Standards that the damage by electrolysis from such currents is practically negligible. These experiments, made on both iron and lead, in moist clay, show that with alternating current at commercial frequencies the amount of metal dissolved is but a fraction of one per cent of that dissolved by direct current, the quantities of electricity passed being the same. To express the same thing in different words, it may be said that with currents in pipes which are equal in point of quantity of electricity passed, it will take the alternating current hundreds of years to accomplish the damage that would be accomplished by the direct current in a single year. Therefore, from the stray alternating currents which may be found in pipes from earthing low-voltage alternating current circuits to them no perceptible damage through electrolysis need be feared. The only possibility of damage is that due to heating if the current flow is heavy, but the likelihood of such currents flowing is so small as to be of no importance. Unless the pipes were very small the currents required to damage them would be thousands of amperes, values beyond the range of possibility in any ordinary case.

It has been stated by some that the passage of electric currents over service pipes may heat the water in them which will result in swelling and sticking in the hard rubber parts of water meters. Such cases have, in fact, been reported; that is, where hot water has been the cause of damage to meters. That such heating can be due to electric currents in the pipes, however, is not likely. It is more likely to be due to the backing up of hot water from water boilers into the service pipes caused by overheating and forming steam at pressure sufficient to force the water out of the boiler. Such cases have been investigated and found to be the result of hot water from water heaters. One case, however, has come to the notice of the Bureau in which a street railway track was bonded to a service pipe and in this case the current flow was the cause of considerable heating. With the ordinary low-voltage alternating current circuit, on the other hand, the possibility of sufficient current flow to cause heating is very remote.

(*b*) *Electrolysis by Direct Current.*—Electrolysis by direct current may arise, or be increased in two ways. In the first place, where the middle wire of a low-voltage direct current system is earthed to a pipe system at a number of points, the pipe forms a conductor in parallel with the middle wire, in which case when current flows in the middle wire current will also flow in the pipes. If the resistance of the pipes is comparable in magnitude with that of the middle wire these currents will also be comparable, being shared in inverse proportion to the resistances. This is the same condition as was shown in the previous paragraphs to exist in the case of low-voltage alternating current circuits, but with the alternating currents the damage is negligible, whereas in the case of the direct currents the damage may be serious, because of the marked corrosive effects of direct current. Earthing direct current systems to water pipes at a number of points is therefore undesirable, and such earthing should be confined to but one point on the system, and that at the power house.

Earthing the middle wire at more than one point is unnecessary, and even when earth connections are made, say, with one to the water system at the power house and others to driven pipes or plates current flow may be considerable and lead to undesirable results. It is to be recommended, therefore, that the middle wire of 3-wire direct current systems be earthed at the power house only, and all other earth connections to the middle wire omitted. An exception to this can be made in the case of connections to service boxes because in such cases the resistance to ground will in general be high. There can, however, be no serious objection to earthing to pipes, machine frames, conduit, or other metallic objects near or enclosing direct-current circuits, and it is desirable to earth them to promote personal safety and safety to property. In this case current would flow only while faults existed in the insulation, and since this flow would be temporary, lasting only until warning could be given of the fault and repairs be made, the resulting damage would be negligible.

In the second place, electrolysis may be increased or transferred from one locality to another, if a low-voltage circuit of any kind is earthed at different points to two metallically separate pipe systems. For instance, in cities where electric railways with ground return are in operation it may be found that one pipe system is at a considerable difference of potential with respect to another. If a low-voltage circuit is earthed to both of them current will flow from one pipe system to the other, with danger of overheating the wires and also of increasing electrolysis on the other system. Moreover, if a low-voltage circuit is earthed at one point to a pipe system which is at a potential difference of several volts against earth, and at another point to the steel-work of a building the latter takes the potential against ground of the pipe, and danger of electrolysis in the building ensues. On the other hand, if different low-voltage circuits fed from the same high-voltage distribution circuits are earthed to different pipe systems no current can flow from one pipe system to the other, because, as shown in Fig. 4, the insulation between transformer windings prevents the flow of current, and current flow would necessarily have to take place over the high-voltage line in order to get from one pipe system to the other. This might occur, of course, if there were faults in the insulation of both transformers, but this is a contingency that can be neglected.

Hence, this general rule can be laid down: In every case where it is necessary and allowable to earth a low-voltage circuit at more than one point, the earthing should be done to the same pipe system, and in no case should separate pipe systems be used.

INSULATING JOINTS.

In connecting a low-voltage circuit to a pipe system at more than one point, it is important that there be no insulating joints in the pipes that may come between the points of connection. If insulating joints are present, the low-voltage circuit will act as a shunt to the joint and heavy current flow over the wires may follow if stray currents from street railways are on the pipes. This presents a dangerous condition because of the possibility of fire, and in the case of direct current systems, of increased electrolysis, and should be avoided. Moreover, if there are insulating joints near a point where an earth connection is made to a service pipe, the joints may so restrict the useful pipe surface in contact with the soil so as to cause the resistance to current to flow from the low-voltage circuit into the earth in case of an accident to insulation to be so great as seriously to impair the usefulness of the earth connection. For this to be the case it is, of course, necessary to have insulating joints on both sides of the point where the earth connection is made. With an insulating joint on one side of an earth connection and lead or screw joints on the other for several hundred feet the earth connection may be considered good. With insulating joints nearby on both sides, however, as would be the case with a cement-joint pipe line, the earth connection would not be very effective. Therefore, in making earth connections using water pipes it is very important to know the character of the joints in the pipe.

PICKING UP OF STRAY CURRENTS BY LOW-VOLTAGE CIRCUITS.

If a low voltage circuit is earthed to a lead-jointed pipe system at several points, and there is current flow in the pipes from electric railway circuits, the current picked up by the low-voltage circuit is not likely to be of importance. This is due, first, to the fact that low-voltage circuits are in most cases of limited extent, and hence do not include enough of the pipe line to be subject to a large voltage drop, and, second, to the fact that the resistance per unit length of the middle wire is in most cases large compared with the pipe line. This refers more particularly to alternating current circuits.

DANGER TO EMPLOYES OF THE WATER SYSTEM.

The question of danger to employes of the water company has been many times discussed. In general, it may be stated that danger is likely to arise in only one case and that is illustrated in Fig. 5. This shows a low-voltage circuit earthed at one point to a service pipe, a failure of transformer insulation having occurred at B. If the service pipe is disconnected at *A* the person making the disconnection is liable to an electric shock. The severity of the shock depends upon a number of factors which have previously been discussed, and it has been shown that conditions may easily arise under which the severity of the shock would be great enough to cause death. Therefore, with low-voltage circuits earthed to service pipes at a single point precautions are necessary to prevent such accidents to employes of the water company when working on them. This can be readily provided for by requiring the electric company to disconnect earth wires from service pipes when work is to be done on the pipes and reconnect when the work is finished. This is a reasonable and sufficient requirement, and has been in force in several places for years with satisfaction to both parties.

With multiple earth connections to water pipes, however, as shown in Fig. 3, even the precaution mentioned above is hardly necessary. Unless all of the service pipes to which earth wires have been attached are disconnected there is very little danger. A person may work on one of the service pipes in perfect safety as far as electric shock is concerned if the other service pipes are undisturbed. Moreover, it is an advantage to the consumers using the circuit to have more than one connection to the water pipe, for if one of the wires becomes disconnected the others still maintain the circuit in a condition of safety. Multiple connection of low-voltage alternating current circuits to water pipes is therefore to be recommended and encouraged. It should be emphasized again at this point, however, that these multiple connections should be confined to a single water system, for reasons previously set forth in this paper. Moreover, when multiple earth connections to water pipes are made, the resistance of the pipe line between the two farthest removed points of connection should be measured in order to make certain that no insulating joints are present. If there are no insulating joints the resistance will in general be found to be but a small fraction of an ohm. If there are insulating joints it may be as much as an ohm or even several ohms.

MECHANICAL CONSTRUCTION OF WATER PIPE EARTH CONNECTIONS.

Where connection is made to a cast iron pipe line with bell and spigot joints the most satisfactory method is probably that prescribed by the National Fire Protection Association. This connection is made by drilling a hole in the bell, tapping it, and screwing in a brass plug to which the earth wire is soldered. This joint can be made with a reasonable amount of labor and will be permanent, especially if the surface of the plug and pipe in the immediate vicinity is heavily coated with pitch or something else to prevent corrosion. Where connection is made to service pipes which can be drained of water while work is being done on them the earth wire can be wrapped several times around the pipe and soldered to it. If the service pipe cannot be drained conveniently the next best thing is a clamp to go around the pipe, with a lug to which the earth wire can be soldered. There are a number of amalgams on the market with which the pipe can be treated before putting on the clamp, making a better electrical connection between pipe and clamp than would otherwise be attainable. Many of the clamps sold for this purpose, however, seem of rather flimsy construction. To obtain good results a clamp of sturdy construction is necessary. Otherwise it is difficult to get as good a contact with the pipe as is in most cases desirable.

The point at which connections to service pipes are made must be considered. This will in most cases be determined by local conditions. In general, however, it may be stated that this point must be chosen so that there is the least likelihood of the pipe being disconnected between the earth connection and the water main. It is desirable that the earth connection in all cases be placed beyond the point where the service pipe is likely to be disconnected by plumbers altering or repairing piping in buildings. Where the water meter is placed in the basement of a building the earth connection should be made on the street side of the meter if possible. If it is not possible, or if the meter is located in a well or manhole under the sidewalk or street, a jumper, consisting of a wire as large or larger than the ground wire should be placed around the meter, connection being made to the pipe in the same way as for the ground wire.

CONNECTING TO GAS PIPE.

Connection directly to gas pipes should in every case be prohibited. The reasons for this are as follows: In the first place many gas mains are laid with insulating joints which are extremely undesirable in a pipe line to which earth connections are to be made. In the second place, if a gas pipe in which even a small current is flowing is disconnected a spark may follow and cause an explosion or a fire. In the third place, where there are gas pipes there are in nearly all cases water pipes and hence connection to the gas pipes is unnecessary.

On the other hand, the connection of low-voltage alternating current secondaries to water pipes should not only be permitted but *be made compulsory*. Such connection has been shown to obviate a hazard that might otherwise arise when lightning or other cause breaks down transformer insulation or wires become crossed. Inasmuch as a considerable advantage to the public results from such earthing, with no appreciable disadvantage to either of the public service companies concerned, there is no good reason why city ordinances or other legislation to require it should be longer delayed. In numerous localities the practice has been tried and found desirable and it should be extended to all localities where high-voltage alternating current distribution systems are in use.

SUMMARY.

1. Many of the dangers which arise from electrical circuits may be eliminated by earthing these circuits.
2. Of the means of earthing electrical circuits water pipes are by far the most desirable.
3. There is no danger of electrolysis by such stray alternating currents as may result from earthing low-voltage alternating current circuits.
4. Direct-current circuits should be earthed at but one point, preferably at the station.
5. Where conditions permit, two or more ground connections should be made on each secondary system.
6. In the case of any individual low-voltage circuit in which a number of earth connections to pipes are made, the earthing should be confined to one pipe system. Measurements of the resistance of the pipe line between the farthest removed points of connection should be made to make certain there are no insulating joints in the part of the pipe line which may cause the electric circuit to carry heavy stray currents from railways.
7. In making either single or multiple earth connections to water systems unless it is positively known that there are no insulating joints nearby the adequacy of the earth connection should be determined by measurement of its resistance. Earth connections should not be made to cement joint lines, or other lines in which there are many joints of high resistance.
8. Connection to pipe lines may be made by screwing a brass plug into the bell in the case of cast iron pipes, or by clamps or soldering to service pipes. Soldering is preferable to clamps where it is possible to do it.
9. Earth connections to service pipes should be made at the point where there is the least likelihood of the pipe being disconnected between the connection and the main. If the water meter comes between connection and main a jumper of the same size as the ground wire should be put around it.
10. Earth connections to gas pipes should be prohibited chiefly on account of the chance of explosions or fires, and also because the almost invariable presence of water pipes makes such connections unnecessary.
11. Because of the great advantage to the public and the slight disadvantage (if any) to the public service corporations resulting from earthing to water pipes, such earthing of secondary systems should be made compulsory.

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Paper before the 1915 annual convention of the Central States Section of the American Water Works Asociation by Messrs. Burton McCollum and O. S. Peters, Electrical Engineers, Bureau of Standards, Department of Commerce, Washington, D. C.

BRIDGES

Some Data on the Use of Mortar-Coated Timber Piles at San Juan, Porto Rico.

(Staff Abstract.)

The following data apply to the use of reinforced wooden piles in the construction of the San Juan bulkhead in Porto Rico. The reinforced piles were what are termed by the originators, Lilley and Thurston, of San Francisco, "gunite" coated piles. They are made by wrapping an ordinary wooden pile (for the distance to be exposed to the water) with wire mesh secured with staples, and placing upon this a coating of cement mortar by means of the cement gun, the thickness of this coating generally being from 1 to 1⅛ in.

BULKHEAD CONSTRUCTION.

The contractors determined to use this type of protected pile on the bulkhead work above referred to. The design adopted for the sea wall is called the cantilever type in contrast to a gravity wall. It extends a distance of about 2,800 lin. ft. around the present shipping portion of San Juan harbor. The type of construction adopted consists of a row of piles every 12 ft., placed at right angles to the face of the wall. Each row is capped with a concrete buttress. These buttresses are connected by longitudinal beams running parallel to the face of the wall, these beams supporting the deck construction. A concrete waling strip runs from buttress to buttress in the rear of the wall, and there is a similar wooden waling strip placed against the inner row of piles below the water surface. To retain the fill tongue-and-groove reinforced concrete sheet piling was driven against these waling strips. The thrust of the fill against the sheet piling is transmitted to the buttreses, there being two batter piles placed in each buttress pier at an angle of approximately 30°.

PRELIMINARY INVESTIGATIONS.

Preliminary borings and test piles indicated that piles of approximately 50 ft. in length would be required, and that the driving would be comparatively easy for all except the last 5 ft. This fact is important, as it had a serious bearing on the use, on this work, of the mortar-coated pile which could not have been foreseen. (In the San Francisco experiments made by the originators of the coated pile it either was possible to set the piles in their final position, or they were easily driven in loose material, dependence being placed on the skin friction to sustain the load. It is also known that the so-called "Ripley" pile, which has a concrete coating, has developed a tendency to break off in hard driving; and to overcome this its promoters have used vertical reinforcing rods in addition to the wire mesh reinforcement.)

DETAILS OF SAN JUAN WORK.

In the San Juan work two thicknesses of metal fabric were spirally wound about eight longitudinal ¼-in. rods, these rods being held in place by staples. The thickness of the gunite coating was also increased from 2½ in. to 3 ins. A number of these piles were prepared, kept wet for several days, and allowed to set for at least 30 days before driving. Directly after being coated these piles showed no indication of surface cracks; but when they were moved and handled, due to the additional weight of the coating (between 2½ and 3 tons), it was noted that the underside of the pile, where it had sagged between supports, showed hair cracks. Moreover, when the pile was revolved through 180°, new hair cracks developed on the underside of the pile. It is also thought that some cracks may have developed in the process of coating, due to the manner in which the pile was supported on rollers, placed about 40 ft. apart. As the mortar is shot onto the reinforcement by the cement gun the building-up process is gradual over the whole length; and as the pile is rotated it sags toward the underside as the weight is increased. Consequently, little cracks are developed before the initial set occurs, while other cracks develop in removing the pile from the rollers with a derrick and in transferring it to the seasoning yard.

Whatever the cause, when these piles were placed in the leads of the piledriver, and subjected, first to a drop hammer and later to a steam hammer, the cracks appeared to open; in fact, in some cases, large pieces of the mortar coating fell off, exposing the reinforcement. This did not occur, however, until the piles reached the final 5-ft. stage of driving, where they encountered a stratum of clay into which it was necessary to go at least 5 ft., especially in the case of the batter piles to prevent the slipping of their points due to the thrust of the backfill. This required such severe driving that many of the piles were damaged. The great cost of making repairs under water made such repairs generally impracticable, and recourse was finally had to solid concrete piles.

The following method of repairing damaged coated piles under water was used: First a steel cylinder, about 6 ins. larger in diameter than the coated pile, was placed around the latter. All joints were then closed, and the bottom of the cylinder was made to fit close to the surface of the pile, with the top of the cylinder open. On the deck, above the pile to be repaired, a tank was set up, with a large valve connected to a piece of 1½-in. single-ply cotton hose; the latter leading down to the bottom of the space between the pile and the cylinder. Cement grout was mixed in the tank and allowed to run down the hose, a diver keeping the lower end of the hose below the surface of the deposited grout until the top of the cylinder was reached. After being left in place for two or three days the cylinder was removed and transferred to another pile needing repair. The results obtained in this manner were considered satisfactory.

EFFICIENCY OF THIS TYPE OF PILE.

It is believed that if some method of rotating the pile without permitting it to sag during the application of the gunite can be devised, and if a satisfactory method of handling the pile from the rollers to the seasoning yard can be originated, this type of pile can be used with satisfactory results. It is undoubtedly less expensive than the solid concrete pile, as the cost of the 2½-in. coating, including all overhead, except plant, up to the time of driving amounted to about 80 cts. per foot of pile coated. The plant cost about $2,000, which for the 2,000 piles coated cost $1.00 per pile, or 2 cts. per linear foot of the pile length. Taking the cost of the piles ready for coating at 20 cts. per foot, and noting that only about 25 ft. of each 50-ft. pile were coated, the total cost of the pile per linear foot is found to be 62 cts. as against $1.00 per linear foot for solid concrete piles of the same dimensions and carrying capacity.

The writer feels that a coating of about 1¼ in. would be much better than one of 2½ in., as it not only reduces the weight of the pile but also covers the reinforcement sufficiently.

The foregoing data were abstracted from a paper by J. P. Carlin, president of the P J. Carlin Construction Co., contractor for the San Juan work, in the November, 1915, issue of The Cornell Civil Engineer.

Results of Some Tests to Determine the Load Distribution Through Reinforced Concrete Slabs.

(Staff Abstract.)

Under the direction of the Highway Department of Ohio a series of tests has been made on reinforced concrete slabs to determine what width of slab may be considered as carrying a concentrated load resting upon it, also how far from the point of concentration the load will cause stresses in the slab. In planning the tests three factors, which it was thought might affect the distribution of stress through the slab, were considered; these were the span, the thickness, and the amount of reinforcement parallel to the slab. The following data apply to the results of these tests and to the conclusion drawn from them, the data being abstracted from Bulletin 28 of the Ohio Highway Department.

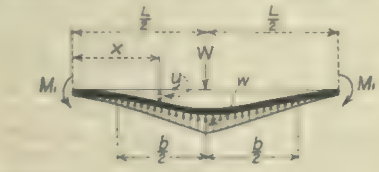


Fig.1

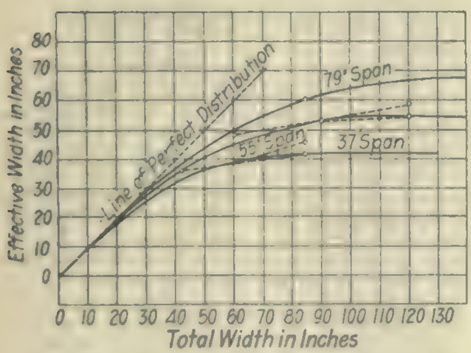


Fig.2

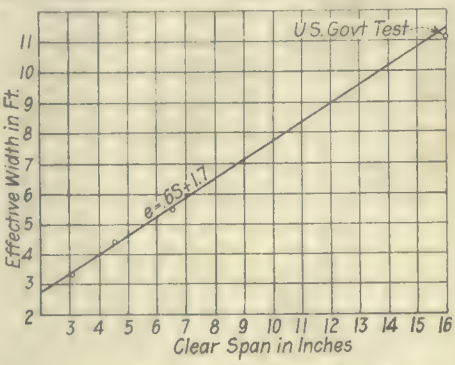


Fig.3

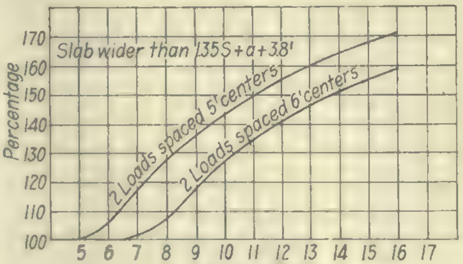


Fig.5

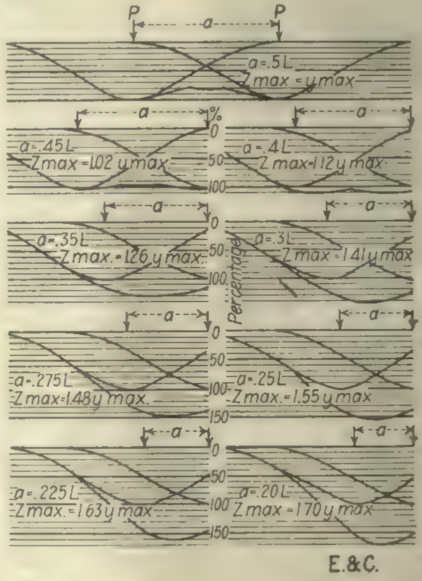


Fig.4

Fig. 1. Diagram Showing Nomenclature Used in Developing Equation for Effective Width. Fig. 2. Curves of Effective Widths of Slabs Tested; Graphs of Effective Widths by Equation 4 Also Shown. Fig. 3. Diagram Showing Relation Between Maximum Effective Width and Clear Span, as Determined by Tests. Fig. 4. Curves Showing Relation Between Span and Deformation for Two Loads and for Various Ratios of Distance Between Loads to Width Affected. Fig. 5. Curves Giving Values of Maximum Deformation for Two Loads in Terms of That for a Single Load for 5-ft. and 6-ft. Spacings of Loads.

SCOPE OF TESTS AND DATA.

Three spans were selected for the tests, 3½ ft., 5 ft. and 7 ft. In each of these spans, except the latter, three widths of slab were tested, 1 ft. width, span width, and two-span width. Part of the slabs were 7 ins. thick and part 4 ins. thick. In all 20 slabs were made and tested. The main reinforcement of all slabs was 1.04 per cent, placed with its center 1 in. above the bottom of the slab. Table I gives complete data on the size, reinforcement and age at which the various slabs were tested.

The slabs were placed on I-beam supports and tested, the spans given in Table I being the distances center to center of I-beams. It was found in testing that the slabs left the outer edges of the I-beams due to deflection, showing that the effective span was about equal to the clear span. The clear span was therefore used in all calculations.

Observations were made of the deflections and of the deformations in the concrete and the steel at various points. The deflection readings were taken with micrometer calipers fastened to the slab and were read by contact on a wire stretched between the supports

TABLE I.—SIZE, REINFORCEMENT AND AGE OF SLABS TESTED.

Reference mark.	Center to center of span, feet.	Width, feet.	Total thickness, inches.	Transverse reinforcement.	Date made.	Date tested.	Age, days.
1 A	3½	1	7	None	1-25-13	5-7-13	103
1 B 3½	3½	3½	7	0.20 per cent	1-25-13	5-10-13	106
1 C 3½	3½	3½	7	0.78 per cent, in middle third of span only	2-11-13	5-13-13	91
1 D 3½	3½	3½	7	0.78 per cent, over entire span	1-25-13	5-21-13	116
1 B 7	3½	7	7	0.20 per cent	1-25-13	5-31-13	126
1 C 7	3½	7	7	0.78 per cent, in middle third of span only	1-29-13	6-20-13	142
1 D 7	3½	7	7	0.78 per cent, over entire span	1-30-13	6-17-13	138
2 A	5	1	7	None	2-18-13	6-23-13	125
2 B 5	5	5	7	0.20 per cent	2-4-13	7-3-13	149
2 C 5	5	5	7	0.78 per cent, in middle third of span only	2-4-13	7-9-13	155
2 D 5	5	5	7	0.78 per cent, over entire span	2-12-13	6-27-13	135
2 B 10	5	10	7	0.20 per cent	9-27-13	2-20-14	146
3 A	7	1	7	None	2-11-13	2-24-14	378
3 B 7	7	7	7	0.20 per cent	9-19-13	2-13-14	147
1 E	3½	¾	4	0.40 per cent, over entire span	6-12-14	7-25-14	43
1 E	3½	¾	4	0.40 per cent, over entire span	6-12-14	7-27-14	45
1 E 5¼	3½	5¼	4	0.40 per cent, over entire span	6-12-14	7-24-14	42
1 E 7	3½	7	4	0.40 per cent, over entire span	8-6-14	12-10-14	126
2 E 7½	5	7½	4	0.40 per cent, over entire span	6-18-14	7-31-14	43
2 E 10	5	10	4	0.40 per cent, over entire span	7-11-14	9-29-14	80

(clear span). The deformations were read with a "Berry" strain gage between holes in metal plugs set flush with the top surface of the slab, and between holes drilled in the reinforcing rods on the bottom. The length between points of the strain gage for measuring deformation was 15 ins.

All slabs were tested to failure by applying a single force to a brick placed at the center of the slab. In general, the load was applied in increments of 2,000 lbs. All of the slabs failed by shear, i. e., by punching the brick through the slab.

DETERMINATION OF EFFECTIVE WIDTH.

From the data secured there are two methods of obtaining the "effective width" for each load on each slab. By "effective width" is meant that width used in designing over which a single concentrated load may be considered as uniformly distributed on a line down the middle of the slab parallel to the supports. The two methods are:

(1) The loads causing known deformations in the 1-ft. slabs may be used as units for comparison with loads causing equal maximum deformations in the other slabs. The division of the load on the wide slab by the load causing equal deformation of the 1-ft. slab will give the "effective width" in feet over which the total load on the wide slab may be considered as uniformly distributed on a line down the middle, in designing.

(2) The deformations on a transverse section (parallel to supports) may be plotted for any load. The area under this curve divided by the maximum ordinate to the curve (maximum deformation) will give the "effective width."

The first of these methods was the one in view when the tests were inaugurated, and if it were certain that the material and workmanship of the 1-ft. slabs were identical with that of all the other slabs, this method would be satisfactory. But with a material like concrete, and with the variations in hand mixing, it is thought that the results obtained by this method are not entirely reliable.

First Method.—The deformations of the steel and of the concrete for the 3½-ft. and 5-ft. spans, 1 ft. wide and 7 ins. thick, were plotted against the bending moments. It was found that the curves for the two spans ran very close together. The averages of the two concrete curves were used in the comparisons for all slabs of this thickness.

The tests for the narrow slabs 4 ins. thick (1 E, Table I) were not satisfactory, as the rigging for the tests was not suitable for applying the small increments of load necessary to get good curves on these comparatively weak beams.

Second Method.—In this method the deformations of the steel and the concrete, and the deflections of the slab on a transverse line (parallel to the supports) down the middle of the slab, were plotted for each load and slab. The area under any one of these curves divided by the maximum ordinate to the curve will give a value of the effective width of that slab for that load.

By this method three values of the effective width are given: one from the deflection, one from the deformation of the concrete, and one from the deformation of the steel. In nearly all cases the concrete deformations gave a less effective width than either of the others, the greatest effective width being given by the deflections.

SUMMARY OF RESULTS.

A summary of the results obtained by the first method is given in Table II and by the second method in Table III. In these tables the minimum effective width, as determined from the three sets of observations, is given for each load, and these are arranged according to the deformation in the concrete. The effective widths are given in percentages of the clear span. The second, third and fourth columns in each table give the averages of the minimum values for the *B*, *C* and *D* slabs (see Fig. 1) of these sizes. Only one percentage of transverse reinforcement was used for the other size of slabs.

TABLE II.—SUMMARY OF EFFECTIVE WIDTHS—FIRST METHOD.

Max. unit deformation in concrete.	Effective widths in percentage of clear span. 1-B-3½ 1-C-3½ 1-D-3½	1-B-7 1-C-7 1-D-7	2-B-5 2-C-5 2-D-5	2-B-10	3-B-7
.00040	105.9	162.5	92.6	102.8	97.6
.00050	102.3	161.6	90.2	109.0	97.0
.00060	102.2	157.1	90.7	113.9	96.3
.00070	100.6	154.9	91.2	114.2	95.7
.00080	99.2	152.4	91.4	114.5	95.1
.00090	99.0	149.8	91.8	115.0	93.8
.00100	98.2	147.9	92.3	115.8	92.3
.00110	97.8	146.3	92.7	114.7	90.8
.00120	97.5	142.4	93.5	112.6	89.2
.00130	97.1	138.6	94.3	110.6	88.0
.00140	97.0	135.6	95.1	108.5	88.0
.00150	96.8	134.5	96.0	107.3	88.0
.00160	97.0	132.9	96.8	106.3	88.0
.00170	97.3	132.5	97.3	105.6	87.9
.00180	97.6	131.8	98.1	105.3	87.6
.00190	97.9	131.1	98.3	105.1	87.3
.00200	98.3	127.6	98.8	104.8	87.0
Average percentages for unit deformations up to .001.					
	101.1	155.2	91.5	112.2	95.4
Average in inches for unit deformations up to .001.					
	37.4	57.4	44.8	61.7	75.4

DISCUSSION.

The effective widths as determined by the first method (by comparison with the 1-ft. wide slabs) are higher in all cases than those determined by the second method, and, owing to irregularities in materials and in mixing, it is thought that the first method is less reliable. In the following deductions, therefore, only the results of the second method (Table III) are used.

An examination of the results of the tests point to the following facts:

(a) The effective width is affected very little by the percentage of transverse reinforcement.

(b) The effective width decreases somewhat as the load increases.

(c) The effective width, in percentage of the span, decreases as the span increases.

(d) The effective width increases with the width of the slab up to some limit.

The decrease in effective width as the load increases is not marked until the safe loads are exceeded, therefore in Table III, at the bottom, there is given the average of the first seven values in each column. This includes values for all deformations up to 0.001 in. per inch, which corresponds to a unit stress of at least 1,500 lbs. per square inch in the concrete. These average effective widths are given both in percentages of the clear span and in inches.

In none of the slabs tested was the width sufficient to show zero deformation at the edges, although in several of them the transverse deformation curves approach very nearly the horizontal at the edges. Evidently a width is possible for each span beyond which the load would have no effect, and this width is of interest in studying the effect of two or more loads on a slab.

The values of the effective widths given in Table III have been derived by dividing the area under the deformation curves by their maximum ordinates. If the theoretical equation for these curves were known it could be used in deriving a theoretical effective width.

From the results of the tests it is known that the intensity of the resistance decreases from the load out and that the shape of the transverse deformation curve is similar to that of the elastic line of a beam fixed at the ends and loaded as shown in Fig. 1. In this drawing,

M_1 = moment necessary to hold the beam horizontal at the ends.

w = maximum intensity of a reaction varying uniformly to zero at the ends.

y = deflection at any point.

W = total load $= \frac{wL}{2}$.

The equation of the elastic line is,

$$y = \frac{W}{6EI}\left(\frac{x^5}{5L^3} - \frac{Lx^2}{16}\right) \quad \text{..........(1)}$$

When

$$x = \frac{L}{2},\ y = y_{\text{max.}} = -\frac{WL^3}{640EI} \quad \text{......(2)}$$

Let b = width of slab, where b is less than L.

Then the area under the elastic line for

TABLE III.—SUMMARY OF EFFECTIVE WIDTH—SECOND METHOD.

Max. unit deformation in concrete.	Effective widths in percentage of clear span. 1-B-3½ 1-C-3½ 1-D-3½	1-B-7 1-C-7 1-D-7	2-B-5 2-C-5 2-D-5	2-B-10	3-B-7	1-E-5¼	1-E-7	2-E-7½	2-E-10
.00040	99.7	117.1	89.3	110.7	82.0	99.1	120.3	92.1	103.3
.00050	98.0	117.7	90.4	110.0	80.1	103.8	114.9	93.6	98.6
.00060	98.5	119.6	88.7	107.0	78.3	108.1	113.9	95.2	98.1
.00070	99.0	124.6	88.2	105.4	76.3	112.5	112.9	97.1	97.5
.00080	98.3	123.5	87.1	103.7	74.2	110.3	109.8	99.0	96.9
.00090	97.1	124.5	85.4	102.1	72.0	108.1	106.7	97.0	96.5
.00100	96.0	125.1	83.9	101.6	70.5	108.0	103.6	95.1	96.1
.00120	94.2	119.3	82.3	98.4	67.4	109.0	97.4	91.0	95.3
.00140	92.3	116.9	80.3	92.9	65.8	109.0	96.2	88.2	93.7
.00160	91.4	113.3	79.3	89.7	65.7	109.0	95.2	86.8	90.9
.00180	91.2	110.5	78.8	87.4	65.4	108.0	93.8	85.4	88.1
.00200	91.3	109.2	78.3	85.0	64.0	105.8	92.7	84.0	85.3
Average effective widths in percentages of clear span for unit deformations up to .001.									
	98.1	121.7	87.6	105.8	76.2	107.1	111.7	95.6	98.1
Average effective width in inches for unit deformations up to .001.									
	36.3	45.0	48.2	58.2	60.2	39.6	41.3	52.7	54.0

the length b will correspond to the areas under the curves representing the deflections or the deformations of the concrete or steel of the test slabs.

$$A = 2\int_{\frac{L-b}{2}}^{\frac{L}{2}} y\,dx = \frac{W}{3\,EI}\int_{\frac{L-b}{2}}^{\frac{L}{2}} \left(\frac{x^3}{5L^2} - \frac{Lx^2}{16}\right) dx$$

$$= \frac{W}{5{,}760\,EI}\left(-9L^3b + 15Lb^3 - 15b^4 + \frac{6b^5}{L} - \frac{b^6}{L^2}\right) \quad \ldots\ldots (3)$$

Effective width, $e =$

$$\frac{A}{y_{\text{max.}}} = b - \frac{5b^3}{3L^2} + \frac{5b^4}{3L^3} - \frac{2b^5}{3L^4} + \frac{b^6}{9L^5} \quad (4)$$

When $b = L$, e will be a maximum, or the effective width of a slab of indefinite width, is,

$$e_{\text{max.}} = \frac{4}{9} L \quad \ldots\ldots (5)$$

In Fig. 2 the effective widths from Table III have been plotted.

By substituting in equation (4) a representative value for e and b, determined from these tests for any given span, the value of L for that span may be determined. The following values have been chosen from the plotted points:

For 37-in. span, e = 39 ins., b = 60 ins.
For 55-in. span, e = 53 ins., b = 90 ins.
For 79-in. span, e = 60 ins., b = 84 ins.

From these values and equations (4) and (5) the following values of L and e are determined:

For 37-in. span, L = 92.85 ins., e = 41.26 ins.
For 55-in. span, L = 122.00 ins., e = 54.22 ins.
For 79-in. span, L = 150.78 ins., e = 67.01 ins.

The graphs of e from equation (4) are shown plotted for the three spans in Fig. 2. Where the total width of the slab is less than the value of L given above, these graphs, or equation (4), might be used in determining the effective widths for these spans.

In Fig. 3 the values of $e_{\text{max.}}$ determined above are shown plotted with the *clear span*. It is seen that a straight line fits these points fairly well, and until further data are available the following equation for $e_{\text{max.}}$ may be used with safety:

$$e_{\text{max.}} = 0.6S + 1.7 \quad \ldots\ldots (6)$$

Where $e_{\text{max.}}$ is the effective width, in feet, of a slab of greater width than L, and S is the clear span, *in feet*. The value of L may be determined from equation (5).

In 1914, a slab of 16 ft. clear span and 32 ft. width, 12 ins. thick, was made and tested by the Office of Public Roads in Washington. The methods of loading were similar to those used in the tests herein described and the deformations were measured in the same manner. The results of this test gave an effective width of from 11.0 ft. to 11.1 ft. Equation (6) would give an effective width for this slab of 11.3 ft.

Equation (6) is independent of the thickness of the slab. It is worthy of note, however, that the points in Fig. 2 for the 7-in. slab, fall above the curves chosen, while the points for the 4-in. slab fall almost exactly on the curves. This would indicate that the thickness has some effect upon the effective width but this is small, and further experiments would be necessary to determine its effect.

EFFECT OF TWO LOADS.

No tests were made with two loads on the slab at the same time, but their effect may be studied by the use of the deformation curve given by equation (1).

The curve for each load may be assumed to be independent of the other and the total deformation at any point may be taken as the sum of the two deformations at that point. This is illustrated by the curves shown in Fig. 4, in which a is the distance between the loads and L is the width of slab affected.

The sum of the deformations at any point is given by the lower curve for each spacing of the loads. The ordinates to this summation curve are called Z, and the value of $Z_{\text{max.}}$ is given for each diagram for that spacing of loads.

By the use of equations (5) and (6) the relation between the span and the maximum deformation for any given spacing of the loads may be determined as follows:

$$e_{\text{max.}} = L = 0.6S + 1.7$$
$$L = 1.35S + 3.825$$

When a is greater than $\frac{L}{2}$ the maximum deformation occurs under one of the loads and is not affected by the other load.

When a is less than $\frac{L}{2}$ the maximum deformation may be obtained from the curves of Fig. 4.

Curves giving values of the maximum deformation in terms of the maximum for a single load are shown in Fig. 5, for a spacing of loads of 5 ft. and 6 ft. This will cover the usual spacings of traction-engine and motor-truck wheels.

SUMMARY.

The tests of slabs seem to warrant the following conclusions as to the "effective width" of a reinforced concrete slab:

(1) The effective width is affected very little by the percentage of transverse reinforcement (parallel to the supports).

(2) The effective width decreases somewhat as the load increases.

(3) The effective width, expressed as a percentage of the span, decreases as the span increases.

(4) The following formula will give a safe value of effective width where the total width of slab is greater than $\frac{4}{3}S + 4$ ft.:

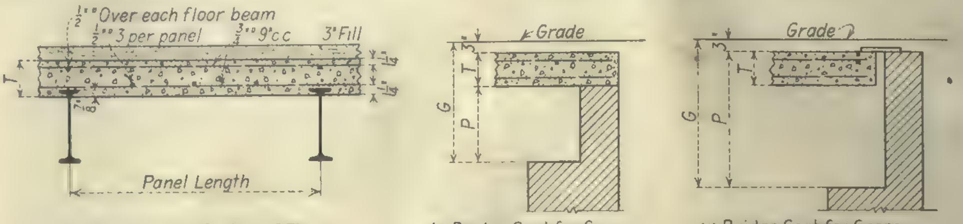
$$e = 0.6\,S + 1.7 \text{ ft.},$$

where e is the effective width in feet, and S is the span in feet.

Concerning the Use of Steel Highway Bridges in Iowa.

(Staff Abstract.)

With the common use of the automobile and heavy steam and gasoline tractors, traffic conditions have suddenly changed, and a transition from light and inadequate construction has become necessary. To have suddenly eliminated the old types of construction would have brought an oppressive burden on the taxpayer, and, of course, would have been impracticable. To bring about the necessary change in design the Iowa State Highway Commission has found it desirable to design a riveted steel superstructure which can be placed on wood piling and can carry a cheap type of floor. These steel bridges, however, are designed to carry a maximum specification loading, which provides for a 6-in. concrete floor and a 15-ton engine or a uniformly distributed live load. The placing of riveted steel spans on wood piling substructure has objections, and such construction should only be used where the strictest economy is necessary and local conditions are favorable.



(a) Longitudinal Section of Floor (b) Bridge Seat for Spans 35' to 65' Incl (c) Bridge Seat for Spans 70' to 100' Incl

Fig. 1. Details of Reinforced Concrete Floor and of Bridge Seats for Steel Pony Truss Spans—Also See Table I.

We have not progressed beyond the age of steel construction, and although there are available other materials worthy of consideration in highway bridge construction, very few, if any, possess a wider range of usefulness. The general limitations in the use of various types of steel structures are quite clearly defined, and it remains for the highway engineers of today to concentrate their efforts more particularly on the perfection of the details of design.

CONDITIONS AFFECTING THE DESIGN.

It might be well to consider here some of the conditions met in bridge construction which affect the design, and which determine, in a large measure, the use of steel or other material. It is a generally admitted fact that no one building material will serve to solve all of the problems of bridge construction

TABLE I.—DATA ON STANDARD STEEL PONY TRUSS SPANS.

Span and roadway, ft.	Number of design.	Height of truss.		Number of panels.	Center to center of trusses.		Thickness of floor, T, ins.	Bridge seat to grade, G.		Height of parapet, P.		Structural steel, lbs.	Floor	
													Reinforcing steel, lbs.	Concrete, cu. yds.
		Ft.	Ins.		Ft.	Ins.		Ft.	Ins.	Ft.	Ins.			
35x16	X1	6	0	4	17	0	8	2	6 15/16	1	7 15/16	12,200	3,470	15.2
35x18	X2	6	0	4	19	0	8	2	6 15/16	1	7 15/16	12,800	3,880	17.0
40x16	X3	6	0	5	17	0	7½	2	6½	1	8	15,300	3,940	16.1
40x18	X4	6	0	5	19	0	7½	2	6½	1	8	16,100	4,400	18.1
45x16	X5	6	6	5	17	0	8	2	7	1	8	16,700	4,340	19.2
45x18	X6	6	6	5	19	0	8	2	7 1/16	1	8 1/16	17,500	4,860	21.5
50x16	X7	6	6	6	17	3	7½	2	6⅝	1	8⅛	19,900	4,820	19.9
50x18	X8	6	6	6	19	3	7½	2	6 11/16	1	8 3/16	21,000	5,370	22.3
55x16	X9	6	6	6	17	3	8	2	7¼	1	8¼	21,400	5,230	23.2
55x18	X10	6	6	6	19	3	8	2	7 3/16	1	8 3/16	23,100	5,830	26.0
60x16	X11	7	0	7	17	3	8	2	7⅛	1	8⅛	25,500	5,850	25.2
60x18	X12	7	0	7	19	3	8	2	7 3/16	1	8 3/16	27,200	6,540	28.3
65x16	X13	7	0	8	17	3	7½	2	6 11/16	1	8 3/16	29,100	6,310	25.5
65x18	X14	7	0	8	19	3	7½	2	6¾	1	8¼	31,000	7,060	28.7
70x16	X15	7	0	8	17	3	8	3	3½	3	0½	34,700	6,580	28.5
70x18	X16	7	0	8	19	3	8	3	3 9/16	3	0 9/16	36,900	7,350	32.0
75x16	X17	7	6	9	17	3	7½	3	3⅛	3	0⅛	39,400	7,040	28.6
75x18	X18	7	6	9	19	3	7½	3	2 13/16	2	11 13/16	41,700	7,870	32.1
80x16	X19	8	0	10	17	3	7½	3	3⅛	3	0⅛	43,800	7,500	30.5
80x18	X20	8	0	10	19	3	7½	3	2⅞	2	11⅞	46,600	8,380	34.3
85x16	X21	8	6	10	17	3	8	3	3 5/16	3	0 5/16	47,100	7,920	34.5
85x18	X22	8	6	10	19	3	8	3	3 7/16	3	0 7/16	49,400	8,840	38.8
90x16	X23	9	0	10	17	3	8	3	3⅞	3	0⅞	50,200	8,490	36.5
90x18	X24	9	0	10	19	3	8	3	3 15/16	3	0 15/16	52,800	9,490	41.0
95x16	X25	9	6	10	17	3	8	3	3 15/16	3	0 15/16	52,400	8,910	38.5
95x18	X26	9	6	10	19	3	8	3	6	3	3	59,200	9,960	43.2
100x16	X27	10	0	10	17	3	8½	3	4 7/16	3	1 7/16	57,200	9,310	43.0
100x18	X28	10	0	10	19	4	8½	3	6½	3	3½	64,000	10,400	48.3

TABLE II.—ESTIMATED QUANTITIES OF MATERIALS FOR STANDARD BEAM SPANS.

	Structural steel, lbs.			Floor					
	Roadway			16-ft. roadway		18-ft. roadway		20-ft. roadway	
Span, ft.	16-ft.	18-ft.	20-ft.	Concrete, cu. yds.	Steel, lbs.	Concrete, cu. yds.	Steel, lbs.	Concrete, cu. yds.	Steel lbs.
16	3,370	3,780	3,800	5.6	600	6.3	680	7.0	740
18	4,280	4,810	4,820	6.2	670	7.0	750	7.7	820
20	4,720	5,300	5,320	6.8	730	7.6	830	8.5	900
22	6,340	7,130	7,150	7.4	800	8.3	900	9.2	990
24	6,840	7,690	7,710	8.0	870	9.0	980	10.0	1,070
26	7,330	8,240	8,260	8.6	930	9.7	1,050	10.7	1,150
28	10,570	11,870	11,880	9.2	1,000	10.4	1,125	11.5	1,230
30	11,240	12,620	12,640	9.8	1,060	11.0	1,200	12.2	1,310
32	11,910	13,370	13,390	10.4	1,130	11.7	1,270	13.0	1,390

Notes: Standard angle railing for wing-walls. Rail Ls., 2½x2½x¼ ins. x 5 ft. 9 ins. Top of rail, 3 ft. 2 ins. above grade. Post Ls., 3x3x¼ ins. x 4 ft. 3 ins. Weight of rails and posts for one wing is 90 lbs.

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and will be suited for use under all conditions. In order, therefore, to make a proper selection of material for construction the limitations of the use of each of the materials must be considered. Since the general term "steel bridge" is generally interpreted to mean the superstructure the following discussion will be based on that use of the term, unless otherwise mentioned.

Cheapness of first cost is probably the greatest point in favor of steel bridge construction. With the exception of some of the shorter spans no other available material or combination of materials at an equal cost will produce a bridge of the same lasting qualities and capable of carrying the same loading as steel construction. Some light concrete designs have been worked out which can be built for a sum approaching the cost of good steel construction, but none of these types has proven to be an entire success under general conditions, and their use has very decided limitations. On some of the shorter spans, up to 40 ft. in length, various designs of concrete will compete closely in first cost with good steel construction. The concrete slab and deck girder superstructures, when economically designed and where local conditions are favorable, can often be built at a less first cost than a riveted steel design carrying a concrete floor. Several factors, such as length of haul of materials, availability of concrete material, etc., will govern in cases of this kind.

On the longer spans, from 40 to 200 ft., it has always been true under the Iowa specifications that the steel design was considerably cheaper. In addition to the lower first cost it should be noted that the use of a steel superstructure will permit the use of a semi-permanent substructure or foundation. This is illustrated by the use of the heavier riveted spans, which are designed for a concrete floor, but which provide for the use of a temporary wood floor and which are placed on wood piling abutments. A fairly substantial bridge capable of re-erection is obtained in this manner at a much less first cost than if concrete or other permanent construction had been used. The necessity for a superstructure which can be removed and replaced without serious inconvenience is particularly essential in the construction of bridges over drainage ditches which require redredging at frequent intervals. For lengths up to 70 ft. the low riveted truss, commonly known as the Warren girder, can be field-bolted without danger of affecting the strength of the connections. When so field-bolted it can easily be removed to permit the free passage of dredging machinery.

SUBSTRUCTURES.

As a general proposition, steel is seldom used in the construction of substructures, or to serve as a foundation material. The fact that it corrodes readily under such conditions, and other materials of a more suitable character for withstanding earth pressure are available, almost prohibit its use. Some of the older bridges in Iowa were built with I-beam or truss superstructures and were supported on built-up steel columns or posts. Wood backing was generally used to support the earth behind the vertical posts. The fact that the steel under such conditions corroded readily, and the supporting columns were seldom held rigidly in place, has eliminated this type of construction from consideration.

We are still compelled to resort to the occasional use of metal tubes to act as supports. These tubular piers, which were generally filled with concrete, are now used only in extreme cases. The tubular pier construction best adapts itself to location where there is little danger of a deepening of the channel or a sudden change in the direction of the stream current. Almost all of the streams of importance in the middle west carry sufficient ice in the spring to prevent the use of construction of this character. Even by the addition of a steel diaphragm wall, which serves to protect these tubes to some extent from ice, driftwood, etc., their use is very limited. The fact that a vertical steel tube will resist comparatively little lateral pressure has largely caused a discontinuance of its use.

Another serious objection to the use of tubular piers is the necessity for some form of earth support at the bridge approach. Very little dependence can be placed on the ordinary vertical steel tubes to resist such pressure. In almost every case where construction of this kind has been employed serious failures have resulted. This is only to be expected since it is practically impossible to design steel tubes economically to resist earth pressure. In only a very few cases have failures been noted due to corrosion of the metal. Whether the metal used in the construction of these tubes has possessed superior rust-resisting qualities or is more accessible for painting is a question which will bear further discussion.

TOWER OR VIADUCT CONSTRUCTION.

In a few cases it is necessary to provide a roadway across a stream at a considerable elevation above the stream bed. If the height is sufficient, and the total length of the structure great, it is often economical to use tower or viaduct construction. The roadway can be carried on steel girders resting on built-up steel towers, which in turn rest on small masonry piers, built to a height above high water stage. A very rigid and economical structure can be obtained by viaduct construction, one which possesses the advantage of permanency under favorable maintenance conditions. One particularly noticeable example of a bridge of this kind is located in Hardin County, near Eldora, Iowa. This structure, which is 80 ft. above the Iowa River, is 960 ft. in length and carries an 18-ft. concrete roadway. The cost of the bridge structure proper was $39,000.

Steel plate girder construction is occasionally used in cases where it is necessary to secure the maximum area of waterway for a given span length. Plate girders of an 80-ft. span have been used in highway construction in Iowa, and when properly designed make a very serviceable structure. The inability of the western bridge shops to lower their shop costs on material of this kind has, to a certain extent, limited their use.

LIFE OF STEEL BRIDGES.

The probable life of a steel bridge is a point of serious consideration, if this type of construction is to be generally used. The life of the steelwork will depend almost entirely upon the attention it receives from the maintenance forces. If properly painted with a good quality of paint there is no apparent reason why the life of a well designed steel bridge may not be very great. From observations of properly painted steelwork the writer is led to believe that under ordinary conditions our present riveted steel structure or I-beam spans should have a life equal to, if not greater than, much of our present concrete construction. To attain a life of even 20 years the steelwork must often receive attention, and corrosion must be checked before it seriously affects the metal. With the general tendency towards more efficient supervision of highway work we are able to provide greater assurance of prolonged life to our metal structures in the matter of keeping them properly painted and in repair. The elimination of details not easily accessible for painting, and the demand for more durable paints, have both tended to increase the general use of steel structures. The annual depreciation and maintenance charge need not be high if the steel receives the proper shop and field coats before erection and if it is given the necessary attention after erection.

NECESSITY FOR RIGID CONSTRUCTION.

Our present traffic requirements are such as to necessitate rigid construction. The time is past when it is economical to consider the light steel construction, except in locations where the traffic conditions will only allow very limited expenditure. In Iowa we find that, at the present prices of lumber and concrete materials, it is false economy to place wood floors on our steel bridges built on main traveled roads. The annual cost of maintenance of a wood floor is considerably higher than a concrete floor, when the life of the latter is taken into account. Two or three renewals of a wood floor will pay the entire cost of a concrete floor.

STANDARD DESIGNS—DATA ON.

In Fig. 1 and in Table I there are given the estimated quantities of materials and essential data on the design of the standard steel pony truss spans (Series X) of the Iowa State Highway Commission; while in Table II there are given the estimated quantities of materials entering into the construction of the standard beam spans.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by J. H. Ames, bridge engineer, Iowa Highway Commission, at the Northwestern Road Congress, Cedar Rapids, Iowa.

DRAINAGE AND IRRIGATION

Construction Methods and Costs, Sacramento Valley Irrigation Project.

Contributed by P. A. Welty, Supervising Engineer, now of Paso Robles, Cal.

III.

CONTRACT WORK ON MAIN CANAL STRUCTURES.

The following work occupied approximately 187 working days, from July 1 to December 31, was scattered through three units of the area developed for about 26 miles along the main canal. The contractor cared for his men in two camps, providing mess and sleeping tents, the men being charged 25 cts. per meal; moving camp as the work progressed. By the terms of the contract the company furnished at railroad warehouse all cement, reinforcement, bolts, corrugated iron pipe, any steel or lumber becoming a part of the structure, did the puddling and backfilling and placed gates and flash boards except on the closed type culverts; the last work being partly done by the maintenance crews. The contractor did all hauling, excavating, furnished labor, form lumber, gravel, water, any materials, such as nails and tie wire, which did not become a part of the permanent structure. Stated as briefly as possible, the work units and cost were as follows:

The separate structure costs would mean little without a detailed description of the various lengths and diameters of pipe, number of openings to check and flood-gates, amount of backfill, which at some of the natural drainway crossings was considerable. All the headgates were fitted with iron gates and screw lift up to 30 ins. diameter and above this diameter the gates had screw lifts, but a framed redwood gate, the check openings being also equipped this way.

Fig. 11. Check-Headgate Showing Structure Numbering, Sacramento Valley Irrigation Co.

The contractor's force averaged about as follows:

	Per day.
2 foremen	$6.00
3 carpenters	3.50
1½ straw boss	3.00
3 laborers	2.75
24 laborers	2.50
4 stock	1.25

The average crew rate was $2.95 per day. The gravel cost the contractors $2.45 an average per cubic yard delivered. On only a small part of the work were they able to bore and get water, but had to haul at a considerable expense. It was required that the concrete walls be wet down for five days. Form lumber was all new material and cost delivered about $1 per cubic yard of concrete. A good deal of it was used three times before it became a total loss. All concrete was board-mixed, as usual, it being thought not economical to operate a mixer, as the actual concreting required but a comparatively small portion of time of the crew. For the yardage poured a very large crew was necessary, but was occupied principally moving, excavating, setting form, wrecking, etc., over 90 separate structures being built on this contract. The contractors maintained a local office and required an auto in the work.

The contractors received for their work $12 per cubic yard of concrete, 55 cts. per linear foot corrugated iron pipe laid, $11 per M. B. M. for bridges built, 25 cts. per cubic yard earth in bridge approaches.

The average output per man-day for the 35.5 men on the 187 days (includes 5 Sundays), 4/10 cu. yd. concrete, ⅓ lin. ft. pipe placed and 14 B. M. lumber placed.

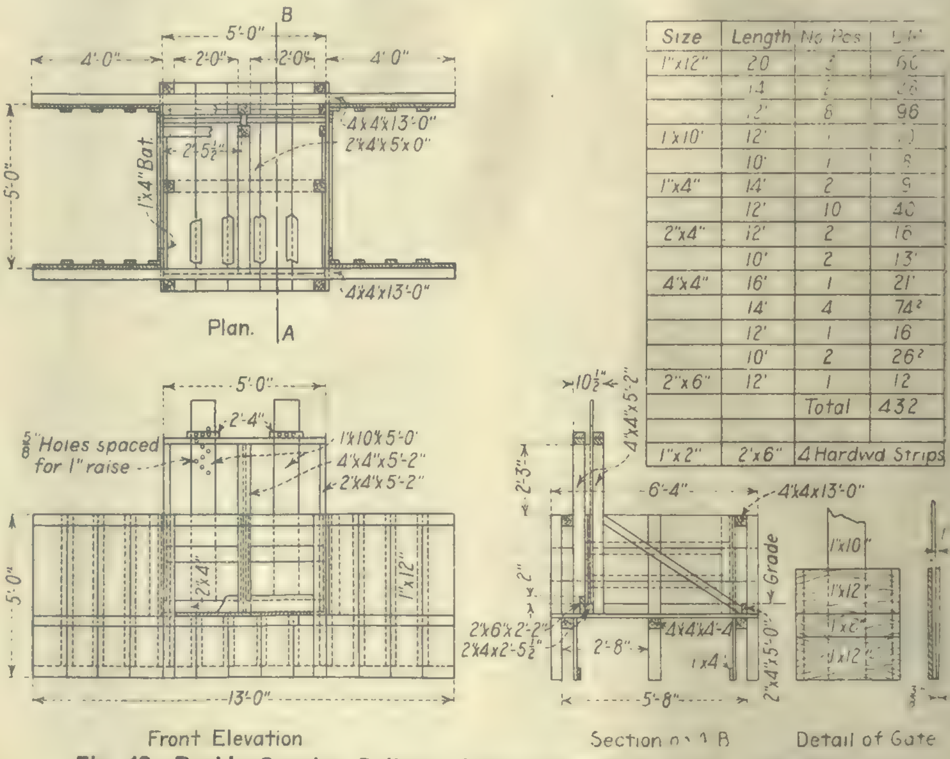
The contract work totaled 2,700 cu. yds. concrete, 3,470 lin. ft. various diameters corrugated iron pipe, 93 M B. M. in bridges, 1,000 cu. yds. in bridge approaches. The principal material items of cost to company were, 3,000 bbls. cement in our warehouse, $2.65 bbl.; 51 tons reinforcement in our warehouse, $2.45 cwt.; pine lumber (bridges), $21.50 M; redwood, $24.50 M; corrugated iron pipe, current prices.

The backfilling of the structure was done by both day-force work and contract—about 18,000 cu. yds. were placed and 20 per cent of this amount was "wet puddle," requiring plenty of water. This work cost from 30 cts. to 40 cts. per cubic yard. No time was lost on account of bad weather. Contractors' costs kept on this contract show them a fair profit in addition to figuring the time of the two partners in at fair salary each per month. The complete contract cost to the company was [illegible].

FORCE ACCOUNT OR DAY WORK ON MAIN CANAL STRUCTURES.

The following work was done from September to February, the work days including Sundays, numbering 165, it being a rush job while the canal was empty. Some few structures embraced in this work were built before water was out of the canal. They required sheet-piling cofferdams, hand-driven. The work extended along the canal for 15 miles, some 69 structures being built, nearly every location being a slough or boggy spot. The old canal had not yet been rebuilt and consequent undulation in the bottom held pools of water full of tules; also many footings were in water-bearing gravel. About half the structures were built at the site of an old one of redwood which was first to be removed. Considering the time of year, time limit, and possible water troubles underground no one would bid on the work. The company put three messes on the line about four miles apart and five concrete crews of about 15 men each and one mule crew to excavate, backfill and haul material. The messes barely paid expenses; a 10-hr. day was paid for, but the days in the winter are short and even on work adjacent to a mess 9½ hours were all that could be put in. The average crew rate was $2.85 per day, as follows: Foreman, $4.75; carpenter, $3.50; 2 form setters, $3; 11 laborers, $2.50.

The average cubic yard of gravel cost delivered $1.80, with a four-mile haul. Form lumber S. I. S. pine or redwood rough, which is sized, cost $26 per M in the field; a third use of the lumber was got and if made into panel forms 5 to 6 uses. For both panel or built forms 1x6-in. and 1x12-in. stuff with 2x4-in. studs on 24-in. centers was used. The cost of form work in place per square foot surface area was $0.05. The average cost of form material erected per cubic yard of concrete was $2.25. The reinforcement used was mostly ⅜-in. and ½-in. round rods, which cost $2.25 per 100 lbs. at warehouse. It cost 40 cts. per cubic yard of concrete to cut and fabricate reinforcement and wire mesh, or $1.30 per cubic yard included cost of material and work.



Size	Length	No Pcs	[illegible]
1"x12"	20	3	60
	14	2	28
	12'	8	96
1'x10'	12'	1	10
	10'	1	8
1"x4"	14'	2	9
	12'	10	40
2"x4"	12'	2	16
	10'	2	13'
4"x4"	16'	1	21'
	14'	4	74²
	12'	1	16
	10'	2	26²
2"x6"	12'	1	12
		Total	432
1"x2"	2'x6"	4 Hardwd Strips	

Fig. 12. Double Opening Delivery Gate, Sacramento Valley Irrigation Co.

Water was too plentiful. Every structure was a hip-boot job, requiring hand sump-pump and at some was used a 4-in. centrifugal pump and gas engine. Some of the old redwood structures were torn out with dynamite, which was an economical way to get out the structure and excavate, but some of the timber, where it had been unexposed to air, was good, and the blasting made kindling wood of it. It also cracked old levees too far back and its use was stopped after the first few blown out.

The backfilling cost 55 cts. per cubic yard of earth and was almost entirely muck. The scraper had to be hand-cleaned almost every lap. The concrete was board mixed and required 4 sacks to the cubic yard, the best run of any entire crew per average man-day being 6/10 cu. yd., or 1 7/10 yds. per man for the six men immediately engaged on the board.

The percentage of cost of the several items of material and work entering into the average of 1,500 cu. yds. of concrete work on this line was as follows:

Item.	Per cent.
Wrecking old structures	[illegible]
Excavation	15
Setting forms	10
Fabricating reinforcements	1
Concreting	12
Wrecking forms, cleaning up	2
Transportation, roustabout team	3
Pumping	2
Backfill	10
Total labor	58
Cement	20
Gravel	12
Hardware, iron, bolts, wire, nails	6
Lumber, forms (used 4 times)	4
Total material	42
	100

Does not include flash boards to open flood gates which were placed by operation department.

The cost of the completed work to the company was $13,103 material and $16,117 labor, or $29,220.

Work consisted of 32 open flood gates, 15 closed culvert flood gates, 9 head gates, 12 canal syphon culverts, 1 bridge; total, 69 structures; 1,500 cu. yds. concrete, 2,340 ft. pipe, 15,400 ft. B. M.

Fig. 13. Deep Drain Concrete Bridge, Sacramento Valley Irrigation Co.

The average cost per cubic yard of concrete work complete, exclusive of overhead, was $17.60 for the work along the main canal. The force account work, in spite of the bad founda-

TABLE V.

Kind of Structure.	Material.	Number of structures: Built.	Number of structures: Prorata per acre.	Number of structures: Prorata per mile lat. dr. rd.	Average units per structure in ft., yds., B.M.	Average cost in dollars per: Unit cu. yd.-lin. ft. B.M.	Average cost in dollars per: Structure.	Average cost in dollars per: Acre served.	Mile of: Lateral.	Mile of: Road.	Mile of: Drain.
Open delivery gates	Timber	255	.0103	1.60	T. 377	82.70	31.00	.312	49.28	......	......
Open delivery gates	Concrete	798	.0324	5.00	C. 2.25	18.66	42.00	1.341	209.47	......	......
Closed delivery gates (box)	Timber	122	.0048	.72	T. 175	90.80	15.90	.078	12.12	......	......
Closed delivery gates (pipe)	Corrg. iron galv.	10	.0005	.07	P. 10	2,63	26.25	.011	1.64	......	......
Total		1,185	.0480	7.39	.....	.....	......	1.742	272.51	......	......
Checks—Hd. gates—Drops	Timber	140	.0057	.875	504	75.20	37.60	.211	32.90	......	......
Checks—Hd. gates—Drops	Concrete	402	.0162	2.51	4.10	17.46	71.60	1.151	179.[illegible]	......	......
Total		542	.0219	3.38	.....	.....	......	1.362	212.79	......	......
Flumes	Timber	2	.00007	.012	3,150	67.50	212.65	.017	2.66	......	2.66
Flumes	Timb. and conc.	2	.00006	.013	C. 36.0 T. 726	16.80 73.50	659.10	.053	8.24	......	8.24
Flumes	Concrete	1	.00005	.006	14.0	20.10	281.35	.011	1.76	......	1.76
Flumes	Conc. and C. I. G.	3	.00012	.019	15.10	17.50	351.55	.042	6.59	......	6.59
Total		8	.0003	.05	.....	.....	......	.123	19.25	......	19.25
Syphons (latrls. under drns.)	Concrete	3	.00012	.019	67.75	16.55	1,121.90	.135	21.04	......	21.04
Syphons (latrls. under drns.)	Conc. & C.I.G.Pp.	3	.00012	.019	C.10.25 P. 36	18.10 2.25	266.60	.031	5.00	......	5.00
Total		6	.00025	.037	.....	.....	......	.166	26.04	......	26.04
Hog-gaps—Swinging	Timber	8	.0003	.05	445	82.25	36.60	.012	1.83	......	......
Total		8	.0003	.05	.....	.....	......	.012	1.83	......	......
Culverts (drns. under latrls.)	Timber	24	.0010	.15	887	77.90	69.10	.066	10.37	......	10.37
Culverts (drns. under latrls.)	Concrete	7	.0003	.044	11.90	16.90	201.00	.056	8.79	......	8.79
Culverts (drns. under latrls.)	Conc. & C.I.G.P.	2	.00007	.012	C. 2.0 P. 30.0	24.84 2.02	110.40	.009	1.38	......	1.38
Culverts (drns. under latrls.)	Cor. iron G. Pp.	3	.00012	.019	40	2.08	83.35	.010	1.56	......	1.56
Total		36	.0014	.225	.....	.....	......	.141	22.10	......	22.10
Floodgates	Timber	3	.00012	.019	525	87.04	45.70	.005	.86	......	.86
Floodgates	Concrete	2	.00007	.013	7.75	14.77	114.50	.009	1.43	......	1.43
Total		5	.00020	.03	.....	.....	......	.014	2.29	......	2.29
Bridges (rds. over latrls.)	Timber	344	.0135	2.15	1,650	37.10	61.20	.842	131.58	131.58	......
Syphons (latrls. under rds.)	Concrete	30	.0015	.19	15.80	16.84	266.20	.319	49.91	49.91	......
Syphons (latrls. under rds.)	*Conc. & C.I.G.P.	15	.0007	.095	C. 5.50 P.24.00	17.83 2.80	203.25	.122	19.05	19.05	......
Syphons (latrls. under rds.)	Timber	1	.00005	.006	500	62.00	31.00	.001	.19	.19	......
Total		390	.0157	2.44	.....	.....	......	1.284	200.73	200.73	......
Bridges (roads over drains)	Timber	132	.0052	.82	1,650	36.51	60.25	.318	49.70	49.70	49.70
Culverts (drains under rds.)	Timber	240	.0097	1.50	350	57.14	20.00	.192	30.00	30.00	30.00
Culverts (drains under rds.)	Concrete	12	.0006	.075	6.50	18.13	117.85	.057	8.84	8.84	8.84
Total		384	.0155	2.40	.....	.....	......	.567	88.54	88.54	88.54
Bridges (deep drain)	Timber	12	.0006	.075	3,600	44.50	160.00	.077	12.00	12.00	12.00
Bridges (deep drain)	Timber and conc.	5	.00025	.03	T.2,576 C.18.00	T.39.30 C.16.75	425.00	.085	13.28	13.28	[illegible]
Bridges (deep drain)	Concrete	6	.0003	.03	42.0	18.25	790.00	.189	29.62	29.62	[illegible]
Culverts (deep drain)	Conc. &72"C.I.Pp.	[illegible]	.00025	.03	C. 20.0 P. 26.0	T.18.70 C.10.50	645.00	.129	20.15	20.15	20.15
Culverts (deep drain)	Timber & "	10	.0005	.07	T. 800 P. 26.0	T.47.20 P.11.10	325.00	.130	20.31	20.31	20.31
Total		38	.0019	.20	.....	.....	......	.610	95.36	95.36	95.36
Grand total		2,606	.1055	16.22	.....	.....	......	6.028	941.45	......	......

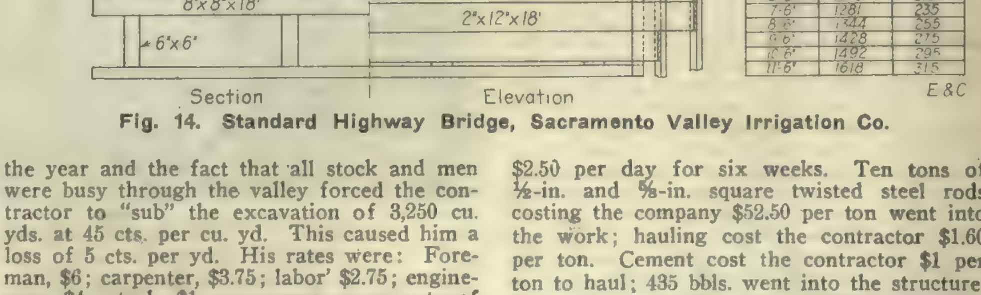
*A few concrete pipe structures included here.

tion conditions, was as cheap as the contract work. A reinforced concrete check of 10 6-ft. wide openings, gates and flash boards completed under average conditions, cost $1,950. A corrugated iron pipe head gate 30 ft. long, 27 in. diameter, reinforced concrete wings, each end completed, cost $255. An average double flood gate of 2 6-ft. wide openings complete, cost $575. An average closed flap-gate culvert through one levee, being 30 ft., of 30 ins. diameter, corrugated iron pipe, cost $135, or if of concrete pipe, 15 per cent less. An average syphon culvert built in connection with the larger flood gates at creek channels required 5 cu. yds. of concrete and 120 ft. of 24-in. corrugated iron or concrete pipe, and cost $340; no reduction if concrete pipe was laid, as it costs more to lay it in mud found here. The average timber bridge of 14,000 ft. B. M., including 260 cu. yds. of dirt in approaches, cost $540. These costs are an average of both contract and day work. Engineering, cost keeping and supervision cost about 2½ per cent on this work.

LONE STRUCTURE CONTRACT ON THE MAIN CANAL.

The contractor agreed to furnish all equipment, labor, forms and nails, non-local gravel, excavate, haul, build, but not backfill a reinforced concrete inverted syphon carrying the main canal under one of the larger creeks which is dry in summer but a torrent at times in the rainy season; the work was 5½ miles from the railroad town on good roads. The contractor was to receive $9.65 per cubic yard concrete placed and 40 cts. per cubic yard earth excavated. The company furnished, f. o. b. cars, cement, reinforcement of deformed bars, and hardware. The contract was to be completed by Dec. 31, was signed Oct. 18, and it was one month later before the contractor got on the ground. He put up bunks, mess, stock sheds, operated his mess, which probably did not pay for small number of men employed, eight being the average.

Gravel cost $1.50 f. o. b. cars and an additional $1.10 to haul to the site, 35,000 ft. B. M. of form lumber of 1x6-in. and 2x4-in. S. I. S. pine cost at the railroad $25 per M and $1.60 per M to haul to the site. This material was used but once and was hauled to use elsewhere. It is estimated that 60 per cent salvage on the form lumber was fair. The season of the year and the fact that all stock and men were busy through the valley forced the contractor to "sub" the excavation of 3,250 cu. yds. at 45 cts. per cu. yd. This caused him a loss of 5 cts. per yd. His rates were: Foreman, $6; carpenter, $3.75; labor' $2.75; engineman, $4; stock, $1; an average crew rate of $3.40.



One Span Ft	Lumber B M	Lbs. Nails
5'-6"	1078	195
6'-6"	1170	215
7'-6"	1281	235
8'-6"	1344	255
9'-6"	1428	275
10'-6"	1492	295
11'-6"	1618	315

Fig. 14. Standard Highway Bridge, Sacramento Valley Irrigation Co.

One of the contractors was on the work all the time, but no account is taken of his time. A Chicago chain belt mixer was used, capacity ¼ cu. yd. to the batch; average run was 6 cu. yds. per hour. The mix was four sacks to the cubic yard in footings and 4.6 sacks to wall, roof and wings. The contractor bored a well 40 ft. deep by hand for $30 and rented a small 2 H. P. engine and pump at $1.33 per day, the equipment furnishing an abundance of water. His entire plant was estimated at $1,200, the depreciation on which run about $2.50 per day for six weeks. Ten tons of ½-in. and ⅝-in. square twisted steel rods costing the company $52.50 per ton went into the work; hauling cost the contractor $1.60 per ton. Cement cost the contractor $1 per ton to haul; 435 bbls. went into the structure

The contractor's labor cost on the structure per cubic yard covering form work, hauling, mixing, placing, steel, etc., was $ 6.80

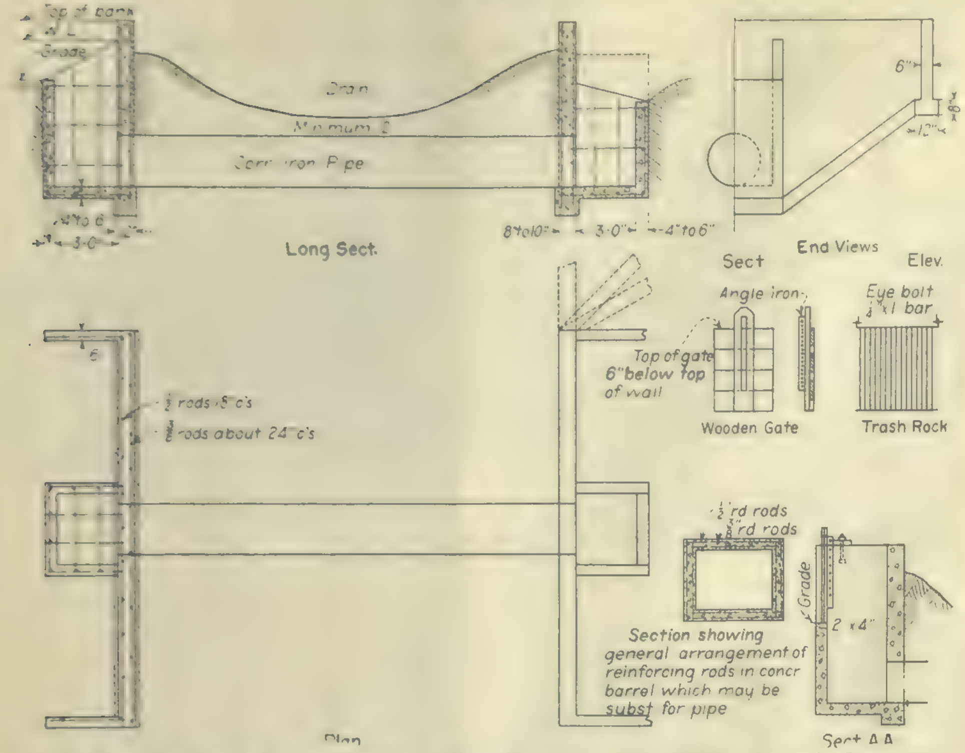


Fig. 15. Road or Drain Lateral System With Corrugated Iron Pipe Barrel, Sacramento Valley Irrigation Co.

The loss on mess and sheds, depreciation on plant, cost of excavation, water, gravel and other supplies totaled $7.45 per cubic yard	7.45
Gross cost to contractor	$14.25
3,250 cu. yds. excavation at 40 cts. (earth estimate based on concrete price)	3.40
Actual cost to contractor per cubic yard	$10.85
Received of company per bid per cubic yard	9.65
Contractor's loss per cubic yard concrete	$ 1.20

The contractor, to have made a 15 per cent profit on actual cost, should have bid $12.50. The cost to the company of backfilling the structure was 30 cts. per cubic yard for 2,100 yards of work. The cost of the completed structure, gates and all in place, including engineering and supervising, was $8,100, or $21.30 per cubic yard. The contractor prosecuted the work with great energy and ability and the only reason he lost money was his low bid.

The structures, so-called permanent, making use of corrugated iron pipe in their construction, are misnamed slightly. The corrugated iron used was the best on the market, according to test, and in the valley conditions will last 20 years or more, judging from experience there and elsewhere. This, as a material of construction, is growing in favor on account of its ease in shipping, handling, hauling and installing.

Concrete, if well made, of good material and properly placed, should be everlasting, but on some of the work we encountered conditions where concrete pipe failed and where to have built a concrete conduit in place would be out of reason, because of the bad foundations at the site or the cost of the work. If the corrugated iron pipe settles or warps out of alignment its value as a structure remains the same. The first cost of a structure with corrugated iron barrel will be somewhat less than a monolithic concrete structure and a little more than a concrete pipe structure, but where bad foundation conditions are encountered or where a quick job is wanted the corrugated iron material is the best to use. When the present corrugated iron structures show signs of rusting through they can be concreted around the pipe, which will answer for the inner form, the earth excavation being the outer. The corrugated iron pipe has a rather high friction co-efficient; this factor should be considered in installing syphons of this material if of any length. Quite a few delivery gates were placed of 18 ins. diameter; corrugated iron pipe 16 gage, 10 ft. long, with galvanized iron slide gate. These cost about $22.50 placed. They were usually intended to water 20-acre tracts and were quickly placed.

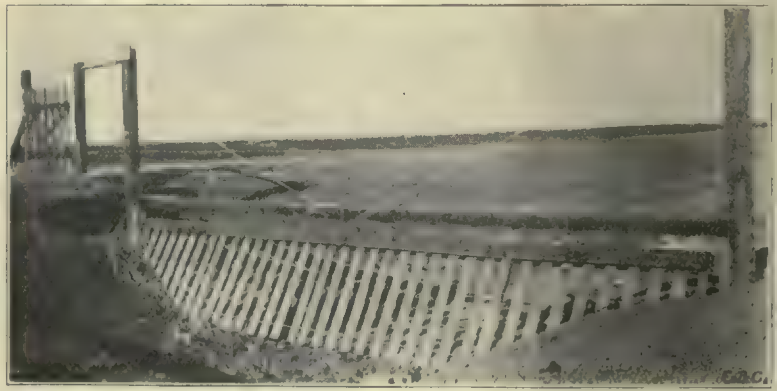


Fig. 16. Hog-Gap, Sacramento Valley Irrigation Co.

With the addition of from ¼ to 1 cu. yd. of concrete for wings or head wall to add stability, the structure became first-class, but the small bit of concrete cost about $18.50 per cubic yard to place. Some of these structures are listed in the cost tables as closed type delivery gates, as are some alternate structures, varying in size from 6 ins. square to 12x24 ins. area box-delivery gates of 2-in. redwood material 8 ft. to 12 ft. long, built like a culvert, with wings and gate of redwood sliding in 2x4 upright grooves. These types of gates were called "Macaroni Straw" gates and while they were cheaper than the open type gates, were not as efficient. Either the corrugated iron pipe or these redwood boxes should have 1 ft. head of water over the top of the barrel to get good delivery and in a flat valley country this is at times almost impossible. A great many structures were placed for delivery gates (over 900) and many more as checks, headgates, drops, weirs in small laterals like Figs. 10 to 12. Referring to Fig. 10, where several head gates, delivery gates and checks occur in groups, these corrugated iron pipes have been worked in the combination very successfully, saving length of wall or wings, as shown in sketch, necessary to prevent slope erosion. The structure varied a little to fit the different conditions and soil types, but usually was the straight wall type, and for small yardage was cheaply placed, because of large number built and the use of substantial adjustable panel forms. These structures cost one-third more than the open type redwood gates per table. The redwood gate found generally most efficient was built as per Fig. 12. In order to reduce the board measure and consequent cost these structures were revised by building the sides of the box sloping down stream at about 2:1 and not placing the downstream cross wing at all except the curtain which protected the structure from back-lash and undermining. This change was found practicable in small canals in gravelly and clay soils, but the saving in lumber was not generally good practice and is not recommended.

As to life of timber structures: The pine or fir obtained was poor, being splintery and brittle, easily warped and shrinking badly. It was only used in the superstructure of bridges, never in touch with the earth, where it would be rotten or worm-eaten in a year. Redwood was used for all timber structures in earth. Old redwood culverts and timber 25 years underground saturated with water were as good as new. Redwood under a fill and moist will last years, but alternately wetting and

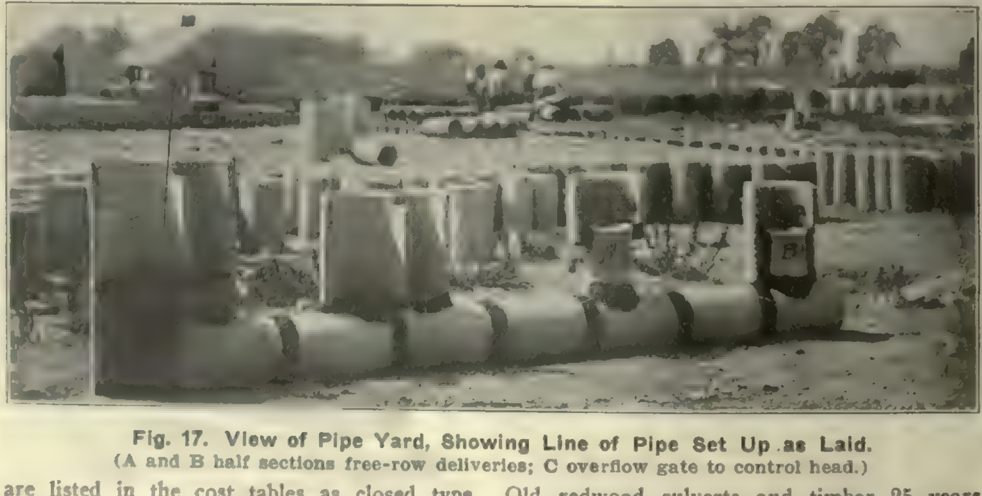


Fig. 17. View of Pipe Yard, Showing Line of Pipe Set Up as Laid.
(A and B half sections free-row deliveries; C overflow gate to control head.)

drying away from sun and wind will last 12 or 15 years if of 2-in. or heavier stuff. Structures exposed to the weather and wind and in use, alternately wet and dry, of 1-in. material will need repair in five years and replacement in seven years in the valley. On the main roads flooring of fir timber of bridges from the gravel and grit under the travel went to pieces in a year, and some of the bridges had longitudinal running planks placed twice a year. On two of the main canal bridges the floor was heavily oiled with crude oil to prevent decay and about a 6-in. layer of pit gravel put on the bridge and crowned for drainage at a total cost of about $25 per bridge. The floor has already been down long enough to prove the work was worth while.

Table V was prepared from construction data obtained on a completed unit of 24,800 acres, being irrigated in 40 and 20-acre tracts (about 70 per cent of the former). Roads were laid out and built each way one-half mile apart on section and half section lines; drains were constructed along land lines or in natural depressions to every 40-acre tract and laterals built along land lines or on ridge locations to every 40-acre or 20-acre lot if so sold. This plan of subdivision requires about four miles each of road, drain and lateral to every square mile of area, or this unit required 160 miles each of road, drain and lateral. Main canal structures are not included. Main office overhead (10 per cent) not included.

Road structures over natural drains were built by the company at county expense, but road structures over constructed drains were built and expense shared by the company.

In estimating structure costs on a subdivision of similar plan the costs per mile of either road, lateral, or drain might be used, as their mileage is practically the same, but in the table in column "cost per mile of" "road" "lateral" "drain" where costs are given in two columns as "flumes" under both "drain" and "lateral" it is really a lateral structure, but might also be considered a drain structure, and is so shown. A head gate is undoubtedly not a road structure and is not so shown—where two unit costs are given under column head "cost per unit," "yd., ft., B. M.," each is of that particular material and not of the entire structure; i. e., cubic yard unit cost is of concrete and B. M. is of the timber under bridge of timber and concrete.

GENERAL

What the Engineering Society Owes to Its Members.

Much has been said concerning the duty of the engineer to join with his fellows in organized efforts for mutual benefit and to utilize the united strength for the public welfare. At the present time we may well look on the other side and consider what is the duty of the organization to its members. It is not enough for men to get together to discuss technical matters of mutual interest, or to promote good fellowship by social gatherings. There is such a thing as building up a machine in which all of the energies are devoted to the perfection of the machine and in keeping it in motion. People quickly get tired of "watching the wheels go round" and begin to ask what is the output and how efficient is the machine in comparison with the power applied to it.

In this connection there are three groups or entities to be considered. First, the engineers as individuals; second, the engineering society; third, the public in general.

The engineer unquestionably owes certain duties to the public, first because of the fact that he has been educated largely at public expense or is afforded larger opportunities by the laws and practices of civilization. The fact that he, as a rule, has wider information and higher development of intellectual faculties is an added obligation to use these for the benefit of the world.

The engineering society, however, has usually been regarded as a collection of individuals and to have few if any duties outside of those performed by individuals. It is conceived as shifting largely in its activities from year to year as the principal officers change. As a matter of fact, however, if we study different engineering organizations we find in each a certain marked peculiarity, not usually revealed in the constitution or by-laws and frequently indescribable or unrecognized by members. Nevertheless all are unconsciously affected by the unwritten laws. These peculiarities are often permanently impressed in the early years of the society and may not be outgrown. It is to these and of their effect upon the individual members that the present discussion relates.

The one thing in which an organization differs from a natural person is that it has nearly unlimited life and strength. It is not merely a collection of individuals—it is more than this; an artificial entity removed from many of the limitations of the ordinary man. When 20 men are associated the new creature may have the strength for good not of 20 individuals but more nearly of a hundred. At the same time this has many of the characteristics of a person. It starts out with infantile vigor and grows in strength and size at a rate corresponding to the marvelous development of the young child. It has certain infantile dangers and diseases and if it passes safely through these, gradually reaches a maturity of judgment and wisdom which is characteristic of a mature age. At first it may be said that the wisdom of the society as a whole is not equal to that of any one of its component members. Later after growth and experience there is usually acquired a wisdom which theoretically at least surpasses that of the individual.

Experience has shown that some societies like individuals are early stunted in mental development and never attain more than mediocre position. Others under more stimulating influences, continue an indefinite growth of mental activities and ever widening circle of influence. This creature of man's invention has a certain form of life, and, though intangible, has certain unwritten laws or courses of action which we call precedents, and is capable of exerting powerful influence. It is of the highest importance that the early habits be correctly formed in order to attain the full wisdom and efficiency of manhood.

Each engineering society has a purpose stated in its charter in glittering generalities. These relate mainly to the advancement of the profession. The first officers elected are usually men of enthusiasm, whose time and strength are given to perfecting methods of procedure and in inducing other men to join. There is quickly established a certain routine of letter writing and of holding meetings. After overcoming the initial difficulties and surmounting various obstacles the society is apt to settle down to a simple plan—one involving monotonous repetition—and to continue indefinitely on what has been termed the "plateau of mediocrity." There is a general feeling that after certain precedents have been established there is little more to be done other than faithfully to follow these.

Such is the history of many organizations which started out with high hopes and advanced rapidly under the stimulus of enthusiastic individuals. The only apparent reason why continued upward progress is not made is in the tendency towards reaction which follows each conscientious effort. After the exertion of a strenuous day the individual desires rest and sleep. If the society entrusts its fortune to a single individual it in turn must seek repose. There is this marked difference, however, between the society and the individual: The former is a purely artificial organization with indefinite life and capabilities of sustained energy. It has no necessity for repose, but, on the contrary, because of its artificial structure, may be so constituted as to continue in action indefinitely. This is possible through the maintenance of effort by proper diffusion of work. Where requirements exist it is possible so to organize and conduct work—for example, in erection of a building—as to be continuously effective 24 hours of the day and 365 days of the year. This is done simply by having relays of shifts of men organized for this purpose under a comprehensive plan. In a similar way the efforts of a society may be so organized as never to relax if we follow the same rule, in force in other work, of having such distribution of effort and fixing of responsibility as assures continuous performance.

All of this implies that the society is planned and organized for the most effective and economical results. The fact that it is thus possible for the impersonal organization to be always on duty and always effective does not necessarily mean that an undue load is imposed on any individual member or officer. It does necessitate, however, a somewhat different form from that ordinarily adopted, and the pursuing of a plan similar to that of modern business houses.

It means, for example, that the officers of the organization should be chosen not simply for their age and experience, or the fact that they have accomplished notable results in the past, but rather because of their capability for work for the good of the society as a whole, and because of the human interest and sympathy with the rank and file of the members and their appreciation of the needs of the individual. This is in many respects a radical departure from current practice.

In many of the largest and most informal engineering organizations it has been the general understanding and practice to select men from their professional reputation and to put in office men whose personality is almost unknown to the individual members, choice being guided wholly by former achievements, often along lines which were almost the reverse of those needed in organized efficiency. It is true that there is nothing in the character nor in the by-laws which brings about this condition, but simply the character which has been acquired or impressed upon the society in its youth and which it has retained with great fidelity throughout its development. A study of some of the engineering organizations, large and small, will show this verv curious and interesting difference in character—one which would not be discovered by reading the official statements, but which is nevertheless as strongly marked as the characteristic which we recognized in an old acquaintance.

Assuming that each engineering society does acquire these peculiarities and does differ from its neighbors in its relation to its members, the question may be asked which of the wide range of possible activities should be encouraged and which discouraged. It follows that in a new or growing organization, as in the case of a child, certain innate tendencies may be strengthened and others repressed. As all courses are open to this artificial creature, which of many should be chosen? It is, of course, assumed that the principal object named in the charter is to be accomplished, but this may be done in an indefinite variety of ways and with many important side issues. For example, the society may be formed for the diffusion of knowledge among its members concerning progress in mechanical engineering; and, while it may conscientiously devote its time to this topic, yet the related activities may be such as to attract and benefit individual members in innumerable ways. If its habitual attitude toward the public in general and toward its members is sympathetic, large results may be accomplished outside of the purely technical work.

What are these and how can this be done without undue imposition upon the few men who are elected to office? There is a limit to human endurance, and solution of this difficulty lies, as above stated, in good organization, good habits, and in such subdivision as is found necessary in commercial work. In other words, the desired result may be attained by planning and distribution of effort among large numbers of members and in the formation of many committees such as will bring into play the stored-up strength which is often untouched in the ordinary organization.

As a rule there are too few committees and too much work is left to one or two men because of the fact that, under the regulation form of the organization, practically everything is left to a president and secretary. If, however, we go a step further and consider that these men are in effect a committee on committees, and that instead of trying to do the work themselves they are to see that it is distributed among many committees, then we may conceive that more and more effective work may be performed, and continuous performance reached. Under this plan the supervision left to the president and one or two managers whose prime duty it is to see that the committees act and who do not diffuse energy in attempting personally to perform everything needed. In short, the duty of the society to its members in considering all of the multifarious interests may be initiated and called forward by using the strength of the organization and calling upon the individual members to serve on well-organized committees.

This is a somewhat radical departure from the current practice in that the proportion of members devoting any considerable thought to the society today as a whole is extremely small—often not 1 per cent; and yet among the 99 per cent are known to be many persons capable of large activities, but not elected to the restricted number of officers selected in connection with the governing of the executive committee.

But what is the new work to be performed and which differs from that of the ordinary scientific society? It may be summed up in the word "Service." A service such as grows out of the recognition of the sentiment so well given by Junius, that "It is an eternal truth in the political as well as the mystical body that where one member suffers all the members suffer with it." Or, to come down to later times, Henry Ward Beecher has declared that "A helping word to one in trouble is often like a switch on a railroad track—an inch between wreck and smooth-rolling prosperity." Organizations are much like individuals. No individual can grow unless he serves. No community can grow economically, socially, morally or ethically unless it is aroused to the need of service. Growth, to be permanent, must come from within; and the only way it can come from within is for the people who constitute it to move, to act, to do something for the common good. In the old days, when we selected a good farmer, because he was a good farmer, to go out and help other farmers, the most surprised man was the good farmer himself, for he found at once that the mere fact of his helping other farmers helped him as much as or more than it did his neighbors. If the work of the society is to be permanent, if it is to accomplish its aims economically, socially, morally and ethically, it must be an outgrowth of the spirit of service, wisely guided, but not directed or dominated by any selfish agencies.

ACKNOWLEIGMENT.

Address before first annual convention of the American Association of Engineers by F. H. Newell, Professor of Civil Engineering, University of Illinois.

Some Notes on the Writing of Compound Technical Terms.

At the recent annual convention of the Society for the Promotion of Engineering Education, the Committee on Technical Nomenclature submitted a preliminary report, in which attention was called to a number of glaring inconsistencies in the writing and use of technical terms. The purpose of this committee, as explained by the chairman, Professor John T. Faig, is not to impose arbitrary standards upon others, but to secure agreement throughout as wide a circle of technical men as possible, regarding the way in which disputed terms shall be written and understood. To this end, the committee has asked for criticisms and suggestions which may result in a better understanding, and perhaps a partial solution, of the problem.

On most questions of interpretation—for example, the distinction between "drill press" and "drilling machine," teachers of English will hardly be expected to venture an opinion. Such controversies may safely be entrusted to persons having expert knowledge of the technical subject involved. Where the issue is primarily one of correctness or consistency of usage, however, some assistance may properly come from those who are interested in expression rather than subject matter. This is particularly true, if as in the present instance, the chief object in studying usage is to deduce from it some practical generalizations as a basis of agreement among writers. It is with the desire to learn the conclusions of others, and perhaps in a small way to aid the committee in their efforts toward the standardization of existing practice, that I offer the following observations on the writing of compound technical terms.

Perhaps the most distinctive feature of the technical vocabulary is its large proportion of compound words. To be sure, one does not encounter in every line such striking examples of compounding as, *"a three-step-cone, double-back-gear, two-countershaft-speed, screw-cutting lathe,"* but similar agglomerations are by no means rare, and with the growing complexity of machines and processes, their number is rapidly increasing. Shorter compounds are so common in technical writing that they might pass unnoticed, were it not for one thing: the perpetual uncertainty as to how they shall be written.

One's first impression, on reading a page of engineering discussion, is that there is no law or custom governing the writing of compound technical words. Even one of the most familiar compounds is written in three ways, "horsepower," "horse-power," and "horse power." Other words in everyday use, such as "switchboard," "waterproof," "blueprint," "crankshaft," are written in two or three ways. Moreover, instances are not wanting in which two or three forms of the same compound are used in the same issue of a given magazine, and even in different parts of a single article. For those who prefer to write consistently, and at the same time with the sanction of usage, this disparity of precedents is hopelessly bewildering. Some comfort, of course, is to be derived from the lists of words which various persons interested have compiled from time to time; but since these lists cannot be exhaustive, and are not always accessible, it would seem desirable to supplement them with a statement of principles which could be more readily and more generally applied.

Some time ago, with the assistance of a class in technical English, I undertook an investigation of the vexing question of writing compounds. We began with lists of words, of the kind already mentioned, and added a number of rules from text-books, some general discussions on the subject of compound words —for example, in the Standard Dictionary, and a few hair-splitting distinctions between special cases, from the *Inland Printer* and other sources. The lists were conveniently specific, but certain inconsistencies in many of them suggested that they had been chosen arbitrarily, rather than by well-defined principles of selection. Many of the rules were helpful, but some of them were too uncertain of application to be useful.[*] The discusions were interesting, and in many respects valuable, but scarcely practical as a guide to writers. The students showed a remarkable aptitude for finding exceptions to both lists and rules; and so potent a superstition is the sanctity of the printed page, that once having seen a certain form of a word in type, they felt forever free to use that form. In fact, the more we studied the question of compound words in general, the more conflicting the evidence became. The next plan adopted was to lay aside rules and precedents, and to undertake an investigation of the technical journals themselves, in order to see whether in the apparent confusion there existed any discernible basis of agreement in the writing of compound words. That there would be some "lawless exceptions" was confidently expected; but it was felt that if a general tendency could be discovered, or if some working rules or principles could be formulated, a comparison of practice would be worth while. Twenty representative technical journals were examined, and about two hundred compounds were tabulated—a sufficient range of material to warrant some fairly trustworthy inferences, if not positive assertions. Too specific mention of the journals is perhaps undesirable, and the details of the investigation would be tedious to include; but some of the facts observed may be of interest.

In the first place, it was noted that in a fairly large proportion of individual journals there was sufficient uniformity in the writing of compounds to indicate an effort at standardization, perhaps through a carefully prepared style sheet, or a competent "style man." Second, a comparison of the various journals showed a tendency toward uniformity throughout the group. Consciously or unconsciously, it seemed, certain principles were being followed, which might be made more useful by being formulated. Incidentally, it may be remarked that these rather surprising facts were only a part of the evidence which showed that engineering journals are rapidly developing a technique of their own.

The practice of American technical journals with reference to the writing of compound words may be briefly stated as follows:

1. *Write compound nouns without the hyphen;*[†] that is, either as two words in the case of separable, or loose, compounds ("cast iron," "friction clutch," etc.), or as one word in the case of inseparable, or close, compounds ("roadway," "falsework," etc.).
2. *Write adjective compounds with the hyphen; e. g.,* "four-cylinder automobile," "cast-iron frame," "low-pressure system," etc.

The second rule is subject to some exceptions, including a few close, or inseparable, compounds, *e. g.,* "overshot wheel," "waterproof lining," etc. More of the exceptions fall under a general rule, which may be stated as follows:

3. *Omit the hyphen wherever the meaning is clear without it; e. g.,* "power plant economy," "machine tool design," etc. This rule is made of course in the interest of further simplification. It includes rule No. 1, and is a corrective for rule No. 2. Obviously, the easier plan would be to follow the second rule consistently, regardless of the number of hyphens which clogged the text. The adoption of rule No. 3 results in a cleaner text, but it necessitates writing with greater discrimination, to decide where the hyphen is needed for clearness and where it may safely be omitted. No difficulty is likely to be experienced in the case of such expression as "machine shop methods," but an expression like "cold-rolled steel" should be written with the hyphen regardless of the context. Those who cannot

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[*] In one excellent text-book on engineering English, for example, the rule for adjective compounds was short, easy of application, and in accordance with what was found to be the practice of writers. The same book contained a rule for compound nouns which proved confusing, rather than helpful to any one in quest of a working principle.

[†] It may be interesting to contrast the tendency of certain English writers. Here are some compound nouns taken at random from Engineering (London), "air-pump," "motor-car," "pig-iron," "gas-main." One or two rather prominent American journals show a preference for the hyphen in all such cases.

easily distinguish the relative clearness of such compounds written with and without the hyphen, will do well to avoid attempting to use rule No. 3.

In the various magazines examined there were of course some exceptions to these rules, and there were also differences in the degree to which the rules were followed. Although some of the exceptions are not without apparent validity,* they are omitted, in order not to obscure the main issues. As we have noted, the rules represent rather the general tendency of sage than the deliberate and consistent practice of technical writers. This agreement in general tendency, however, is significant; for it indicates what will probably become the settled tradition in technical journals. If the practice is wrong, it is high time to set about correcting it. If it is right—that is, if besides being simple and convenient, it can be reconciled with any defensible theory of compounds —then it should be encouraged, and its general adoption should be hastened. Although the rules embodying the practice are stated in terms of the hyphen, it is evident that the hyphen itself is purely secondary, and that the rules have weight only in so far as they rest upon a sound theoretical basis. Before passing judgment on the rules, therefore, it will be well to consider briefly the theory of compound words.

A compound word is formed by the union of two or more words in a special sense, other than that conveyed by simple grammatical relationship. As in mathematics a quantity enclosed in marks of parenthesis is regarded in its entirety, so a compound word is considered as a whole, rather than as a succession of separate parts. We may of course recognize the parts—as we do in the case of many derivative words,—but the test of a compound is whether the expression as a whole constitutes a single word. Within the compound, the first part usually limits, or qualifies, the second part, and receives the stronger accent. Thus, in "gas producer" and "producer gas," the descriptive part of the compound word comes first and is accented in order to distinguish the kind of producer, or gas. The importance of accent in compound words, as will be more fully explained later, is twofold; in that it not only aids in identifying the expresion as a compound, but also indicates the extent to which the parts are unified.

LOOSE, OR SEPARABLE COMPOUND NOUNS.

Compound words vary widely in the closeness of the relationship between their parts. In the case of compound nouns, for example, we have at one extreme the loosely connected pair of words only one step removed from being a simple word and its modifier. Such words as "motor truck," "drill press," and "machine tool" clearly unite to express a single idea, but they are not felt to be inseparable. Each retains its identity and a certain degree of its original accent. In such cases, the preference of most technical writers is for the omission of the hyphen (Rule No. 1.) Several reasons may be assigned for this preference. The comparative independence of the words is recognized, the meaning is made sufficiently clear by juxtaposition, the text is cleaner, and the problem of writing is simplified by putting the compound in the form of two words. Or perhaps we may say that the hyphen is taken for granted; an invisible hyphen, as it were, connects the parts of the compound. Some engineers with whom I have discussed this question insist that these compounds, being technical, and being written almost wholly for technical men, need not be labeled in order to be understood. One man gave this as his reason for wishing to abolish the hyphen altogether. Whether we are willing to go so far or not, we must admit the validity of the argument that technical men have a right to be consulted as to the form of their own vocabulary. At any rate, compound nouns are not likely to be misunderstood by the technical men who use them. The following list contains only a few examples of the large class of compound nouns which in most technical journals are written as two words.

air chamber
air compressor
air pump
arc lamp
balance wheel
ball bearing
blast furnace
boiler room
cast iron
coal dust
coal tar
cost reduction
double track
drafting board
drafting room
drill press
dust guard
end thrust
engine room
escapement wheel
feed water
freezing point
friction clutch
gas engine
gas producer
gate valve
generator room
lamp cord
locomotive engineer
machine shop
machine tool
motor car
mud drum
oil cup
oil groove
oil pan
oil well
ore bed
peak load
pig iron
pipe tongs
pipe wrench
power plant
pressure gage
pump room
pump shaft
safety valve
sheet iron
steam chest
store room
surface elevation

It would be easy enough for the captious critic to place a strained interpretation on many of these pairs of words. Every one is familiar with the type of person who with an air of great subtlety would point out that "rolling mill" without the hyphen might mean a mill which is constantly describing a rotary motion. This kind of critic is only a harmless Dundreary, who lacking the restraining influence of a sense of proportion, delights in discovering all manner of absurd ambiguities. We know, for example, how Dundreary at his worst would soliloquize over an everyday expresion such as "vacuum cleaner." "Why should anybody *want* to clean a *vacuum?*" And then, in a burst of triumphant reasoning, "What could he possibly *find* to clean, in a vacuum? What a perfectly superfluous invention!" It is perhaps not putting it too strongly to say that many objections to the separation of compound technical terms would belong in this class. They would be exceedingly farfetched, and would differ in degree rather than in kind from the exaggerated perversions of a Dundreary.

CLOSE, OR INSEPARABLE COMPOUND NOUNS.

At the opposite extreme from the separable compounds is a class of compound nouns which, because of close connection and long association, are written solid. In these words, the literal meaning of the separate parts has become obscured or forgotten, and the result is a single word that has become completely unified. "Foreman," for example, is felt to be as closely unified as the simple word "boss," or as the derivative, "superintendent." The tendency toward close unification is strong in compound words which are much used, particularly if they are spoken, rather than written. To the eye, a term like "forecastle," though closely unified, shows its original makeup, but the spoken word has become something like "focsl," showing the sailor's recognition of its unity and his disregard of its elements. Other examples of nautical terms which will readily suggest themselves are "bosn" for "boatswain," and the remarkable condensation "fotogansl," scarcely recognizable in its spoken form as "foretop-gallantsail." What takes place in these oft-used compounds is true to a lesser degree in the familiar compound words of other associations. Usually, the strong accent given the first part of the word—an involuntary testimony to the extent of its unity—aids one in deciding whether a compound word has gained its right to be written solid. Though the practice varies somewhat, the following words are representative of a fairly large class of compound nouns which are preferably written solid.

airship
backfire
battleship
bedplate
bedrock
blowoff
blueprint
brakeshoe
brasswork
breakdown
bucketful
bulkhead
busbar
camshaft
candlepower
capscrew
countershaft
crankpin
crankshaft
cribwork
crosshead
crowbar
cutoff
drawbar
engineman
falsework
firebox
flashlight
flywheel
foreman
framework
gangway
handbook
horsepower
hotwell
input
intake
jackshaft
keyseat
lookout
manhole
network
offset
orebody
overflow
output
passageway
penstock
railroad
rainfall
roadway
roundhouse
runway
sandpaper
spillway
standpipe
stockholder
switchboard
tailrace
tailstock
tidewater
turntable
underframe
voltmeter
washout
watershed
waterwheel
wattmeter
wheelbase
woodwork
workmen
wristplate

In some discussions of compound words an effort is made to distinguish an intermediate degree of intimacy between the separable and the inseparable compounds, and the hyphen is used to make the middle shade of relationship. This distinction offers many excellent opportunities for argument, but there is little evidence to show that technical writers in general pay any serious heed to it. On the whole, they are probably justified in disregarding a difference so difficult to determine and of so little practical value. By distinguishing broadly between only two classes, the separable and the inseparable compounds, they at least reduce the area of debatable ground.

COMPOUND ADJECTIVES.

The use of the hyphen in compound adjectives is more common than its omission in compound nouns. There is a grammatical principle, which, whether stated or not, doubtless accounts for the joining of adjective compounds. In expressions like "cast-iron frame," or "crude-oil engine," for example, if some arbitrary sign were not used to show that the two words as a unit modify the noun, the natural inference would be that they were separate adjective modifiers. Thus, "a cast iron frame" might indicate that the iron was cast in one piece, and "a crude oil engine" might mean an engine, crudely designed, using oil as fuel. These distinctions, it will be observed, mean more than the Dundreary quibbles mentioned in the discussion of separable compound nouns. As a matter of fact, the compound adjective consists of a modified modifier. First, the base of the compound is limited by the descriptive part; then, in its modified form, it in turn describes a noun. In the expression, "low-water mark," for example, "water" is modified within the compound, and the new word thus formed modifies "mark." Perhaps in the brief discussion of adjective compounds on page 5, too strong a case was made for rule No. 3. Although in many adjective compounds, such as those cited under rule No. 3, the meaning could hardly be mistaken if the expression were written as two words, nevertheless, there is much to be said for the practice of using the hyphen regularly between the parts of the compound adjective. (Rule No. 2.) The hyphen emphasizes the intended construction, and errs, if at all, on the side of clearness. In addition to this advantage, there is some satisfaction in being able to use the hyphen consistently.

The examples given below are chosen to illustrate the principal ways in which adjective compounds are formed.

Noun + Noun Compounds.

tool-room (practice)
machine-tool (operation)
motor-generator (set)
railway-accident (problem)

Numeral + Noun Compounds.

two-cycle
four-inch (4-inch)
six-cylinder
40-horsepower
three-ply
2200-volt
16-candlepower
third-class

Descriptive Adjective + Noun.

high-speed (engine)
open-hearth (process)
heavy-duty (engine)
high-potential (insulator)
cast-iron (frame)
high-pressure (system)

Compound Participial Adjectives.

wedge-shaped
nickel-plated
motor-driven
shunt-wound
direct-connected
home-made
cold-rolled
water-jacketed
high-priced
wood-working (machinery)
wire-drawing (machine)
cost-keeping (methods)

Phrase Compounds.

drop-of-potential (method)
make-and-break (ignition)
two-by-six (rafters)

Expressions like the above, whether nouns or adjectives, are regularly written with the hyphen.

To revert to the three rules, I am not quite prepared to advocate their unqualified adoption, or to suggest definite limits within which they should be applied. They have been brought together primarily as a statement of what a more or less informal investigation shows to be the chief tendencies in this regard among technical writers. Personally, I confess to a rather deep-seated prejudice in favor of the hyphen in most compound words which cannot be written solid. I must admit, however, that there is much common sense in the practice of technical men, and that so far as I have observed, they have not seriously offended against the theory of compound words. Without doing violence to the meaning of compounds, they have been working toward a simpler and more uniform method of writing. It is hardly likely that such rules could ever be generally adopted outside of technical contexts, but where there is much repetition of certain compounds, and a limited reading public, to whom the expressions are familiar as technical terms, the opportunity for agreement upon a conventional practice is excellent. Surely such a result would justify concessions by individuals in many matters of personal preference. If the Committee on Technical Nomenclature and others working with them can bring about the substitution of uniformity and greater simplicity for our rather complex and inconsistent ways of writing technical terms, they will have earned the gratitude of all who have to do with engineering English.

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*For example, the compound nouns, "foot-pound," "kilowatt-hour," and similar expressions.

ACKNOWLEDGMENT.

Reprint of paper by C. W. Park, Assistant Professor of English, University of Cincinnati, in the November, 1915, Bulletin of the Society for the Promotion of Engineering Education.

Method of Laying at True Grade an 8-in. Submerged Iron Pipe Line Across a Narrow Stream.

The present article describes the methods employed in laying an 8-in. cast iron pipe across a narrow stream. The pipe crossing was intended to form a part of a sewer line and was laid at a true established grade line. The cutting off of the supporting piling under water is especially interesting.

The stream was approximately 75 ft. in width and about 5 ft. in depth at the time the work was done. As the river was used for boating no obstruction which would interfere with such use was permitted. The bed of the stream was gravel overlaying a deposit of mud. The crossing was located close to and parallel with an existing highway bridge, from which all of the work was carried on.

A platform steam derrick mounted upon rollers was erected on the bridge so that it could be moved back and forth as the work progressed, the boom being long enough to reach out over the pipe location. A small orange peel bucket was used to remove the gravel slopes at either bank as well as to dredge the shallow trench necessary for the pipe. A pan of wooden leads containing a pile-driving hammer were suspended from the boom end, which was securely guyed in position, while spruce piles were driven in bents of two, the same being spaced 3 ft. on centers. There were 22 piles or 11 bents required in all.

It was necessary to cut and cap the piles at an exact grade, and as the cutting point was more than 5 ft. under water, the following method was devised to accomplish the purpose:

A light riveted steel cylinder 6 ft. in diameter and 10 ft. in length was lowered over a bent of two piles until it rested vertically upon the bottom. To seal the bottom edge, some sand and gravel was deposited around the outside. A pulsometer pump was then swung out by the derrick, the suction lowered into the cylinder, and by means of a steam connection with the hoisting engine the water was removed from the interior of the cylinder so that men could enter, cut the piles with an ordinary cross-cut saw, and cap them at the required grade with 6-in. by 6-in. timbers. When this operation was completed, the cylinder was withdrawn and placed over the next bent of uncut piles.

When all of the pile bents had been thus capped, the pipe was assembled on the bridge, the joints leaded and calked, and by means of the derrick and a guyed gin pole, the entire length of pipe was suspended over the desired location and lowered through the water till it rested on the pile caps previously placed. A diver was employed to wedge the pipe securely in place, this being the only part of the work on which a diver was used. The pipe was then backfilled with some of the dredged material.

The entire cost of this work exclusive of the cast-iron pipe and lead for joints was $561.

ACKNOWLEDGMENT.

From an article contributed to the December, 1915, number of the Journal of the Boston Society of Civil Engineers by Charles R. Gow, President Charles R. Gow Co., General Contractors, Boston, Mass.

Commission to Investigate Canal Slides

A commission of eminent engineers, geologists and scientists has been named by President Wilson to go to Panama and investigate the cause of the slides in Gaillard cut which have again closed the Panama canal to the commerce of the world. The commission is to study the entire subject of the slides and will make a report thereon to the President. The commission consists of the following experts: Charles R. Van Hise, of Madison, Wis., chairman, president of the University of Wisconsin; Brigadier General Henry Larcom Abbott, of Cambridge, Mass., who designed the mine defense of the United States; John Casper Branner, president of Leland Stanford, Jr., University, California; Whitman Cross, of Washington, chief of the section of patrology of the United States Geological Survey; John Fillmore Hayford, of Evanston, Ill., director of the College of Engineering of the Northwestern University since 1909 and formerly connected with the United States Coast and Geodetic Survey; Harry Fielding Reid, of Baltimore, special expert in charge of the earthquake records of the United States Geological Survey since 1902 and professor of dynamical geology at Johns Hopkins University; Dr. Charles D. Walcott, of Washington, president of the Smithsonian Institution; Rollin Clinton Carpenter, of Ithaca, professor of engineering at Cornell since 1895; Arthur Powell Davis, of the United States reclamation service, and John Ripley Freeman, of Providence, R. I., who was consulting engineer for the Isthmian Canal dams and locks from 1907 to 1909 and is consulting engineer to the Canadian Government on water-power conservation. Before designating the members of the special slides investigation commission the President called upon the National Academy of Sciences to nominate the members of the body.

Railway Construction in Greece.—The earliest railway construction in Greece took place in 1869, and after nearly a half century there are in operation today only about 1,367 miles of single-track line, ranging from 0.60 to 1.44 meters in width. Of this mileage about 70 per cent lies in old Greece, and the remainder was acquired as a result of the war with Turkey. The need of additional railway lines is realized by the Government, and there are under consideration today plans for the construction of main and branch lines totaling 603 miles. The Junction Line, 56 miles long, is slowly approaching completion. Stations, warehouses, and water tanks for the new line have been completed; station houses in marshy districts are screened, and it is hoped to drain the smaller marshes. Rails and ties for this line, as well as 20 locomotives for the Saloniki-Athens service, were purchased in the United States. Many improvements in the roadbed of the entire line, beginning at Piraeus, must be made, and these improvements have been placed at $1,500,000. Apart from this expenditure, the entire cost of building and equipping the new 59-mile link is estimated at $2,500,000, or about $42,000 per mile. With regard to the new lines to be built, the far greater portion will be in the new provinces, the network of railways in old Greece being practically completed. During the Turkish occupation, no railways were constructed in either Crete or Epirus.

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Research Fellowships at University of Illinois.—Five research fellowships in the Engineering Experiment Station at the University of Illinois are to be filled. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. Appointments to these fellowships are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the Master's degree will be granted. Not more than half of the time of the Research Fellows is repuired in connection with the work of the department to which they are assigned, the remainder of the time being available for graduate study. Nominations to fellowships, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than the first day of February. These nominations are made within the month of February by the station staff, subject to the approval of the faculty of the graduate school and the president of the university. Appointments are made in March, and they take effect the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times. Nominations to these fellowships are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself.

The Lighter Side of Engineering and Contracting

Bottom at Last.

THEY were sinking a shaft for a water works tunnel and had got down about 100 ft. One of the workmen fell in but did not go the whole distance immediately. He lodged about a third of the way down and his fellow laborers struggled to save him. Just as they thought they had succeeded Pat crashed down another 25 ft., when another obstruction caught him and the rescue campaign was begun anew and with greater difficulty. When they were a second time on the point of success, to the dismay of the rescuers, Pat went headlong into the lower depth. All was silent, no sound coming from the unfortunate Irishman. The foreman leaned over the edge of the shaft and shouted: "Pat, I say, Pat." From the depth came the answer: "Hurroo."

"Are you much hurt, Pat?"

"I am not."

"Where are you, Pat?"

"What's that ye're sayin'?"

"Where are ye?"

"Where am I? Where am I? Glory be to heaven, I am on the bottom at lasht."

The Menace.

JOHNNY EMMONS, the eminent street paver, is a fervent believer in the doctrines of the Republican party. He never hesitates to express an opinion that a Democrat is a person with a cloven hoof, horns and a spiked tail. Recently one of Johnny's favorite foremen applied for his naturalization papers. The Italian swore allegiance to the United States Government and answered several questions quite satisfactorily.

At last the Judge asked: "Do you belong to any society or organization inimical to the Government of the United States?"

This was beyond the understanding of the would be citizen and he remained silent. The Judge explained the meaning of his query and again asked the question. A gleam of intelligence overspread the face of the Italian and he replied:

"Yes, Judge, I'm a Democrat."

Scientific Management.

AN advocate of scientific management told the following tale the other day:

"Two men stood watching a steam shovel at work. With a clatter and a roar the shovel bit into the steep bank, closed on a cartload of earth and dumped it on a waiting car.

"It makes me wild," said the first onlooker, "to see that monster taking the bread out of good men's mouths. Look at it. Why, it's filling up those cars faster than a hundred men with picks and shovels could do it."

But the other onlooker shook his head and answered: "See here, mister, if it would be better to employ a hundred men with picks and shovels on this job, wouldn't it be better still, by your way of thinking, to employ a thousand men with forks and tablespoons?"

Was Willing to Look It Over.

IN the smoking compartment of the single coach of an accommodation freight traversing an out of the way branch line of one of the big western railroads sat, or rather sprawled, a mule skinner bound for a new job. In his system still lingered the effects of his most recent ill advised devotions to squirrel whiskey, said devotions being the cause of his pre-emptory banishment from his late lamented job as a mule chauffeur on reservoir construction in an eastern city. He was sleepy and his soul was filled with anguish at the congenial surroundings he had left behind and the barren prospect which the labor agency had thrust upon him. With his feet in the seat ahead and his hat pulled down over his face he dozed fitfully. At intervals his slumbers were rudely disturbed by the voice of the conductor bawling out the names of the dinky stations along the way. At such times the skinner would awaken with a start, straighten up and look out at the village at which they halted. With true urban contempt for everything rural he would then, after a brief glance, resume his angle of repose, pull his hat down and rush back into the arms of the more or less well-known Morpheus. As the journey progressed he became more and more peevish from the result of the conductor's vocal efforts. Finally, after a peaceful half-hour of repose, the door was flung rudely open and the pestiferous conductor sang out the name of a station in an unusually grating key. The skinner straightened up, looked out upon a landscape marred only by a water tank, a depot and a few scattered houses, turned a withering glance on the conductor and said: "Bring it in!"

Apropos of I. C. C. Rulings.

THE Interstate Commerce Commission had told the New York, New Haven & Hartford R. R. what it could do and what is couldn't do. Apropos of the rulings Howard Elliott, president of the road, told the following story:

"The average board of directors of the average railroad these times is in the same distressful fix as was the old negro who fell ill," said Mr. Elliott. The attending physician warned the patient he must go to bed early every night and then prescribed a certain diet.

"When the doctor had gone the old man raised his voice in protest:

"'How does dat white man 'spect me to eat chicken breas' once a day if I ain't got my evenin's free to go out and git de chicken?'"

He Was Not 'Appy.

SOME time before the present war, a Roman celebration was being held in England and the soldiers were dressed up to represent Roman soldiers. It was a chilly day and the men were far from being comfortable. An old lady was walking along looking at the soldiers and finally approached one of them and asked, "Be you Appius Claudius?" The soldier looked at her a moment and then replied, evidently with deep feeling: "No, I'm un'appy as 'ell."—W. A. H., N. Y.

You Can't Stop 'Em from Swearing.

AN instrument man in a survey party in Idaho was a very refined young gentleman who was never known to swear. It was his misfortune to be allotted a light transit that had seen too much service. One day he was set up facing the usual Idaho breeze and the transit was trembling like it had the palsy, when the chief came up behind him and heard him say, "You are the by-Godest transit that ever was made. You are no more fit to be called a transit in spite of hell."—H. H., Macomb, Ill.

Poor Judgment.

PADDY HOGAN had been on a layoff for several days in the interest of prohibition, trying to down booze. The other morning he struck the boss like this: "Ah! Marnin', Captain! Fine marnin'! By the way, you couldn't let me have a dime to get a drink wid, could ye?" The Captain, who is strictly temperate, barring grape juice, coffee and Skinner Mulvey's hillside navy looked Paddy over critically and responded, "Paddy, it's my judgment that you have had a plenty." It was Paddy's turn to look the Captain over. With a shrug, "As a pilot of a sand barge pusher yer jedg'ment is good, but when ye get out of yer line, yer jedg'ment is poor, dom poor."—W. B. H., St. Joseph, Mo.

His Maiden Name.

A NEGRO lad applied for a job as water boy for a grading gang in the South. "What is you name?" asked the foreman. "Well, boss," said the applicant, "everywhere I goes they gives me a new name but my maiden name it wuz George Booker T. Washington."

Skinner Mulvey says: I wish you all a happy and prosperous New Year. May everybody that is indebted to you pay up and everybody you owe declare a moratorium.

CURRENT NEWS

The Doings of the Week.

Trade, finance and industry maintained their forward momentum during the past week. Reports of commercial agencies state that at no time heretofore has the general conditions for business as a whole reflected more distinct improvement or assurance of solid prosperity. Bank payments showed heavy gains over the corresponding week of last year; clearings were nearly 50 per cent over those for 1914 and well above the amount for the preceding year. Transportation returns made substantial gains. Advices from Washington indicate that at the end of 1915 this country will have a trade balance of $2,000,000,000. This amount has piled up in the 17 months since the start of the European war. During this time the United States has exported products valued at approximately $4,500,000,000, while the imports have approximated $2,500,000,000. In the construction field operations are now at their lowest ebb. Very little new work of any importance came up for advertising the past week. There are good indications, however, that a considerable number of municipal improvements will reach the call for bids stage early next year. Building construction is holding up remarkably well, considering the lateness of the season, and a fair amount of public structures—court houses and school building—are ready for proposals. Several cities in the middle west are planning to make an early start on their improvements and consequently will begin calling for bids next month. In the iron and steel trade demands were up to the average of previous weeks. Domestic consumers are benefiting from the railroad embargo on export shipments of iron and steel products. The 1.80 ct. Pittsburgh price on contract bars, shapes and plates is the highest since the formation of the U. S. Steel Corporation. Inquiries in the Chicago district for reinforcing bars were heavy. One of these was for 8,500 tons for a Pacific coast warehouse. Orders for some 15,000 tons of fabricated steel were placed in this district. Recent rail orders include 25,000 tons for the Great Northern, 6,000 tons for the Clover Leaf, 10,000 tons for the Chicago & Eastern Illinois and 18,000 tons for the Southern. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Dec. 22 were as follows: '

Finished Iron and Steel.	Dec. 22.	Dec. 15.
Per lb to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill ...	1.25	1.25
Iron bars, Philadelphia.....	2.059	1.959
Iron bars, Pittsburgh........	1.80	1.80
Iron bars, Chicago...........	1.75	1.75
Steel bars, Pittsburgh.......	2.00	1.80
Steel bars, New York........	2.169	1.969
Tank plates, Pittsburgh......	2.25	1.90
Tank plates, New York......	2.419	2.169
Beams, etc., Pittsburgh......	**1.90**	**1.70**
Beams, etc., New York......	2.069	1.869
Skelp, grooved steel, P'gh...	**1.70**	**1.70**
Skelp, sheared steel, P'gh...	1.80	1.80
Steel hoops, Pittsburgh......	**2.00**	**1.90**
Sheets, Nails and Wire.		
Per lb to large buyers		
Sheets, black, No. 28, P'gh.	2.50	2.50
Galv. sheets, No. 28, P'gh..	4.75	4.75
Wire nails, Pittsburgh....	2.10	2.00
Cut nails, Pittsburgh........	**1.90**	**1.90**
Fence wire, base, P'gh..	1.95	1.85
Barb wire, galv., P'gh.....	2.95	2.85

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs. ¼ in. thick and over, zees 3 in. and over, 1.80 cts. to 2 cts.

Railways.—No developments looking to the immediate undertaking of any big construction jobs by the railways have occurred during the past week. A few small contracts were let and new work made its appearance. The railroads at present are doing very little new financing, but with the improved conditions of the bond market and the recovery in earnings, it is probable that the carriers will soon take up the matter of securing capital for a part at least of their construction needs. During the last three months high grade railroad bonds have advanced 5 or 6 points. The Public Service Commission of New York City began calling for bids for the construction of Sec. 2 of Route 12—the Eastern Parkway subway in Brooklyn. This commission also authorized the New York Municipal Ry. Corp. to award the contract for the reconstruction of the Brighton Beach Line to the Inter-Continental Construction Co. at about $1,000,000. The Contra Costa Construction Co. at $120,000 was low bidder for the extension of the Church St. street car line for the city of San Francisco. H. S. Kerbaugh & Co., New York City, were awarded contract by the Baltimore & Ohio R. R. for a 4-mile spur to Security, Md. Winston & Co., Richmond, Va., are understood to have been awarded a conditional contract for the construction of the Richmond, Rappahannock & Northern R. R., a new 17 mile line, to extend from West Point, Va., to Urbana, Va.

Roads and Streets.—No particularly large jobs in either the highway or street paving fields appear to have reached the call for bids stage during the past week. Various counties in New Jersey have begun taking proposals on a considerable amount of road work. The County Freeholders at Mays Landing, N. J., open bids Jan. 1 on a 4 mile boulevard, 60 ft. wide. Middlesex County opened bids on a 7.7 mile job, Abraham Jelin, New Brunswick, N. J., being low bidder at $168,885. Middlesex County also opened proposals Dec. 27 on work to cost about $140,000. The State Highway Department of Washington opened bids on four grading contracts and one graveling contract and the California Highway Department let a $72,000 job. The Supreme Court of Illinois has approved the $1,000,000 bond issue of Vermilion County and contracts will be let about March 1 for 172 miles of brick or concrete roads.

Bridges.—A considerable amount of small bridge contracts came up for advertising during the past week. Counties in western states are now beginning to call for bids for their bridge and culvert work for the ensuing year. Chouteau County, Montana, is asking proposals for a 180 ft. span steel bridge; Morgan County, West Virginia, opens bids Jan. 14 on two reinforced concrete arch bridges of 60 ft. and 80 ft. spans respectively. The Walsh Construction Co. was awarded contract for 96 ft. long reinforced concrete bridge at Berne, Pa., for the Philadelphia & Reading Ry. The Ambler-Davis Construction Co., Philadelphia, Pa., was awarded the contract for the construction of the Mont Clare bridge for Montgomery and Chester Counties, Pennsylvania, at $103,252.

Drainage and Irrigation.—The U. S. Reclamation Service is calling for bids for 9½ miles of laterals requiring 56,200 cu. yds. of excavation. The Ward County Irrigation District No. 1 of Barstow, Tex., opens bids Jan. 25 for constructing dams, reservoirs, head gates and other improvements.

Sewerage.—Philadelphia, Pa., opens bids Dec. 29 on a sewage disposal plant for Bureau of Charities, estimated to cost $115,000. Youngstown, O., is asking bids on two sewer jobs, one calling for 16,500 ft. of 18 in. to 5 ft. sewer. Houston, Tex., awarded a $70,500 storm sewer contract. Kenova, W. Va., let contracts for a sewer system calling for an expenditure of nearly $50,000.

Water Works.—Norfolk, Va., is calling for bids for rebuilding three dams and spillways. Oshkosh, Wis., is asking proposals on a large water filtration plant. East Youngstown, O., awarded contracts for water works to cost $165,000; Ventnor City, N. J., let contracts for artesian water works improvements to cost $30,674; Milwaukie, Ore., awarded a $22,500 distributing system job; Galveston, Tex., let a contract for submerged water mains across Galveston Bay; Salt Lake City, Utah, awarded a $88,670 contract for a reinforced concrete dam.

Rivers and Harbors.—Portsmouth, O., rejected the bids received Dec. 8 for the second section of the flood protection wall, the work including 7,670 cu. yds. of reinforced concrete. Port Arthur, Tex., will vote on a $175,000 bond issue for levees and pumping machinery.

Buildings.—The contracts let recently include a $800,000 office building at Omaha, Neb., a $861,665 county jail for Hudson County, New Jersey, a $400,000 loft building at Philadelphia, Pa., and $390,000 group of structures for the new east side high school at Cincinnati, O.

1915.

Two more days and 1915 passes out. Engineers and contractors will not regret its going. From a constructional standpoint the year probably has been the worst in the last decade. Many contractors state that never in their experiences have they seen so little activity in their line. Construction operations have been far below normal. The railroads, which, in the past, have furnished many big jobs, undertook little new work this year. Municipalities, also, held back on their improvements. Public utility companies made no effort to carry out their betterment and extension programs. Scarcity of bidding opportunities, bad weather and low prices have been the outstanding features of the past 12 months. Nineteen fifteen has been a most disappointing year for the engineer and the contractor. Few members of these professions have suffered during this period from enlargement of the pocket book. The new year opens under far more favorable conditions for construction undertakings than did the present one. The railways at last are enjoying real prosperity; the grain crops were the greatest in the history of the country; there is a trade balance of nearly $2,000,000,000; the bond and security markets are in excellent shape for new financing. The new year begins auspiciously.

The Embargo and Subway Work.

Information that the railroads entering New York City have levied an embargo upon all shipments from outside points except foodstuffs and clothing has caused a great deal of anxiety among the subway contractors and engineers of the Public Service Commission for the First District. The embargo, of course, is understood to be only temporary and for the purpose of enabling the railroads to clean up the existing freight congestion at their terminals, but if it should last any appreciable time it might lead to a suspension of construction work on many contracts of the Dual System of rapid transit at New York. More than 60 construction contracts in the Boroughs of Manhattan, The Bronx, Brooklyn and Queens are now under way, and the contractors are using daily large amounts of steel and cement. The item of cement alone is a large one. Vast amounts of reinforced concrete are used in the subway construction, and the present contracts are using up cement at the rate of 100,000 bbls. per month. It is estimated that fully 600 railroad cars a month are necessary to bring this amount of cement into the city.

GRADE CROSSING ELIMINATION AT DALLAS, TEX.

Belt Line to Cost $900,000 May Be Constructed.

Other Plan Calls for Subways to Cost About $5,000,000.

Dallas, Tex., a city of some 110,000 population, has about 160 grade crossings within its limits. Eight railroads enter the city, and in addition to the main lines there are numerous spurs and connections. As a result the development of the city is somewhat restricted. Steps to improve conditions have been taken recently by the officials of the municipality. John F. Wallace, consulting engineer, of Chicago and New York City, was retained to make a study of the situation and to suggest some solution of the problem.

Mr. Wallace submitted his report to the mayor and commissioners the latter part of November. In it he outlines a plan for grade crossing elimination calling for an estimated expenditure of about $5,000,000. As a simpler solution of the problem, however, he suggests the construction of a belt line to intercept all the railroads outside of the city limits. By utilizing the present lines of the Missouri, Kansas & Texas Ry. and by closing the gap it is estimated that a belt line could be obtained for about $900,000. Of this total $500,000 is for new construction and $400,000 for grade separations along the Turtle Creek line of the M., K. & T. Ry. The location of the suggested belt is shown in Fig. 1. The illustration also shows the improvements proposed under the plan for the elimination of grade crossings.

The belt line would be used by all the railroads for their through freight and passenger business, which thus would be diverted around the city. The line also would give the roads access to their present local freight facilities. Two alternative locations are proposed for the new construction. One of these proposes the utilization of a short section of the Texas & New Orleans R. R. Two clearing yards are suggested, and layouts also are proposed for groups of local freight houses. Further study may show that it will be desirable to let each road provide its own yard facilities at various points on the belt line.

The plan for grade separation provides for track elevation with a limited amount of street depression. The total estimated cost of the work is $4,785,000, of which $4,675,000 is the cost of track elevation. The estimate provides for about 100 subways and is based on the use of embankments with retaining walls where necessary, and subways of the unit reinforced concrete type. A continuous elevated structure is provided in certain locations.

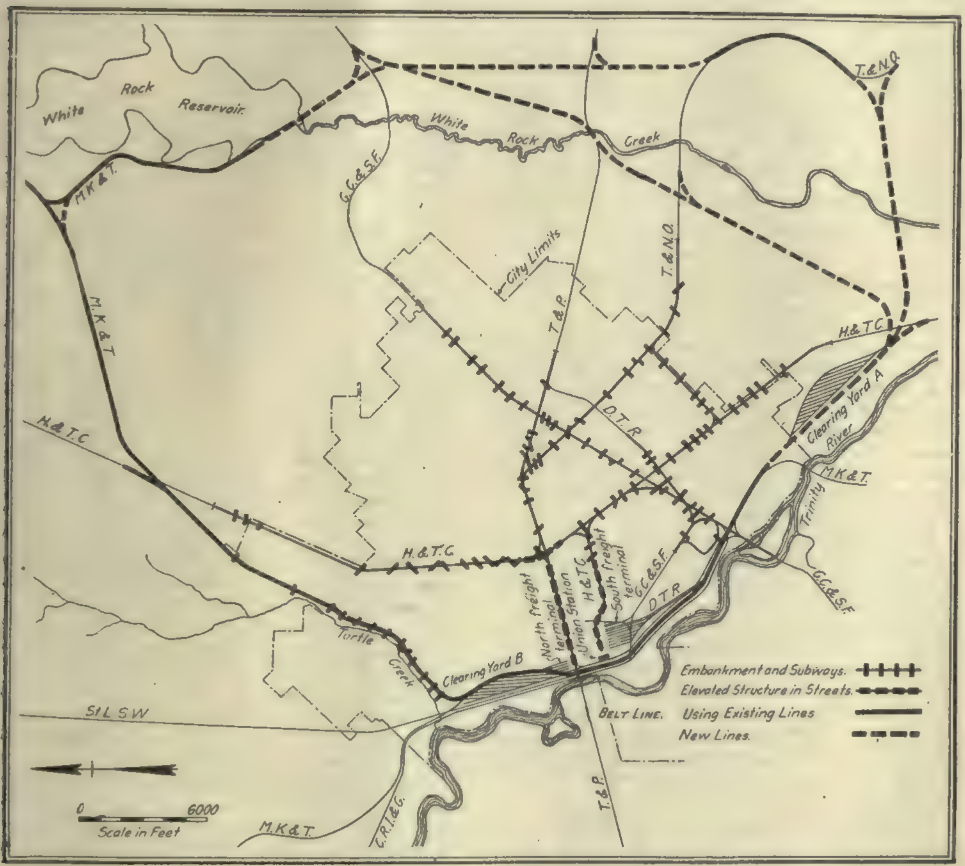

Fig. 1. Location of Proposed Belt Line Railroad for Dallas, Tex.

Progress on Buenos Aires-Lima Railroad.

Construction was started recently in Bolivia on a link of the most ambitious interoceanic railway project in South America. This scheme has for its ultimate object the connection of Buenos Aires, Argentina, with Lima, Peru. The section now being built in Bolivia covers the 100 kilometers of line between La Quiaca and Tupiza. The total length of the so-called Pan American R. R. will be 3,164 kilometers. Of this about 75 per cent already is completed. The following table shows the present railways and the gaps to be filled before a railway connection between Buenos Aires and Lima is obtained:

	Constructed, kilometers.	Under construction, kilometers.	Pending, kilometers.
Argentina:			
Buenos Aires-Tucuman	1,165	.....	.....
Tucuman-La Quiaca	638	.....	.....
Bolivia:			
La Quiaca-Tupiza	.....	100	.....
Tupiza-Atocha	.....	.....	94
Atocha-Uyuni	100	.....	.....
Uyuni-Oruro	312	.....	.....
Oruro-Viacha	302	.....	.....
Viacha-Guaqui	64	.....	.....
Guaqui-Desaguardero	.....	.....	20
Peru:			
Desaguardero-Puno	.....	.....	140
Puno-Cuzco	384	.....	.....
Cuzco-Ayacucho	.....	.....	551
Ayacucho-Huancayo	.....	.....	260
Huancayo-Lima	347	.....	.....
Totals	3,164	100	1,065

A $1,000,000 Water Supply for Phoenix, Ariz.

A water supply project, estimated to cost $1,000,000, is under consideration by the commissioners of the city of Phoenix, Ariz. The present domestic supply is obtained from wells driven to a depth of from 400 ft. to 800 ft. An investigation for a new source was conducted recently by J. B. Girard, city engineer, and a report submitted. This report was adopted by the commissioners and permission was granted to employ a consulting engineer to act in an advisory capacity on the plans recommended. The entire matter will be presented to the citizens at an early election for its adoption or rejection by a referendum vote.

The recommended plan provides for a supply from the Verde River. This source was selected for the following reasons: Live watershed, unlimited quantity, purity, gravity line could be installed and filtered water obtained without pumping, city owns prior right. The intake will be at a point about 35 miles from the city limits. At this location there are two water bearing strata. One of these is 10½ ft. below the surface of the ground, 5 ft. 2 in. thick, and composed of coarse sand and gravel. The second was encountered at a depth of 21 ft. 2 in. in coarse sand and gravel.

The proposed plan is to crosscut or dig a trench across the underflow of this lower stratum and place a perforated conduit of not less than 5 ft. diameter. This pipe, without perforations, will then be continued down the river for a distance of a mile, where a bypass will be installed in order that the water can be diverted back to the surface flow of the river. At this point the 42-in. pipe line will begin. The bypass will be used principally for sluicing out any sand or silt that might collect in the pipe at the intake. The actual surveyed distance from the intake to the city limits is 184,120 lin. ft. The surveys indicated that the pipe line could be installed with a minimum of excavation and that very little rock work would be necessary. It is proposed to install a 42-in. pipe line which will deliver at least 15,000,000 gals. per day. A reinforced concrete reservoir of 25,000,000 gals. capacity will be installed on the line at such an elevation above the city as will insure a constant pressure for domestic purposes. At the present rate of consumption this would give the city a week's supply.

The estimated cost of the system is as follows:

Digging trench, 5 ft. by 5 ft., 35 miles, and back filling	$ 250,000
42-in. pipe specials, etc.	475,000
24,000,000-gal. reinforced concrete reservoir	150,000
Intake and headworks	100,000
Engineering and supervision	25,000
Total	$1,000,000

A $120,000 Drainage Letting in Florida.

A $120,000 drainage job in Pinellas County, Florida, will come up for letting probably in January. The work is to be done for the Lake Largo-Cross Bayou Drainage District of Largo, Fla. It includes the excavation of canals requiring the handling of about 374,000 cu. yds. of material.

The canals, yardages and other details are as follows:

	Bottom, ft.	Yardage.
Main 1	2	22,644
Main 2	2	40,802
Main 3	2	100,304
Main 4	2	56,330
Main 5A	20	25,971
Main 5B	2	55,420
Main 6	..	25,719
Main 7	..	46,813

The side slopes will be 1 in 2. The work is suitable for dry land dredges. Part of it can be done with a floating dredge. The Atlantic Coast Line R. R. has a switch ½ mile from the main canal. Furthest point of the work is 4½ miles distant from a railroad. Isham Randolph Co., Chicago, Ill., is chief engineer of the district. F. R. Francke is president of the Board of Supervisors.

IMPROVEMENTS TO WATER SYSTEM OF LYNCHBURG, VA.

Betterment of Pedlar River Supply Proposed.

Meterage—New River Crossing—Filters—Storage Reservoir.

Lynchburg, Va., is considering making extensive improvements to its municipal water supply. A report on the project was submitted to the council's water committee on Dec. 6 last by George W. Fuller, consulting engineer, New York City, in which the following recommendations were made: (1) Buy cultivated areas on Swapping Camp and Brown's Mountain Creek; (2) raise the spillway of Pedlar dam 5 ft. and build an aerator below the dam; (3) duplicate the 30-in. cast-iron crossing at James River; (4) install a Venturi meter to measure all water used by the city; (5) adopt a policy of gradually metering all consumers in the city; (6) build a filter plant at College Hill; (7) build a storage reservoir in Riverside Park, with all needed pipe connections; (8) construct a force main from 7th St. station to College Hill, and also an intercepting sewer to eliminate local pollution from the James River if it should ever be necessary to send this supply to the filter plant.

The present supply is obtained from Pedlar River, and it is assumed that the consumption averages 5,000,000 gals. per 24 hours. There also is an emergency supply from the James River. The pipe line from Pedlar Lake to the College Hill reservoir in Lynchburg is about 22 miles in length and consists of approximately 6,000 ft. of cast-iron pipe, 88,000 ft. of wood stave pipe and 16,000 ft. of riveted steel pipe. The pipe line will carry 8,000,000 gals. daily, which is the rated capacity of the dry weather yield of Pedlar Lake.

The cost of the aerating plant below the Pedlar dam is estimated at $12,000. It is estimated that the spillway of the dam could be raised 5 ft. at a cost of $5,000. The plan suggested provides that part of the increased height be secured by concrete construction and part by the use of flash boards. The cost of duplicating the 30-in. cast-iron stream crossing at James River is estimated at $25,000. It is proposed to place meters at once on at least 25 per cent of the service pipes at a cost of about $15,000, and to expend about $5,000 a year for each of the 10 following years to allow the entire supply to be metered. The total estimated cost of these betterments, together with land purchases and the installation of a Venturi meter, is $70,000.

The storage reservoir proposed for construction at Rivedside Park would have a capacity of 30,000,000 gals. At the site there is an area available of about 43 acres upon which it would be feasible to locate a reservoir. The estimated cost for a basin with an available water depth of 30 ft., and a concrete lining built in two layers, with the upper face of the bottom layer waterproofed, is $4,600 per 1,000,000 gals. capacity. This includes an allowance of 15 per cent for omissions, contingencies and supervision. At the Riverside Park site it also will be necessary to spend about $51,000 for building 3,000 ft. of 12-in. pipe for the Pedlar line and about 24,000 ft. of 24-in. pipe to the foot of 7th St.

The estimated cost of the filter plant is $100,000. This would provide for a plant of a rated capacity of 6,000,000 gals. per 24 hours. The estimate includes a Venturi meter at the filter plant and a steel standpipe. This latter would serve as a coagulating tank, in which sulphate of alumina would be mixed with the water, and the clay and other impurities allowed to subside in part to the bottom before the water would pass through the filter, under pressure, and rise to the top of the present standpipe.

River and Harbor Estimates.

Estimates for river and harbor work for the fiscal year beginning July 1, 1916, submitted to Congress on Dec. 6, call for appropriations aggregating $45,839,510. This amount is $7,538,000 less than the estimates last December. It is probable the sums asked for will be reduced by Congress although indications are that the reductions will not be so great as they were last year, when a $30,000,000 lump sum appropriation was allowed.

Of the total amount asked nearly one-third is for the Mississippi and Ohio Rivers. Of first mentioned $9,982,000 is wanted, and for the Ohio River the appropriation requested is about $5,500,000. The larger estimates are as follows:

Mississippi River: Southwest pass....	$ 850,000
Mississippi River: Head of passes to mouth of Ohio, including expenses of Mississippi River Commission........	6,000,000
Mississippi River: Ohio River to Missouri River........................	1,000,000
Mississippi River: Missouri River to Minneapolis	1,900,000
Missouri River to Fort Benton.........	2,275,000
Ohio River: Lock and dam construction	5,000,000
Ohio River, continuing maintenance and improvement	509,000
Hudson River, continuing maintenance and improvement	1,970,000
Delaware River: Trenton to the sea..	2,465,000
Columbia River: Pittsburgh Landing, Ore., to the sea....................	2,502,000
St. Mary's River, Michigan............	1,300,000
Tennessee River......................	2,601,000
Cumberland River.....................	710,000
Inland waterway, Norfolk to Beaumont, N. C..........................	1,000,000
Harbor of Refuge, Cape Lookout, N. C.	600,000
Chicago, Ill.	714,000
Indiana Harbor, Ind..................	795,000

Proposed Willamette River Bridge at Salem, Ore.

Bids for the construction of a good sized bridge over the Willamette River at Salem, Ore., probably will be asked in the near future. The structure will be a low-level bridge, provision for navigation being made by movable spans. The vertical clearance above low water will be at least 70 ft., and the horizontal clearance measured normal to the channel will be not less than 120 ft.

The bridge will have a clear roadway width of 30 ft. and two sidewalks with a clear width of 6 ft. each. Provision will be made for the construction of a future single-track street car line in the center of the roadway. The roadway deck and sidewalks will consist of reinforced concrete construction with a 2½-in. bituminous wearing surface laid directly on the roadway slabs. The main portion of the bridge will have an approximate length of 780 ft. The approaches, including about 500 ft. of earth embankments, will be about 900 ft. in length.

Plans and estimate of cost of the proposed bridge were received on Dec. 24 by the board of viewers appointed by the commissioners of Marion County, Oregon. Plans were invited for both steel and concrete structures. Max Gehlhar, Salem, Ore., is county clerk.

New York Barge Canal Contracts to Be Advertised Soon.

A considerable amount of construction on the barge canal system of New York state will be let early next year by the state superintendent of public works at Albany, N. Y. The new contracts that will be awarded after Jan. 1 include the following:

Contract 46B—Completing lock and dam at Mays Point; estimated cost, $314,661. Contract 63A—Completing canal channel between west line of Wayne County and King's Bend; estimated cost, $567,741. Contract 47A—Completing canal channel from Galen to New York Central R. R. crossing at Lyons; estimated cost, $1,038,469. Contract 129—Construction of substructures, superstructures and approaches to Freemans Bridge over Mohawk River, near Schenectady; estimated cost, $80,976.

Frank M. Williams, Albany, N. Y., is state engineer and surveyor.

PERSONALS

Mr. K. S. Johnson will be superintendent of the water and light department of Biwobik, Minn., after Jan. 1, 1916.

Mr. George H. Burnette has been appointed assistant engineer of the Monongahela Railroad Co. with offices at Brownsville, Pa.

Mr. Amor E. Kistner was recently appointed chief engineer of Cincinnati Building Commissioner's staff by Safety Director John R. Holmes.

He is the author of a considerable number of scientific papers and of Bulletins Nos. 55, 72, 77 and 83 of the Illinois Engineering Experiment Station.

Mr. Charles G. Stoneburner has been named assistant superintendent of water works at Zanesville, Ohio, and W. C. Zimmer has been appointed secretary.

Mr. Frank L. Raschig, assistant city engineer of Cincinnati, was recently elected president of the Cincinnati Branch of the American Society of Mechanical Engineers.

At the University of Illinois, Mr. Beyer will be especially concerned with investigations which are to be conducted under the general direction of Professor E. C. Schmidt in the Locomotive Laboratory.

Mr. O. S. Beyer, Jr., of Horton, Kansas, has been appointed First Assistant in the Engineering Experiment Station in the Department of Railway Engineering of the University of Illinois, effective December 14, 1915.

Mr. Michael Cahill, who has been in the employ of the Lynn, Mass., water works for 43 years has been pensioned by the Lynn Municipal Council. In all his 43 years of service Mr. Cahill was never absent a single day from his post of duty.

Mr. Beyer was born in Woodridge, New Jersey, in 1886, and graduated from Stevens Institute of Technology in 1907 with the degree of Mechanical Engineer. He later did advanced work in economics and railway freight rates at the University of Pennsylvania and also at the University of New York. Before graduating he served the E. W. Bliss Company for a year as Apprentice and Draftsman, and for a year following graduation he was assistant in the Bureau of Estimates and assistant to the Superintendent of the Tire Rolling Mill of the Midvale Steel Company. He was with the Erie Railroad from 1908-12 as Special Apprentice. Since 1912 he has been with the Rock Island Lines, first as Assistant to the Second Vice-President at Chicago, and later as General Foreman of the Horton Shops at Horton, Kansas.

Mr. Yensen was born in Christiania, Norway, in 1884. He graduated from the University of Illinois in 1907 with the degree of Bachelor of Science in Electrical Engineering, and he received the degree of Master of Science in 1912 and of Electrical Engineer in 1913. The thesis which he submitted in partial fulfillment of the requirements for the Bachelor's degree won for him in 1907 the Edison Medal conferred by the American Institute of Electrical Engineers. After graduating he served for a time in the Testing Department of the General Electric Company of Schenectady, New York, and later as Assistant Engineer of the Shawinigen Water and Power Company of Montreal, Canada. In 1910 he became assistant in the Engineering Experiment Station in the Department of Electrical Engineering of the University of Illinois.

The Board of Chosen Freeholders of Bergen County, New Jersey, announce that they will appoint, on their taking office, Jan. 3, 1916, Henry Welles Durham, Consulting Engineer of New York City, as County Engineer. Mr. Durham will retain his office for consulting practice at No. 366 Fifth Avenue, New York City, and will be available in connection with any work not affecting the interests of Bergen County. Mr. Durham was until recently, Chief Engineer of Highways of the Borough of Manhattan, New York City, having served under Borough President McAneny during the period of reconstruction and modernization of the city pavements, work which aggregated a total of over $7,000,000. During this period he made investigation of European pavements, the result of which has been published in book form by the City of New York. He was formerly in charge of the construction of the Cape Cod Canal, and before that Resident Engineer of Municipal Improvements at Panama, and Assistant Engineer on the New York Subway.

OBITUARIES

Mr. James Mapes Dodge, Chairman of the Board of the Link-Belt Co., died at his home in Philadelphia on Dec. 4. He was born at Waverly, N. J., on June 30, 1852. He was a grandson of Prof. James J. Mapes, a noted chemist and scientist, and a son of Mary Mapes Dodge, a well known author, who, for many years, edited the St. Nicholas Magazine. Mr. Dodge spent three years at Cornell University and a year at Rutgers. At the latter institution he took a special course in chemistry. After spending a short time at the Morgan Iron Works in New York City, he entered the shops of John Roach, the shipbuilder, at Chester, Pa., where his marked mechanical ability and ingenuity brought him rapid advancement. During the three years there he was successively journeyman, foreman, and superintendent of erection. In 1876, he left the shipyard, and after several years of experience in the East, went to Chicago. It was here that he formed the acquaintance of William D. Ewart, the inventor of the Ewart Link-Belting, and soon after he joined Mr. Ewart and his associates in the development of the chain business. At that time, about 35 years ago, the application of chains to power transmission was exceedingly limited, and their use in elevating and conveying machinery was practically unknown. The Ewart chain blazed the way for a new industry, and Mr. Dodge and his associates were quick to seize the opportunity. Mr. Dodge's early work was confined principally to development and manufacture, and here his genius had full play. New chains, new methods of manufacture, and new conveying and elevating appliances were brought out in rapid succession. After this period of development Mr. Dodge went East and entered into partnership with Edward H. Burr under the firm name of Burr & Dodge, who represented in Philadelphia the Ewart Mfg. Co., of Indianapolis—the original manufacturers of Ewart Detachable Link-Belt—for the exploitation of the Ewart Chain and its allied interests. Out of this partnership grew the Link-Belt Engineering Co., organized in 1888, and after the formation of this company, Mr. Dodge carried out his idea of development along strictly engineering lines. A highly specialized engineering staff was developed, a scientific study was made of the characteristics of the materials to be handled, and special appliances were invented to meet varying conditions. Machines grew from capacities of 30 tons per hour to capacities of 1,000 tons per hour, and from simple problems solved by detached machines, the company expanded its field to the planning and arranging of works to secure the most economical and efficient handling of both raw and finished product under guarantees of accomplishment. In all this development Mr. Dodge was the creative and guiding spirit. In 1889, after having become thoroughly acquainted with the needs of the anthracite coal industry, Mr. Dodge developed the boldest and perhaps the most original of his inventions. This was his system of storing anthracite coal in large conical piles, and reloading it by machinery—accomplishing this result with little labor and practically no breakage. For this meritorious invention he was presented with the Elliott Cresson Gold Medal, in 1907, by the Franklin Institute of Philadelphia. When it is considered that "The Dodge System" of coal storage reduced the cost of handling coal, in and out of storage from 30 and often 40 cents per ton per round trip, to less than 5 cents, it is evident that the saving effected on the 5,000,000 tons handled by this system annually, has been a large item. Fertility of invention and mechanical ingenuity are rarely coupled with a high order of executive ability. Yet such was the combination of qualities that brought success to Mr. Dodge, who as an inventor had the distinction of being mentioned in Patent Office reports among the few who had been granted over 100 letters patent, and as an executive had won success as the president and active managing spirit of such successful industrial engineering corporations as the Link-Belt Engineering Co. and the Dodge Coal Storage Co. (later called the J. M. Dodge Co.). He was elected president of these companies in 1892, and chairman of the Board of Directors of the Link-Belt Co. when it was organized in 1906 through the merger of the allied companies—the Link-Belt Engineering Co., Philadelphia, the Link-Belt Machinery Co., Chicago, and the Ewart Mfg. Co., Indianapolis, at which time Mr. Charles Piez became president of the Link-Belt Co. Mr. Dodge was responsible for the design of the links and attachments in all of the various sizes of Link-Belting used today throughout the world, and owing to the excellence of his original designs they have not as yet been improved upon. Among Mr. Dodge's important inventions and improvements were those relating to the construction and manufacture of Silent Chain. His invention of the bushed joint as applied to this type of power transmitting medium again marked his mechanical ingenuity, for he put on the market a long-sought-for product which is receiving constantly increasing recognition for the transmission of power. Though for many years a large employer of men, Mr. Dodge never met with any strikes or other labor difficulties. He was deeply interested in the personal welfare and advancement of his associates, and a conspicuous leader in the general introduction of the best elements in "scientific management," having the double purpose of producing greater efficiency in the mechanical and human equipment, and greater pay with shorter hours and improved conditions for the men. He was for many years closely associated with the late Frederick W. Taylor in the accomplishment of remarkable results for the benefit of both employers and employes, in a wide circle of industries. His influence was always towards the development of self-help, initiative, ambition and responsibility in the men, and of a spirit of fair play and humanitarianism as real business assets in the many employers who recognized Mr. Dodge's leadership in modern progressive methods of shop management. He was a past president of the American Society of Mechanical Engineers.

NEW CATALOGUES

Reinforced Concrete Pipe.—Paper, folder, Keystone Pipe Co., Union, Neb.

Describes and illustrates the "Keystone" locked and sealed reinforced concrete pipe, made in sizes from 18 ins. to 7 ft.

Blowers and Compressors.—Paper, folder. De Laval Steam Turbine Co., Trenton, N. J.

Describes and illustrates some characteristics of the De Laval centrifugal blowers and air compressors. Catalog on request.

Steam Shovels.—Paper, folder, Erie Engine Company, Erie, Pa.

"Bulletin S-14." Describes and illustrates the adaptability of the "Type B" ¾-cu. yd. Erie revolving shovel to various classes of work.

Drag Line Excavators.—Paper, 9x12 ins.; 38 pp. The Monighan Machine Co., 2016-36 Carroll Ave., Chicago.

"Catalog 17." Describes and illustrates, by photographs and line drawings, all details of the Monighan walking drag line excavators. Also describes briefly the skid and roller drag line excavators made by this company, and shows numerous views of the excavators engaged on various kinds of work. The illustrations are exceptionally clear cut and instructive, and the catalogue is an exceedingly attractive one.

Expanded Metal Construction.—Paper, 6x9 ins.; 12 pp. North Western Expanded Metal Co., 37 W. Van Buren St., Chicago.

"November, 1915, Bulletin." Illustrates use of and gives data on expanded metal in residence construction. Bulletin sent regularly on request.

Hydrated Lime.—Paper, 3½x6 ins.; 16 pp. National Lime Manufacturers Association, Oliver Building, Pittsburgh, Pa.

"Pamphlet F." Points out the advantages to be gained by incorporating hydrated lime with cement mortar and concrete by increasing the plasticity and waterproofing qualities of same. Also describes the use of hydrated lime in important structures and gives the opinions of various authorities concerning its use in concrete work.

Air Compressors.—Paper, 6x9 ins.; 16 pp. Chris D. Schramm & Son, 308-312 N. Fourth St., Philadelphia, Pa.

"Catalog No. 10." Describes and illustrates the use and adaptability of the Schramm portable air compresor on various kinds of work; such as stone cutting, concrete handling, excavation work, and blasting, trench tamping, steel fabrication and erection, etc.

Explosives.—Paper, 6x9 ins.; 32 pp. E. I. du Pont de Nemours & Co., Wilmington, Del.

"Explosives for Quarry Blasting." Gives practical information on the selection of explosives and on the methods of application to assure the most satisfactory results. This publication will be found of great value to those engaged in quarry blasting or similar work.

High Explosives.—Paper, 6x9 ins.; first section, 128 pp.; second section, 24 pp., E. I. du Pont de Nemours & Co., Wilmington, Del.

This comprehensive handbook on high explosives is in two parts: the first section treating of the manufacture, handling, storage and use of high explosives; and the second section of the kinds, grades and brands made by this company. The detailed information given in the first section will be found of great value to users of high explosives and to those desiring to acquire knowledge on the manufacture and use of such explosives. The second section gives the important properties of each kind of high explosive and the class of work to which each is particularly adapted. Copies of either or both publications will be sent on request.

INDUSTRIAL NOTES

H. C. Beckwith, Chicago manager of the T. L. Smith Co., of Milwaukee, will locate Jan. 1, 1916, at Ravenna, O., as treasurer and general manager of the Byers Machine Co., manufacturers of hoisting and excavating machinery.

The Walter A. Zelnicker Supply Co., of St. Louis, Mo., dealers in new and relaying rails, locomotives, iron and steel products, etc., has opened a Chicago office at Room 423, First National Bank Bldg. The office will be in charge of Ed Elson.

Mr. Walter H. Kestin has been appointed sales manager for the concrete machinery department of the Northwestern Steel & Iron Works, Eau Claire, Wis. This addition has been made necessary by the marked increase in the demand for Northwestern mixers and the return of activity in the building lines. Mr. Thomas W. Rosholt, vice-president of the company, who has heretofore devoted a portion of his time to this work, will in the future devote more of his time to work among the trade. Mr. E. R. Hamilton, secretary and general manager, states that they have had a substantial increase in the business during the past twelve months and that present indications seem to insure still greater gains for the coming year.

RAILWAYS

PROSPECTIVE WORK.

Arkansas:

Pine Bluff, Ark.—George B. Blanchard, Chicago, has obtained franchise to operate railroad over recently constructed free bridge over the Arkansas River near here. The contract provides road must be in operation from Pine Bluff over the bridge to some point on the Mississippi by 18 months.

Fort Smith, Ark.—Fort Smith, Subiaco & Eastern R. R. is reported to have revived project for construction and extension to Dardanelle. It is stated that the line will be built in early spring, if $60,000 bonus and free right-of-way are given.

Connecticut:

New Haven, Conn.—The New York, New Haven & Hartford R. R. is expending about $1,200,000 for the construction of side tracks. It also probably will take up the four-tracking of the Westbrook-Saybrook section of the shore line.

Idaho:

Caldwell, Ida.—Caldwell Traction Co. will start work next year on electrifying the Wilder branch of the Oregon Short Line. The branch is eleven miles long.

Illinois:

East St. Louis, Ill.—Alton & Southern Ry., now operating eleven miles of belt line, has secured right-of-way for about four miles of additional line.

Peoria, Ill.—St. Louis, Springfield & Peoria line of the Illinois Traction System has been granted permission to issue $1,000,000 of bonds, the proceeds to be used in improvements.

Bloomington, Ill.—State Public Utilities Commission has granted permission to the Bloomington, Decatur & Champaign Ry. Co. to issue $500,000 in bonds; proceeds will be used in improvements, it is stated.

Indiana:

Vincennes, Ind.—Vandalia R. R. will expend about $150,000 for coal yard and terminal facilities at Bicknell.

Maryland:

Baltimore, Md.—Curtis Bay R. R. Co. has applied to Public Service Commission for permission to exercise a franchise for constructing line from Sledd's Point on Curtis Bay to Hawkins Point, connecting the two manufacturing plants of the Davison Chemical Co. Railway has a capital stock of $10,000. Incorporators include C. Wilbur Miller and John Lentz.

Michigan:

Jackson, Mich.—The Michigan Railway Co., Michigan United Traction Co. and the Grand Rapids, Holland & Chicago R. R. Co., have been united and will be operated as the Michigan Ry. Co., with headquarters in Jackson. John F. Collins is general manager.

Missouri:

Kansas City, Mo.—State Public Service Commission has authorized the Kansas City Connecting Ry. Co. to issue $1,000,000 in stock and $1,000,000 in bonds. Company proposes to connect the railroads with the stock yards.

Nebraska:

Lincoln, Nebr.—Omaha, Lincoln & Beatrice Interurban R. R. is reported to be planning to start work soon on the completion of its line to Omaha

New Jersey:

Hoboken, N. J.—Delaware, Lackawanna & Western R. R. Co. has purchased 16 acres of land in Hudson St., which will be used to relieve the congestion in downtown yards.

New York:

New York, N. Y.—Engineering plans for subway under East River at 60th St. have been completed and Public Service Commission will let contract before March.

North Carolina:

Henderson, N. C.—The Seaboard Air Line Ry. is reported contemplating building line from Henderson to Goldsboro with ultimate terminal at Wilmington or Southport. The line from Henderson to Goldsboro will be about 75 miles in length.

North Dakota:

Beach, N. D.—It is reported here that the Northern Pacific R. R. will soon begin work on extending its Beach-Ollie line to Ekalaka and the Camp Crook district.

Ohio:

Lima, O.—Cincinnati, Hamilton & Dayton R. R. will shortly start work double-tracking between Erie Junction and Cridersville, five miles.

Youngstown, O.—Youngstown & Niles R. R. Co., incorporated recently with a capital stock of $10,000, is reported to be planning to start construction this spring on its new line along the south side of Mahoning river. The company is reported to be a subsidiary of the Mahoning & Shenango Railway & Light Co., of which R. P. Stevens is president.

Cleveland, O.—Cleveland Underground Rapid Transit Co. has filed plans and specifications with the Director of Public Service, and it is stated will start construction next month on its subway. Thomas Schmidt is secretary of the company.

Portsmouth, O.—Scioto Valley Traction Co. is reported to be planning to start work next spring on a new line to connect Ironton with Columbus.

Zanesville, O.—South Eastern Ohio Ry. Light & Power Co., operating 13-mile traction line between Zanesville and Crooksville, has been incorporated under the name of the South Eastern Ohio Ry. Co. and will extend its line from Crooksville to New Lexington, 10 miles. E. R. Meyer of Zanesville is an incorporator.

Oregon.

Mount Angel, Ore.—Willamette Valley Southern Electric Ry. Co. is reported to be contemplating extending its line from Mount Angel to Salem and Stayton by way of Silverton, Maclean, Shaw and Aumsville.

Pennsylvania:

Wellsburg, Pa.—The Pennsylvania R. R. is reported to be planning to build a 30-mile railroad line through Brooke County.

Stroudsburg, Pa.—Slate Belt Traction Co. of Pen Argyl, Pa., is reported to be planning the purchase of Stroudsburg Line and its extension to a connection at Wind Gap.

Mayfield, Pa.—The Delaware & Hudson R. R. contemplates changing its present line just north of this borough.

Tennessee:

Collinwood, Tenn.—Tennessee Valley Iron & R. R. Co. proposes to extend its line from Collinwood to Savannah, Tenn., and to Wayne Furnace. Company has about 15 miles of line in operation.

Utah:

Salt Lake City, Utah.—Salt Lake & Ogden R. R. will build second main track between Centerville and Wilcox, a distance of 3 miles.

Virginia:

Newport News, Va.—The Chesapeake & Ohio R. R. is understood to be planning extensive improvements to its property at this place.

West Virginia:

Hewlett, W. Va.—Baltimore & Ohio Ry. has location work under way for an extension up the eastern side of Big Sandy River from Hewlett to Shelby Junction. Maps of the proposed line have been filed in County Clerk's office and a considerable portion of the right-of-way already has been purchased.

Wisconsin:

Milwaukee, Wis.—Milwaukee-Western Electric Ry. Co. will obtain right-of-way this winter for its proposed electric line as far as North Lake.

BIDS OPENED; CONTRACTS LET

California:

San Francisco, Cal.—Contra Costa Construction Co. has been awarded contract at about $120,000 for extension of Church St. municipal street car line.

Maryland:

Hagerstown, Md.—H. Kerbaugh & Co., New York City, have been awarded by the Baltimore & Ohio R. R. contract for new four-mile branch from this city to Security, Md.

Virginia:

Westpoint, Va.—Winston & Co., Richmond, Va., are reported to have been awarded conditional contract for construction of Richmond, Rappahannock & Northern R. R., proposing new line from Westpoint northeast to Urbanna, 17 miles. Estimated cost of construction and equipment is reported to be $300,000.

Washington:

Port Angeles, Wash.—Erickson Construction Co., Seattle, is reported to have been awarded contract for terminals here for Seattle, Port Angeles & Western R. R.

ROADS STREETS

BIDS ASKED.

California:

Santa Barbara, Cal.—Until Jan. 3, by County Supervisors, C. A. Hunt, Clerk, for paving portion of Maria Guadalupe Road.

San Gabriel, Cal.—Until Jan. 4, by City Clerk, for about 100,000 sq. ft. of macadam.

Bakersfield, Cal.—Until Jan. 6, by County Supervisors, for seven miles of road construction.

Indiana:

Fort Wayne, Ind.—Until Jan. 17, by Park Commissioners, for 27,200 sq. yds. of asphalt macadam, 17,720 cu. yds. of excavation and 8,175 ft. of concrete curb and gutter.

Maryland:

Sharpsburg, Md.—Until 11 a. m., Jan. 20, by Depot Quartermaster, Washington, D. C., for construction of a walk.

Michigan:

Kalamazoo, Mich.—Until 10 a. m., Jan. 8, by County Road Commissioners, for about 3,000 ft. of road resurfacing work.

Minnesota:

St. Paul, Minn.—Until 10:30 a. m., Jan. 10, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Oxford St.

St. Paul, Minn.—Until 10:30 a. m., Jan. 10, by Aug. Hohenstein, City Purchasing Agent, for furnishing 21 cars of low-grade, non-asphaltic road oil, also 60,000 gals. of high-grade asphaltic road oil.

St. Paul, Minn.—Until 10:30 a. m., Jan. 3, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Osceola Ave

Missouri:

Seymour, Mo.—Until Jan. 5, according to reports, by Seymour Special Road District, for road work to cost about $30,000.

New Jersey:

Mays Landing, N. J.—Until Jan. 1, by County Freeholders, for improvement of Meadow Boulevard for a distance of 4 miles and a width of 60-ft. A. H. Nelson, County Engineer, Atlantic City, N. J.

New York:

New York, N. Y.—Until 2 p. m., Jan. 3, by S. M. Marks, president Borough of Manhattan, for furnishing 500 tons of Portland cement, 3,000 tons of limestone dust, 7,000 cu. yds. of binder stone, 15,000 cu. yds. of asphalt wearing surface sand and 2,000 tons of refined asphalt. Material is to be delivered to the Municipal Asphalt Plant.

Oregon:

Astoria, Ore.—Until Dec. 31 by County Commissioners for clearing, grading and draining 4½ miles of road.

Tennessee:

Memphis, Tenn.—Until Jan. 6, by County Commissioners, Thos. B. King, Chairman, for furnishing road gravel for county, during the year 1916.

Washington:

Seattle, Wash.—Until Jan. 16 by County Commissioners for construction of permanent highway No. 12, Newport road.

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